Reducing Lower Extremity Injury Risk in the NFL (football athlete)

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Dr. Courtney Conley

- Owner/CEO Gaithappens
- Owner/CEO of Total Health Solutions/Total Health Performance
- National/International Lecturer on foot pain and gait assessment
- Works with professional athletes/orgs to improve foot health and performance
- Patented product designer
- Author





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Objectives

- ✓ Review lower extremity anatomy and function
- ✓ Develop a deeper understanding of the most common LE injuries in NFL/ athletes
- ✓ Recommend strategies for assessment and intervention for the football athlete

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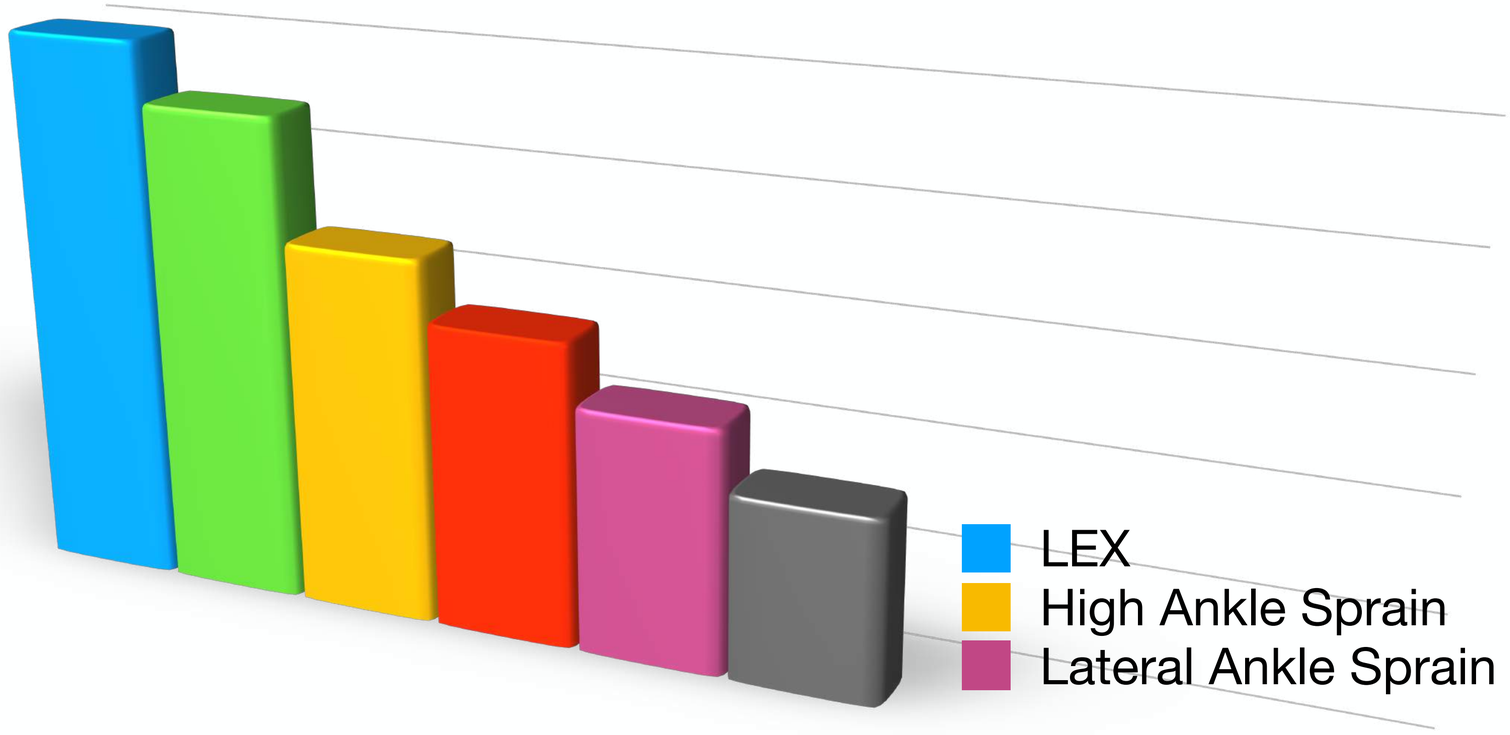
Current State of Affairs

Average Days Missed Injury Burden per NFL Season



Lower extremity injuries are rampant *in the NFL. Many resources have been allocated to understanding them and working to prevent them*

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Ex. High Incidence of AT injuries

An Apparent Achilles Heel of the NFL: Have Achilles Tendon Injuries Significantly Increased to Unacceptably High Incidence Levels in the NFL and if so, why? A Clinical Insight

Timothy E Hewett [1] [2], Chad D Lavender [3], Andrew L Schaver [3]

Age, activity level, height, body mass and BMI are all increasing in the NFL

- *"Bigger, stronger, faster"*

Absence of sufficient preparatory training

Surface x shoe interface, rigid ankle taping, bracing

Use of anabolic and corticosteroids

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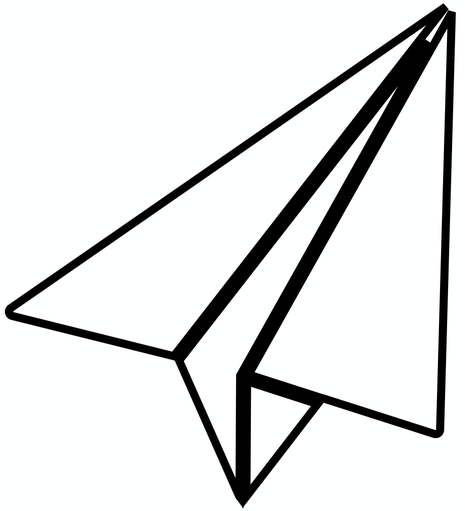
Bigger, Stronger, Faster Factor

Greater forces to dissipate

Shoes are getting lighter while experiencing **higher levels of traction and friction**

- Evolutions in playing surface technology
- Forces acting on the foot and ankle are simply too high to survive/thrive



“You can’t build a jet engine on a paper airplane.”

-Jay Dicharry

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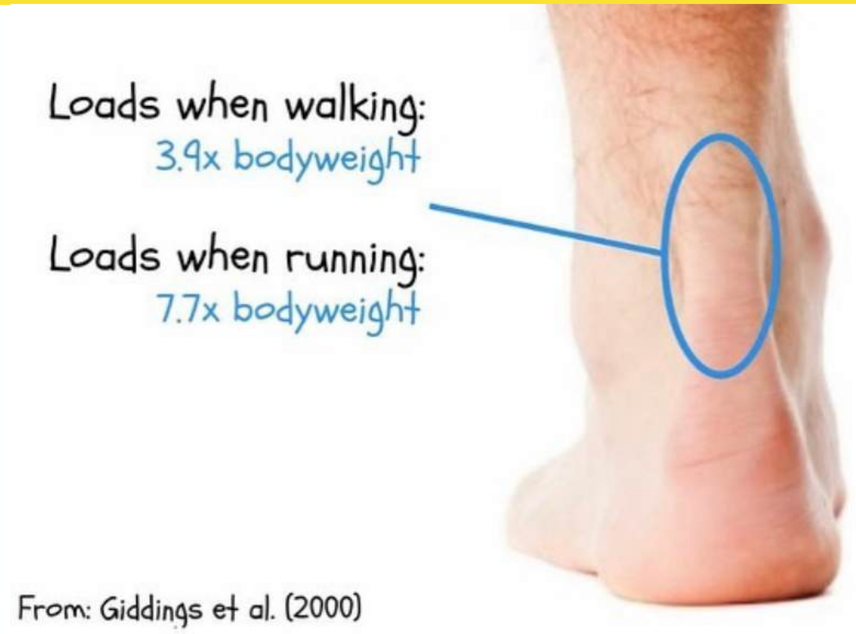
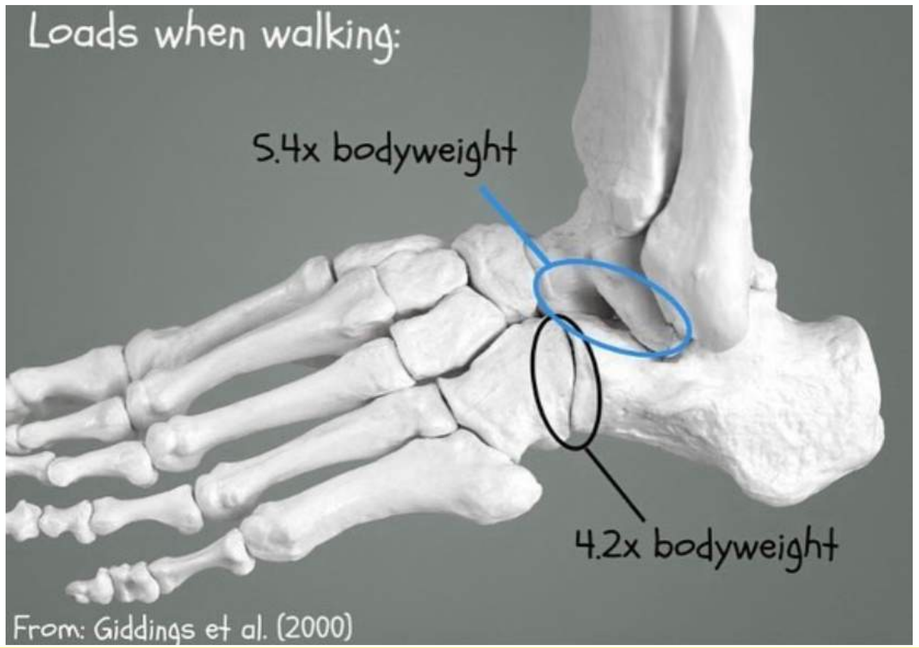
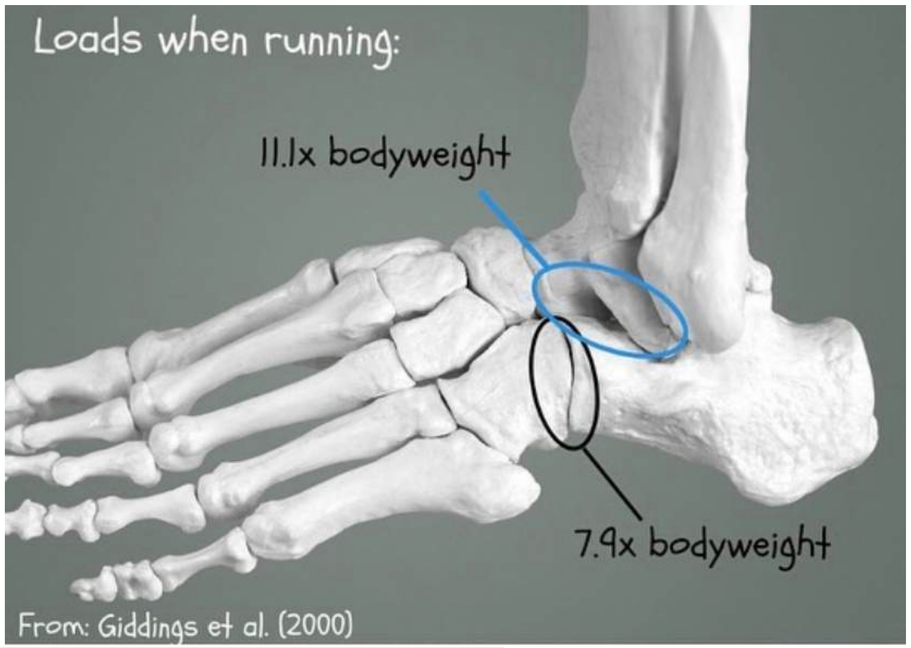


From: Giddings et al. (2000)





Surface x Shoe Interface

Orthop J Sports Med. 2024 Aug 29;12(8):23259671241265378. doi: 10.1177/23259671241265378

Lower Extremity Injury Rates on Artificial Turf Versus Natural Grass Surfaces in the National Football League During the 2021 and 2022 Seasons

Nikit Venishetty [*], Angel X Xiao [†], Ramesh Ghanta [†], Rohit Reddy [‡], Nirav Kiritkumar Pandya [†], Brian T Feeley [†,§]

Conclusion: *The 2021 and 2022 NFL seasons of our analysis demonstrated a higher incidence rate of injuries on artificial turf surfaces compared with natural grass surfaces. In addition, the odds of injury requiring season-ending surgery were found to be significantly higher on artificial turf compared with natural grass.*

Is there good news?

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The ‘Good’ News

1. 29% decrease in time missed due to LE strains

2. 50% lower recurrence rate of LE injuries

3. Injury Rates on Turf and Grass Surfaces Were Equal

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How did this Happen?

- ✓ Injury prevention process in the offseason
- ✓ Individualized programs
- ✓ Data driven preseason acclimation strategies

The Last 5 Super Bowl Champions ranked #1 (x2) , #5, #6, and #16 in the lowest number of LEX strains during training camp.

This st matters.**

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Best Recipe for Success

Preparation

+

Acclimation

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Let’s explore the most common diagnoses and how we continue this success by paying attention to the **WHY**

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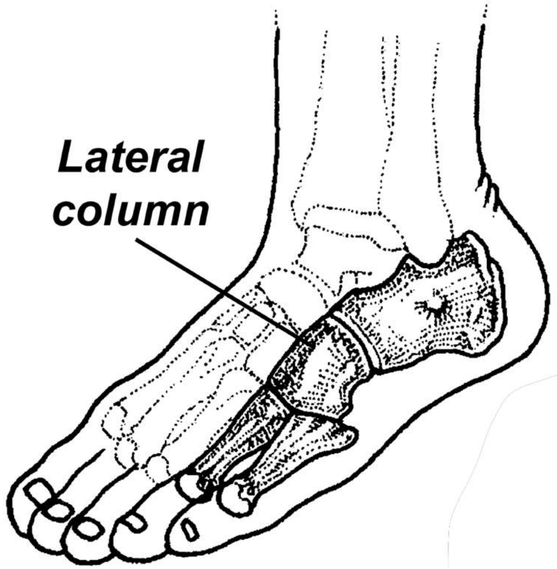
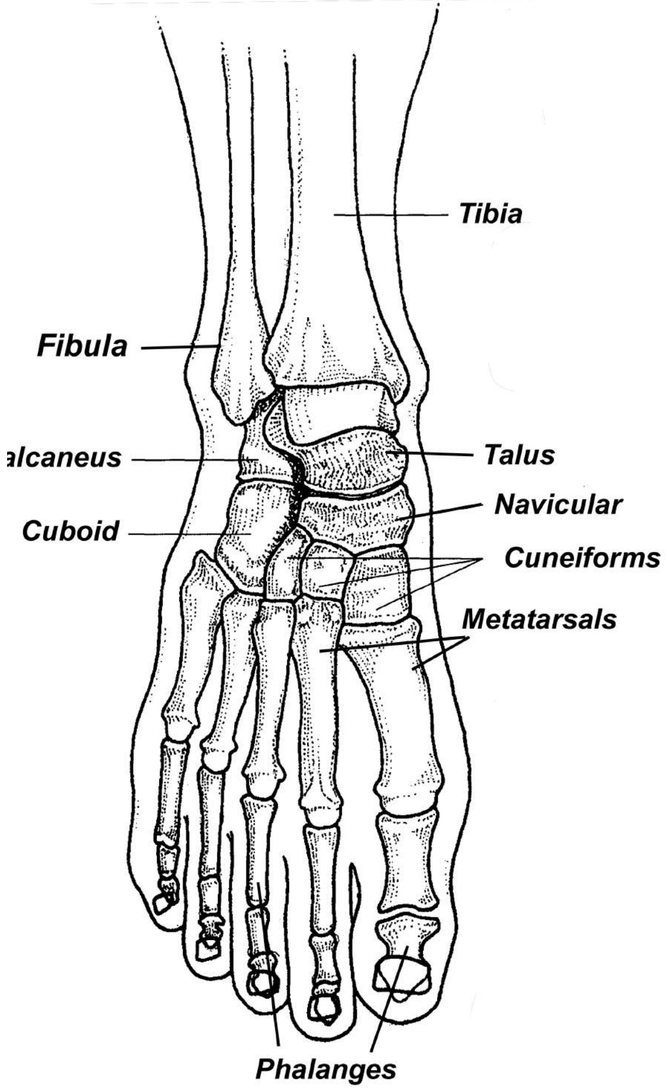
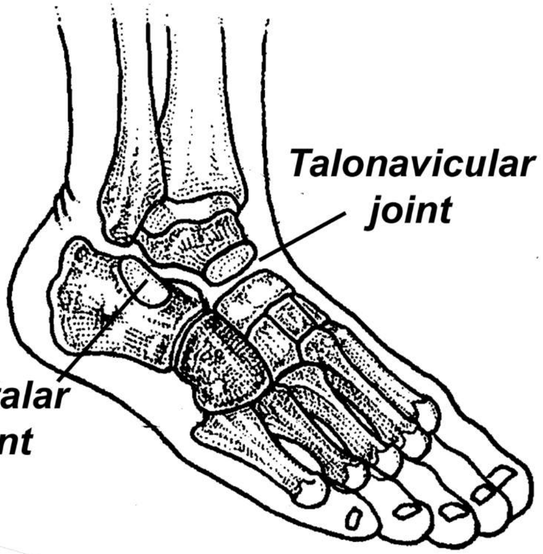
But first a quick review...because everyone loves anatomy!

Bones of the Foot







Functional Anatomy

3 Arches

- Lateral longitudinal arch
- Transverse arch
- Medial longitudinal arch

Sesamoids

- Sitting in the sagittal plane

Talus

- Only bone in the body with no muscular attachment

Calcaneus

- 2 tubercles on the bottom
- Incredible shock absorber

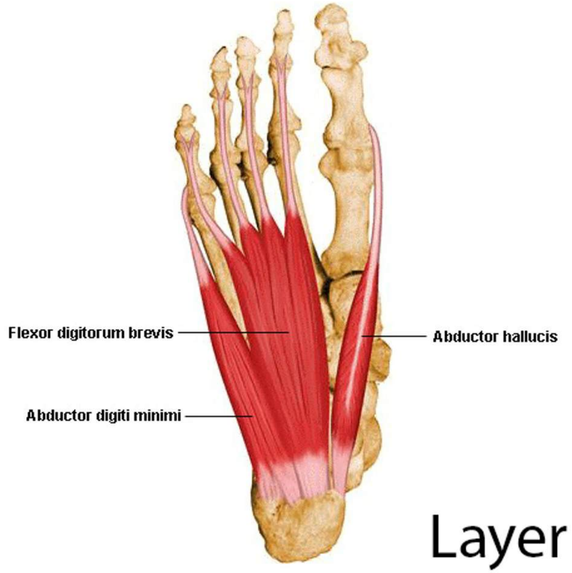
Cuboid

- Calcaneal cuboid joint: the “locking” mechanism

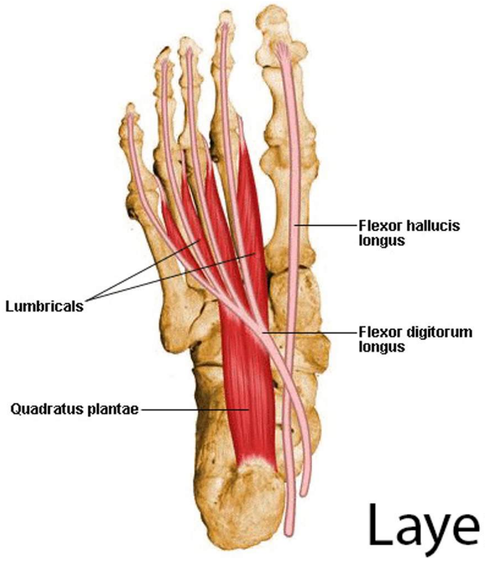
4th Metatarsal

- Rotated metatarsal base to create transverse arch

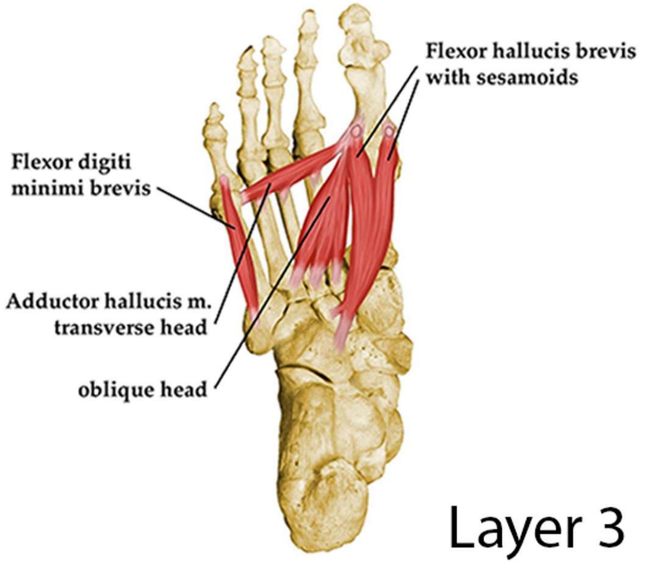
Intrinsic Muscles



Layer 1



Layer 2



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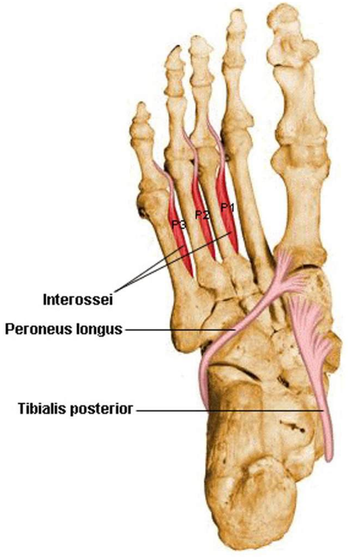
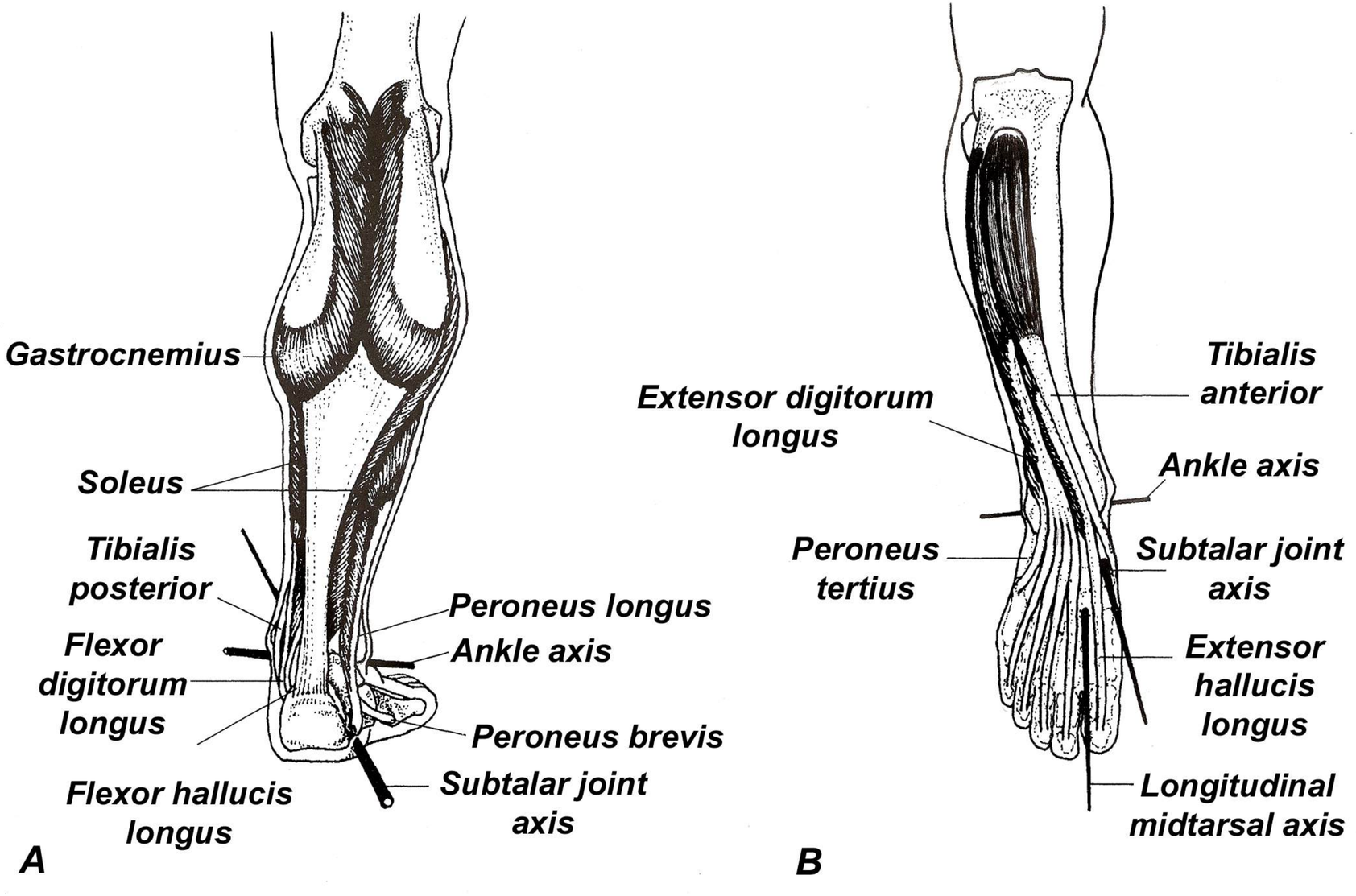


Layer 4

Extrinsic Muscles

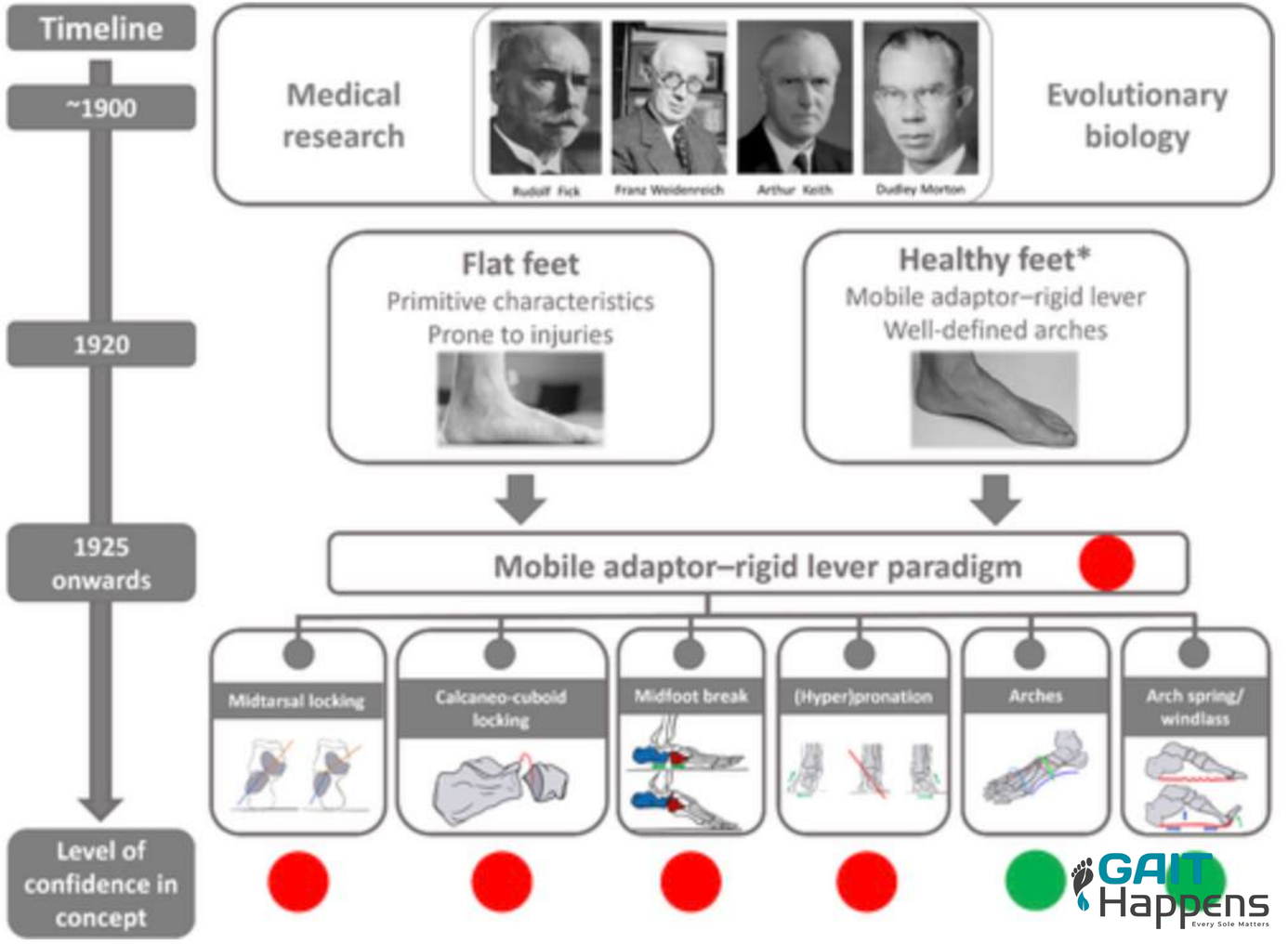


New Research

Chasing footprints in time – reframing our understanding of human foot function in the context of current evidence and emerging insights

Anja-Verena Behling [1] [2], Michael J Rainbow [2], Lauren Welte [3], Luke Kelly [1]

The foot is a highly versatile and adaptable system. Healthy feet does not mean that they cannot be flat.



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"Humans and their living relatives (e.g., chimpanzees) have often been compared in terms of how their feet are built. The most obvious difference is the high arch of the human foot versus the more flat foot of the chimpanzee. This difference in foot shape, combined with the fact that humans can walk long distances upright on two legs while chimpanzees can only do so for short distances, led many early scientists and doctors to believe that not only were humans superior to their flat-footed relatives, but also that a low arch was inherently undesirable in humans and the source of all evil."

- Anja Behling

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Implications of this Study

1. **They urge the scientific community to abandon the long-held mobile adapter - rigid lever paradigm**

   We find *evidence suggesting that the foot never transitions* from mobile and early stance to rigid or highly stiff in propulsion.

2. **There is no evidence to support the idea that the human foot is rigid or increases in stiffness during propulsion**

   They have provided a *new framework that presents the foot as a highly versatile and adaptable system*, with functions enabled by substantial joint mobility, rather than rigidity.

3. **The central nervous system delivers adaptive control, with the muscles of the foot, adding or removing energy from the system as required to meet whole body locomotory demands**

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Why Should You Care?

We can no longer assume that passive structures with in the foot are primarily responsible for the ‘rigid lever’.

No-one gets a free lunch.

Foot strength is now more than ever coming to light on improving function.

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The Best Athletes have the strongest feet and ankles.

Human foot muscle strength and its association with sprint acceleration, cutting and jumping performance, and kinetics in high-level athletes

Romain Tourillon [1] [2], Antoine Michel [1], François Fourchet [2] [3], Pascal Edouard [1] [4], Jean-Benoît Morin [1] [5]

Acceleration: The findings indicate that the athletes with the superior acceleration tend to exhibit **greater relative ankle plantar flexion and quadricep torque** enabling them to produce high amounts of force in both vertical and horizontal directions

Maximal Speed: ***The MTPj deserves consideration in Sprint training*** as evidenced by a previous study demonstrating improved 50 m Sprint Time Performance following an 8-week toe flexion strength protocol. (Hashimoto and Sakauraba, 2014)

Cutting: It was discovered that increased ***relative ankle plantar flexion torque, foot ankle reactive strength*** and a more supinated foot posture could collectively account for 35% of the variance in performance

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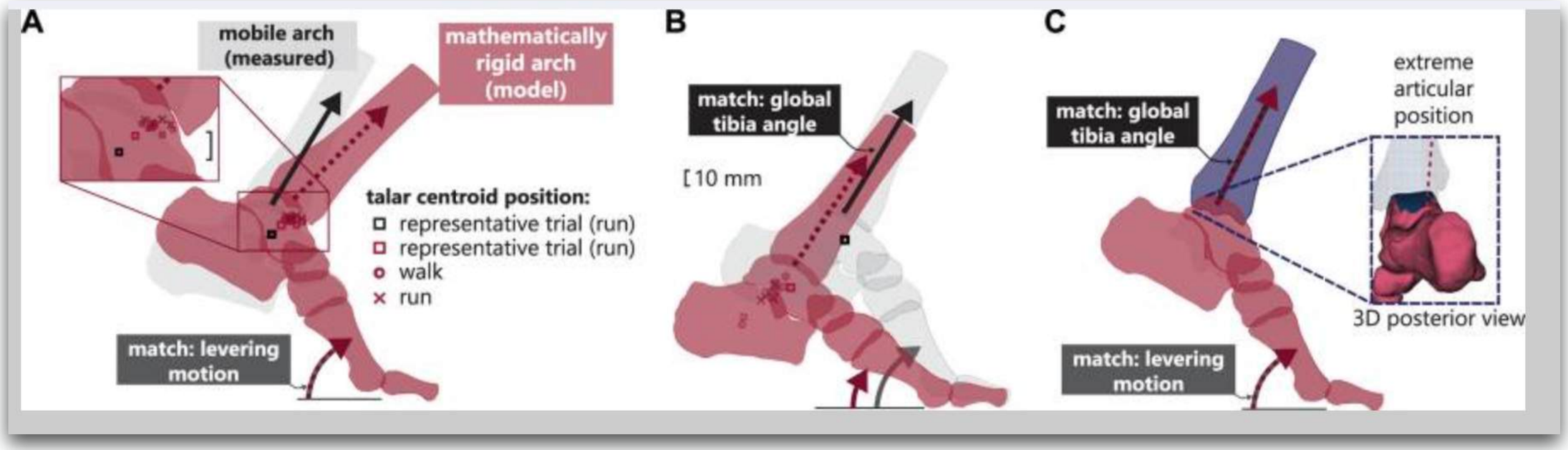
New Research



Medial column PF (arch recoil) enables the upright orientation of the talus at a higher global ankle position = More Efficient

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Implications of This Study

1. **Arch Recoil**
   When you have an arch that recoils it places your foot in an optimal position. It places the talus and tibia in an optimal position to produce energy more efficiently. Indirectly helps propel the center of mass rather than ‘lifting’ the body. Less of a spring, but puts the ankle in a more desirable position.

2. **Arch Plantarflexion Mobility**
   Implications for *footwear design*, understanding *pathology* and *surgical practice*

3. **Certain Footwear Modifications**
   Increasing the bending stiffness of the shoe’s sole, or wearing *arch restricting inserts, both reduce arch plantarflexion* and can respectively *modify the ankle’s muscular contractile conditions during locomotion.*

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Why Should You Care?

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Most Common LEX Injuries in the NFL

1. Achilles Tendinitis/Tendinopathy/Rupture
2. Heel Pain/Plantar Fasciitis/Fasciopathy
3. Ankle Sprain and Jones' Fractures
4. Turf Toe *(Hallux Limitus/Rigidus)*
5. ACL/MCL and Meniscus Tears

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Achilles Tendinitis/Tendinopathy/Rupture

Prevalence	Causative Factors	What We Can Control
2023: 22 ATR's in NFL 36% never RTP > 50% reduction in performance, as demonstrated by their power ratings	Decreased plantar flexion strength Abnormal gait pattern w/ decreased forward progression Lateral foot rollover at the forefoot flat phase	Plantar flexion strength *(ie: Soleus)* *Identifying Foot type:* Foot Intrinsic Strength Midfoot mobility Gait Assessment/Retraining

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Identifying What the Foot Needs

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“It’s hard to fix feet in the weight room.”

- *Unnamed NFL Trainer (LER article)*

Baseline Capacity

Flexor Hallucis Longus (impt in ankle sprain prevention)

- 10% body weight

Flexor Digitorum Brevis (impt in heel pain prevention)

- 7-8% body weight

Standing/Seated Single Leg Calf Raises (Impt in Achilles rupture prevention)

- .5x BW standing single leg
- 1.5x BW seated single leg

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Importance of Specificity of Training

Muscle contributions to tibiofemoral shear forces and valgus and rotational joint moments during single leg drop landing

Nirav Maniar[1] | Anthony G. Schache[2] | Claudio Pizzolato[3,4] | David A. Opar[1]

Soleus weakness precedes achilles tendinopathy

Soleus prevents anterior translation of the tibia relative to the femur, more so than biceps femoris *(ACL consideration)*

Soleus controls knee valgus by keeping the knee aligned while the hip prevents excessive femoral IR

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Turf Toe/Forefoot Injuries

Prevalence	Causative Factors	What We Can Control
45% of NFL players Sig loss of playing time Avg median RTP 28 days	Restrictions in big toe/ ankle mobility Instability of the first ray Instability of the forefoot during the push off phase of gait	First Ray stability: FHL, PL strength **specifically measure **assess foot type Ankle ROM/ m. Gastroc Toe weakness, Abductor Hallucis Footwear

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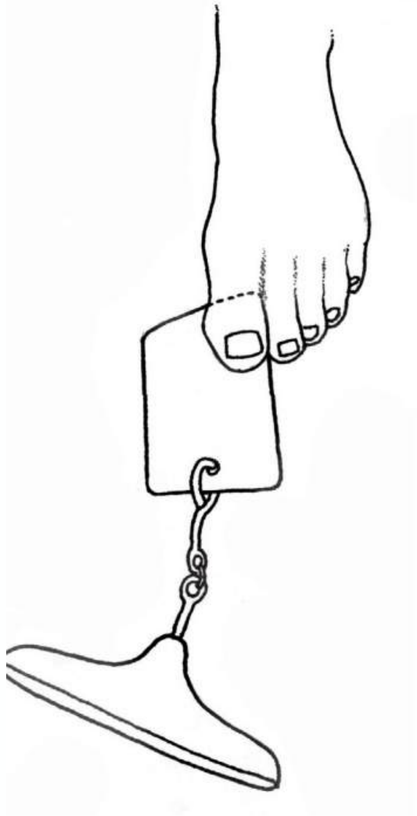
First Ray Stability: Talk to me Goose…

Assessing for Toe Strength



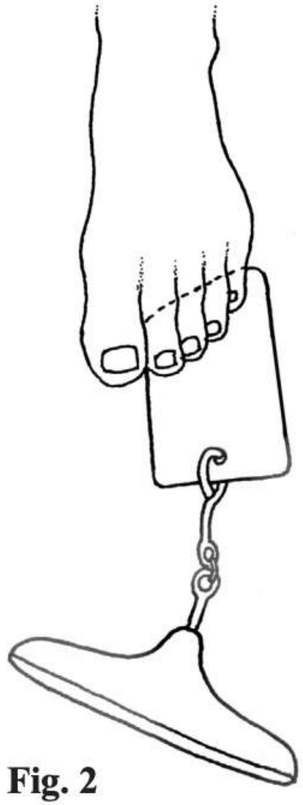


Fig. 2

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Strengthening the Intrinsic Muscles of the Foot

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Importance of Specificity of Training

Isolated gastrocnemius tightness

Christopher W DiGiovanni [1], Roderick Kuo, Nirmal Tejwani, Robert Price, Sigvard T Hansen Jr, Joseph Cziernecki, Bruce J Sangeorzan

Medial gastrocnemius will restrict ankle dorsiflexion the most

- Premature Heel Lift

5x more likely to have a forefoot injury

- Flat footed athletes are more dependent upon muscular restraining mechanisms

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Ankle Sprains (High + Low) / Jones Fractures

Prevalence	Causative Factors	What We Can Control
High rate of recurrence 3-4 months recovery for Jones Fracture Complications from JF: Nonunion, refracture 12% of athletes need repeat of surgical procedure	Previous sprain Torn ATFL/ talar instability Proprioceptive loss Jones Fx's occur almost exclusively in receivers/ defensive backs	Identify medial drift; Varus posts / **Tib post Improving lateral cutaneous stimulation; 256 hz sinus tarsi PL and PB specificity **Speed increase**

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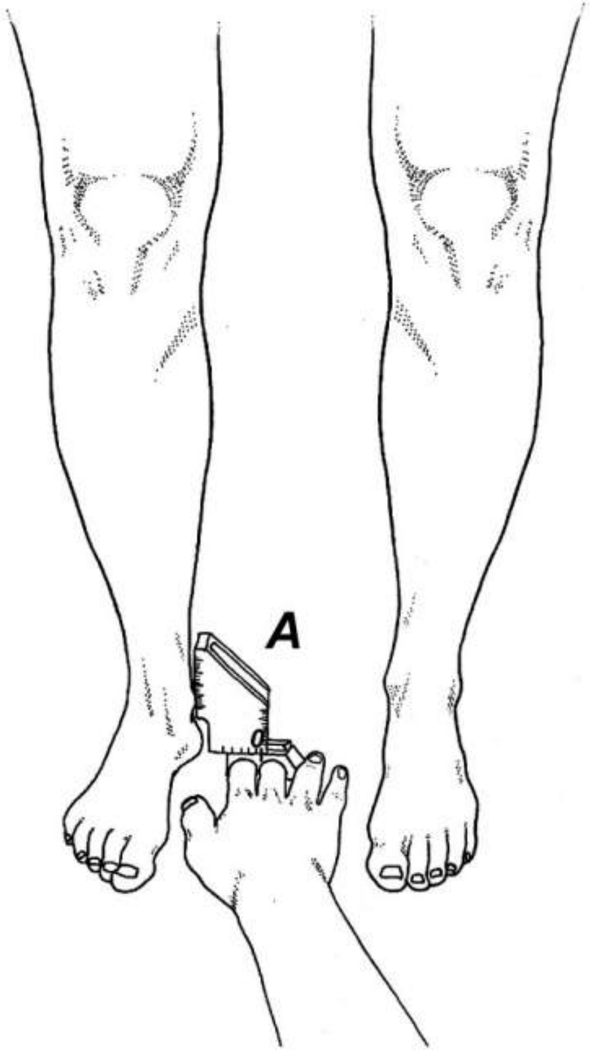
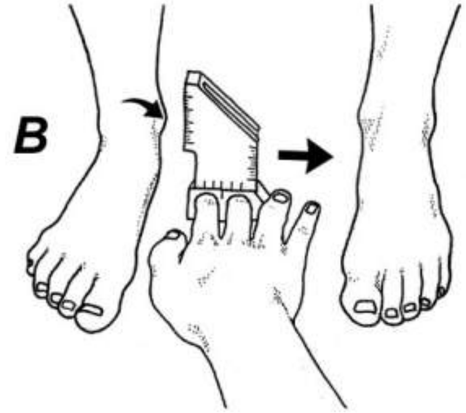
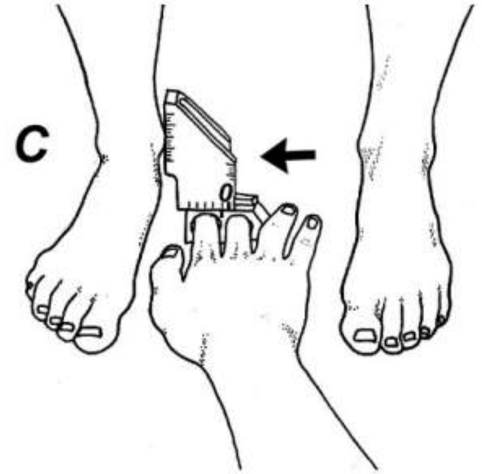
Medial Drift and Forefoot Varus Posts







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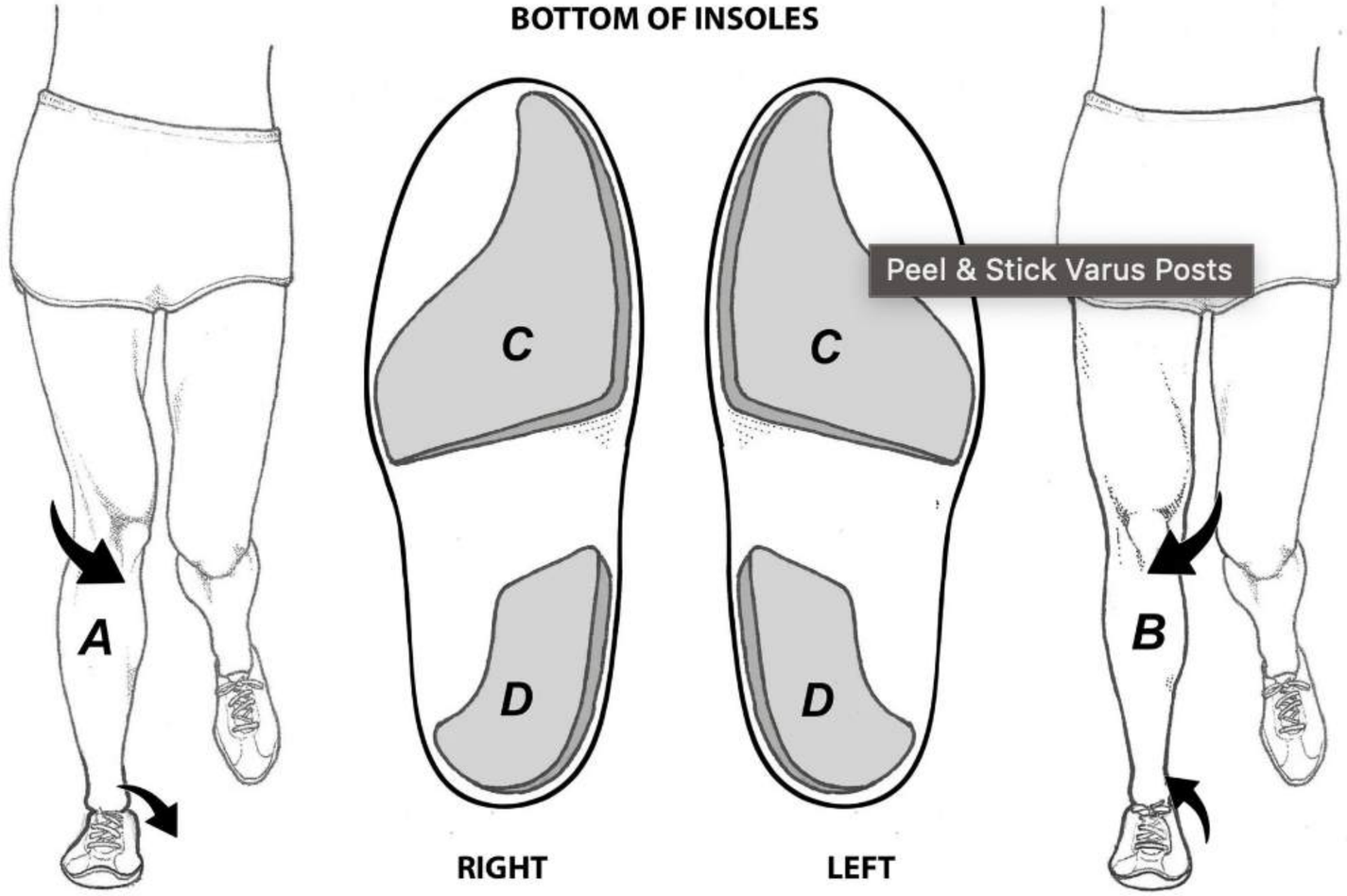
Medial Drift and Forefoot Varus Posts



Varus Posting

Immediate Effects of Medially Posted Insoles on Lower Limb Joint Contact Forces in Adult Acquired Flatfoot: A Pilot Study

Yinghu Peng [1], Duo Wai-Chi Wong [1 2], Yan Wang [1 2], Tony Lin-Wei Chen [1], Qitao Tan [1], Zhenxian Chen [3], Zhongmin Jin [4], Ming Zhang [1 2]

"The reduction in the patellofemoral joint force and ankle contact force could potentially inhibit flatfoot-induced lower limb joint problems, despite a greater knee adduction moment."

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Importance of Specificity of Training

Selective activation of tibialis posterior: evaluation by magnetic resonance imaging

Kornelia Kulig [1], Judith M Burnfield, Susan M Requejo, Michelle Sperry, Michael Terk

Tibialis Posterior (TP) shows continued EMG activity the entire time the foot is on the ground in stance phase.

TP was activated selectively and most effectively during foot adduction

Specific isometric training PER set to improve tendon resiliency

Syndesmotic injuries and forefoot abduction

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Let’s Talk About It

Original Research

Concussion is not associated with elevated rates of lower-extremity musculoskeletal injuries in National Football League Players

Thomas A. Buckley, Steven Browne, Katherine J. Hunzinger, Thomas W. Kaminski & Charles Buz Swanik

Pages 325-330 | Received 02 Apr 2022, Accepted 17 May 2022, Published online: 27 May 2022

> Foot Ankle Orthop. 2023 Dec 4;8(4):24730114231213372. doi: 10.1177/24730114231213372. eCollection 2023 Oct.

Multiple Ankle Injuries Are Associated With an Increased Risk of Subsequent Concussion in National Football League Players

Victoria E Bergstein [1], Henry T Shu [1], Blake M Bodendorfer [2], Steven DeFroda [3], Amiethab A Aiyer [1]

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Feed Forward Training: Gait Termination Task

FORCEFUL step forward; stop and then balance

FORCEFUL step forward with different head positions; head moves first, 8 positions, 5-10 reps each

FORCEFUL step forward, turn head at the same time

FORCEFUL step forward, using arms, spinal motions, bending, turning

Heel Pain / Plantar Fasciitis + Fasciopathy

Prevalence	Causative Factors	What We Can Control
DDX PTTD, Baxter's neuropathy, Periostitis, Stress fx 80% of PF patients had symptoms 12 months after initial injury	Flexor Digitorum Brevis Peroneus longus weakness Turf toe, HL/HR OFFloading the PF w excessive orthotic usage Overutilization of steroid injections	Determine the exact etiology Toe strength (FDB) Eversion strength Progressive loading of the PF

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Importance of Specificity of Training

Musculoskeletal and activity-related factors associated with plantar heel pain

Justin Sullivan [1], Joshua Burns [2], Roger Adams [3], Evangelos Pappas [3], Jack Crosbie [4]

Peroneal weakness was the strongest predictor of the development of plantar fasciitis

Flexor digitorum brevis creates a compressive force that keeps the PF from excessively stretching

Strong FDB absorbs tensile strain

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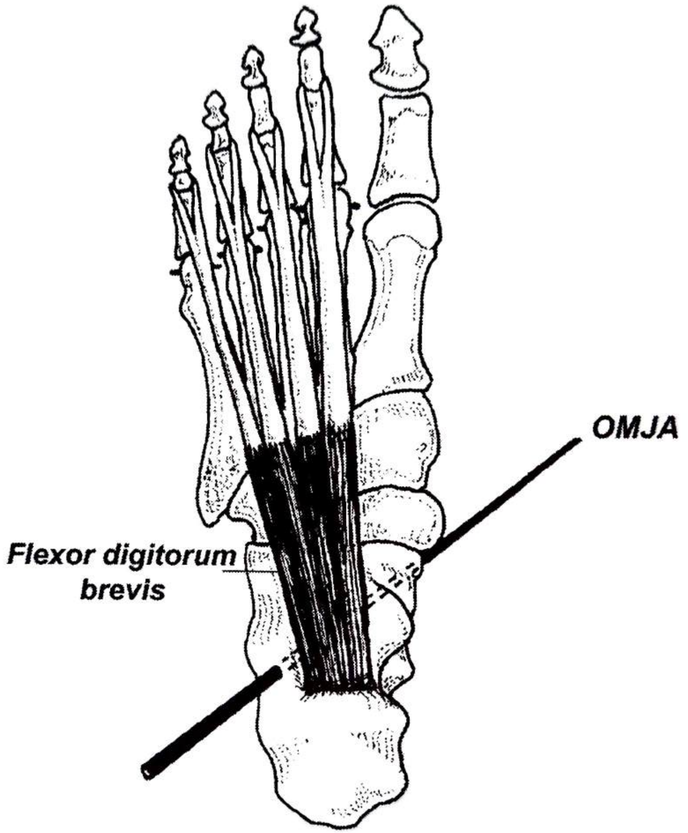
Flexor Digitorum Brevis

- Supports the plantar fascia by unloading the PF during propulsion
- Most active at heel lift/toe off
- Bone spurs occur at the insertion point



J Appl Physiol (1985). 2019 Jan 1;126(1):231-238. doi: 10.1152/japplphysiol.00736.2018. Epub 2018 Nov 21.

Intrinsic foot muscles contribute to elastic energy storage and return in the human foot

Luke A Kelly [1], Dominic J Farris [1 2], Andrew G Cr

Proc Natl Acad Sci U S A. 2019 Jan 29;116(5):1645-1650. doi: 10.1073/pnas.1812820116. Epub 2019 Jan 17.

The functional importance of human foot muscles for bipedal locomotion

Dominic James Farris [1 2], Luke A Kelly [2], Andrew G Cresswell [2], Glen A Lichtw

J R Soc Interface. 2020 Jul;17(168):20200208. doi: 10.1098/rsif.2020.0208. Epub 2020 Jul 15.

Foot stiffening during the push-off phase of human walking is linked to active muscle contraction, and not the windlass mechanism

Dominic James Farris [1], Jonathon Birch [1 2], Luke Kelly [2]

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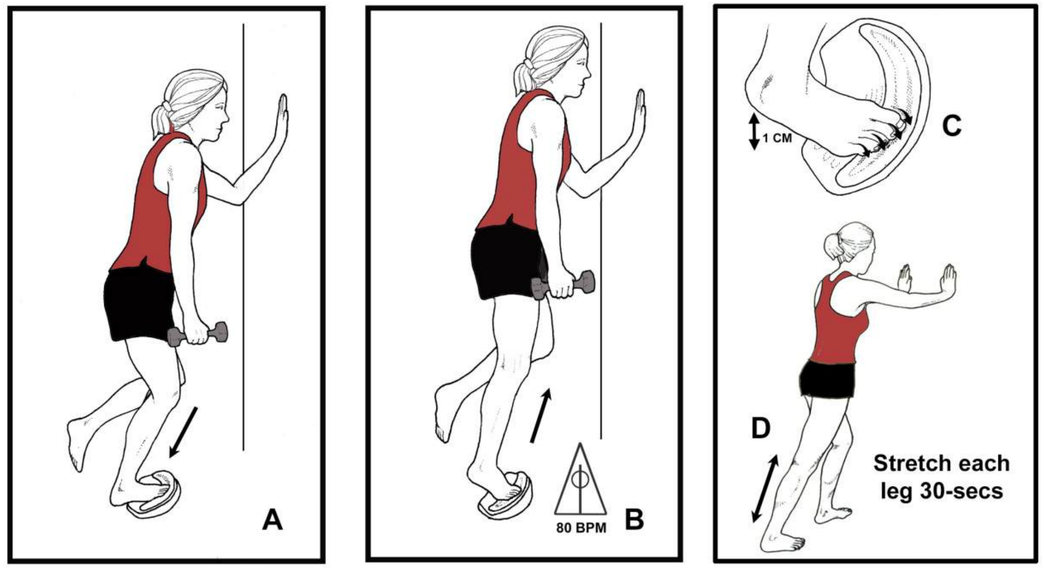
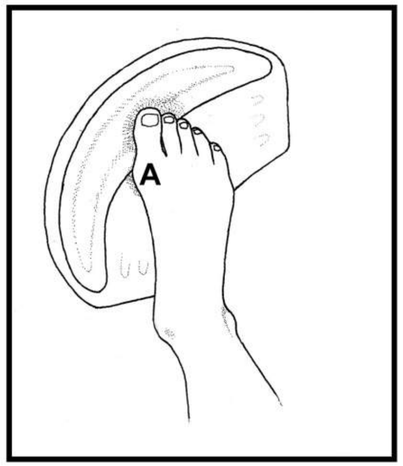
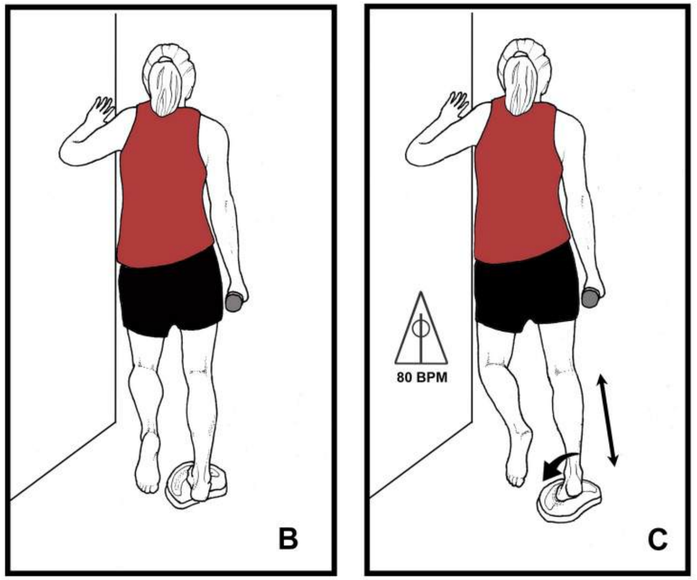
Metronome + Isometrics (photo cred. humanlocomotion.com)





Peroneus Longus
and Brevis



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Load Progression

Barefoot Running on Grass as a Potential Treatment for Plantar Fasciitis: A Prospective Case Series

MacGabhann S, Kearney D, Perrem N et al. See more

International Journal of Environmental Research and Public Health, (2022), 15466, 19(23)

"Mounting evidence supports the thesis that **plantar fasciitis maybe a mismatch disease associated with modernity** (modern footwear-surface use).....Changes in running biomechanics and foot morphology have been associated with barefoot running.

Barefoot running on grass appears to be well tolerated by runners with symptomatic plantar fasciitis. Within this case series pain associated with plantar fasciitis appeared to become lower while running load increased in a group of recreational runners completing a barefoot running intervention."

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Make it Meaningful

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GH Recommendations for Treatment

✓ **Identify Foot Architecture**
- Bunions, hammertoes, accessory navicular, midfoot exostosis, arch height

✓ **Baseline Capacity Assessments**
- 6-8 assessments specifically for foot/ankle

✓ **Footwear** *(To be used as 'training')*

✓ **Extrinsic Modifications**
- Posts vs Orthotics
- Toe spacers

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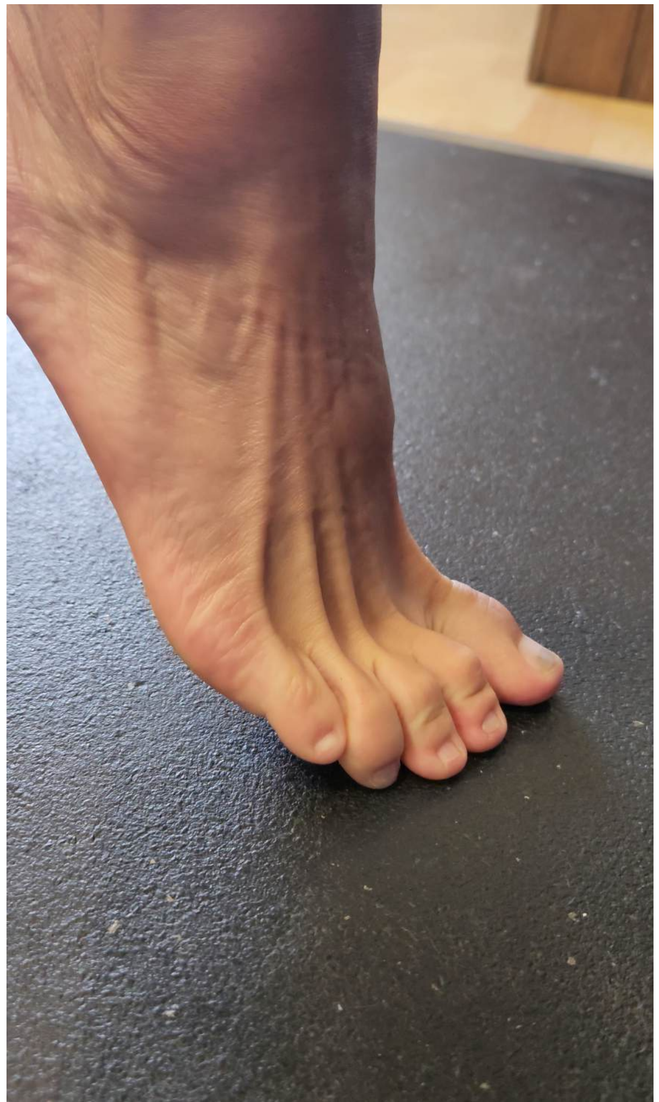
Good Clinicians = Best Detectives

- Identify foot architecture



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Baseline Capacity Assements

1. Toe Strength
2. Plantar flexion strength
3. Eversion/Inversion strength
4. Ankle DF
5. Plyometric (ALL Functional planes)

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Footwear: Easy WIN. (Tolos Barefootwear)

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What Makes a Shoe Functional?

Wide toe box, not a wide shoe

Flexible, thin sole

Heel and Toe are in the same plane - “Zero Drop”

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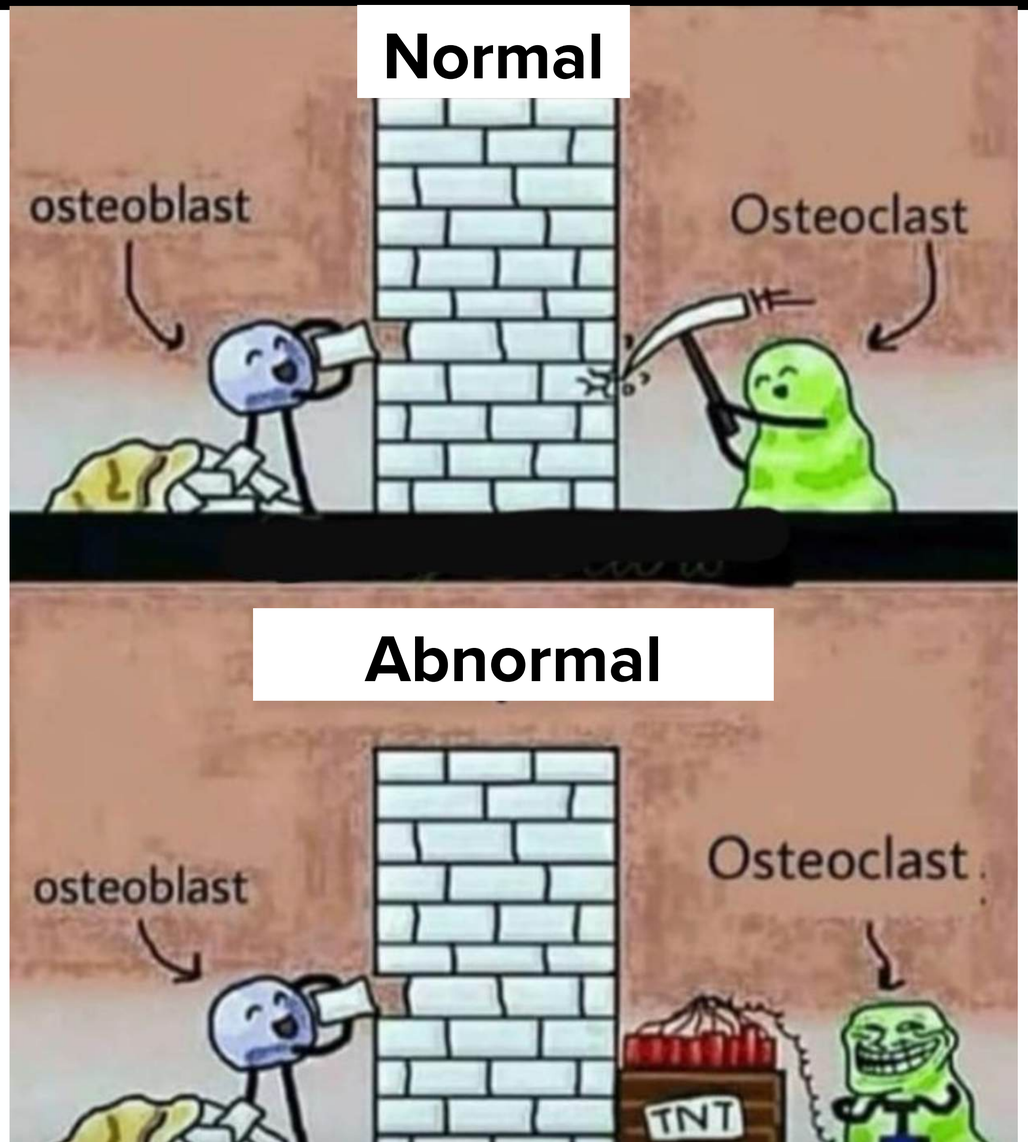
Functional Footwear and Bones



Bone Turnover
vs
Bone Injury

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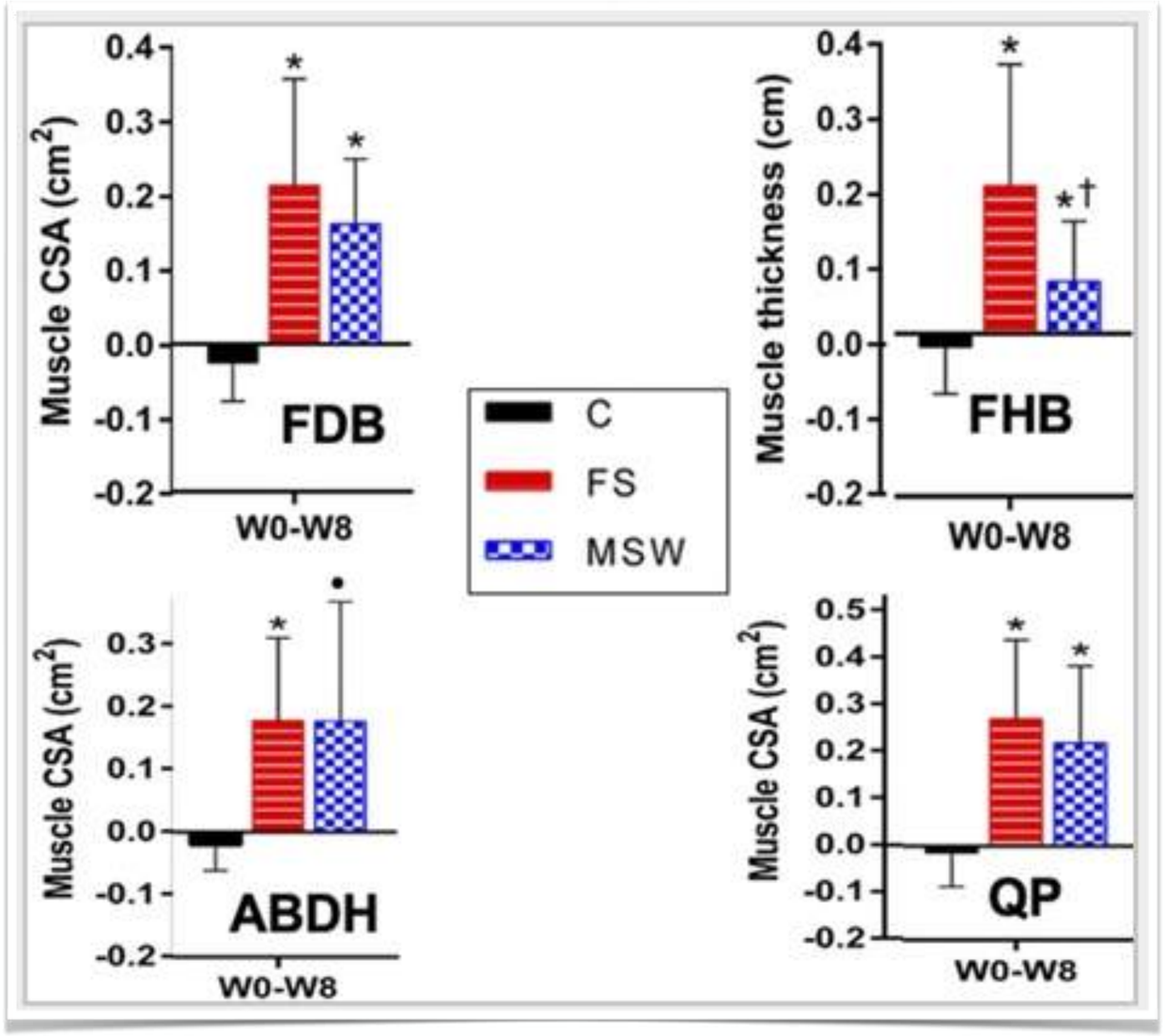
Functional Footwear and Muscles



Walking in Minimalist Shoes Is Effective for Strengthening Foot Muscles

Sarah T Ridge [1], Mark T Olsen [1], Dustin A Bruening [1], Kevin Jurgensmeier [1], David Griffin [1], Irene S Davis [2], A Wayne Johnson [1]

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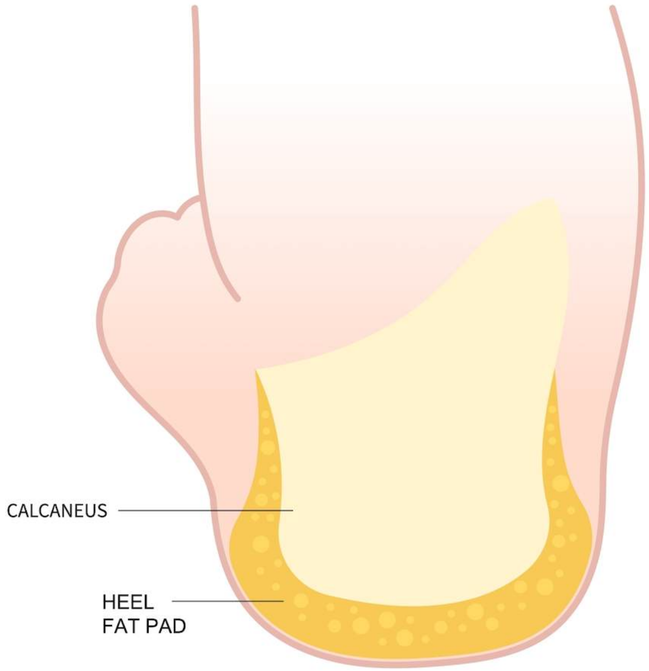
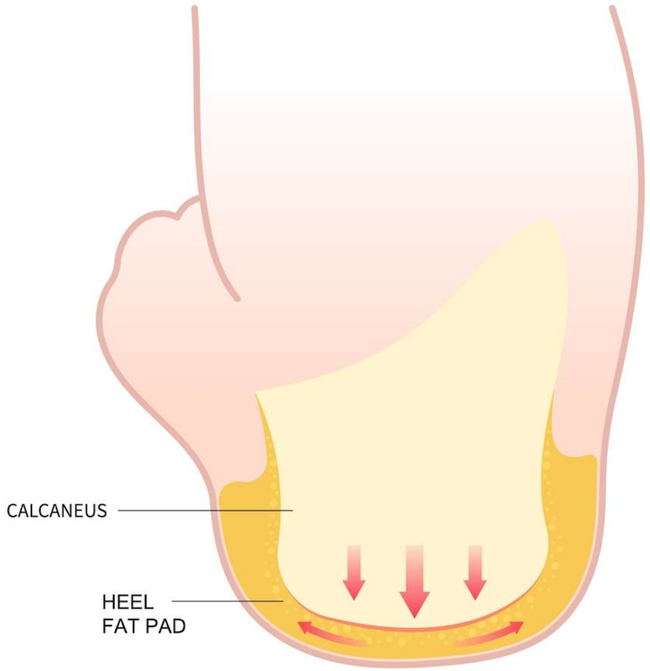
Functional Footwear and Tendons/Plantar Fascia

Functional Footwear and Fibroadipose Tissue



NORMAL
CALCANEAL FAT PAD



THINNING AND DEGENERATION
OF THE FAT PAD

1. Shock reduction
2. Energy dissipation
3. Protection against excessive plantar pressure; proprioceptive role

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Have a Shoe Spectrum

TOPO ATHLETIC PHANTOM
5 mm heel to toe drop
33 mm stack height

ALTRA ESCALANTE
0 drop
24 mm stack height

XERO HFS
0 drop
5-8.5 mm stack height

WIDE TOE BOX

HEEL TO TOE DROP

STACK HEIGHT

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How To Transition: Think OFF SEASON

1

Have a variety of footwear. Tool for the trade.

2

Slow and steady, stacking behaviors.

3

Begin in the gym.

4

Work on integration into daily wear.

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Recommendations for Team Intervention

Prevention Strength and Conditioning	Treatment Medical Staff
Foot and ankle screen **(Identify Risk profile)** **Development of a specific foot intervention plan** *(2-3 priority based on assessment)* **Gait Training** **Shoe Recommendations** *Specific based on goals**	**Assessment based on need** **Specificity of training per dx** **Posts, orthotics, ext mods as needed**

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Best Advice for NFL Teams:

HIRE A FOOT PERSON

OR

CONSULT A FOOT PERSON

OR

BE THE FOOT PERSON.

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Thank You!

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Please come see us at our booth, and see how strong those toes are!!

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