Assessment of the Foot in Relation to Gait Dysfunction and Injury
Day 2 - Advanced

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Day 2

1. Some of day 1 is repeated in day 2, this is as a recap to those who did day 1 yesterday, and also for those who did day 1 years ago!

2. May be spending up to an hour on recapping, allowing questions. This has been requested and always is popular!

3. Some topics in day 2 also appeared in day one in past years, these are moved to allow for a better day one and expansion into video gait analysis on day 2 (therefore a better day 2!)

4. Although I've done this quite a few times before, relying on technology is always "fun".

Overview (rather than a rigid plan)

- Straight into gait analysis (walking and running) as an advance area of our practice
- Use this to recap normal and abnormal in relation to gait dysfunction and injury
- Use examples from the group
- Use real time case presentations to highlight evidence based treatment plans
- Will focus on Foot Orthoses Prescription but also introduce other options in treatment planning

Introduction

Very briefly:

Who you are
What you do
Where you work

Happy where we are?

General Gait Analysis introduction

* Clinicians are often recommended to conduct gait analysis as part of a general or lower limb musculoskeletal (MSK) adult patient assessment (Baker, 2007; Coutts F, 1999; Curran and Dananberg, 2005; Norris, 1998; Payne & Bird, 2012; Richards and Levine, 2012; Rose, 1983; Southerland, 1995, Whittle, 1996).

* The analysis of gait may be conducted with or without the use of computerised recording analysis equipment with aims to aid in diagnosis, determine treatment goals and evaluate treatment outcomes (Brunnekreef, 2005; Coutts, 1999; Richards and Levine 2012; Rose 1983).

* But is this **"clinical"**?

Clinical Observational Gait Analysis

* **Clinical** gait analysis could be interpreted to mean gait analysis ‘pertaining to a clinic’.
* However, Whittle (1996) stated that ‘clinical gait analysis’ usually consists of videotape examination, measurement of gait parameters, kinematic analysis, kinetic measurement and electromyography.

Clinical Observational Gait Analysis

* The term 'clinical gait analysis' therefore does not appear to reflect the assessment undertaken in the majority of therapy clinics or centres, but is more associated with assessments conducted in specialised gait laboratories (Coutts, 1999; Davis, 1997)
* However, most clinicians working in MSK clinics are generally assumed to have limited access to such instrumentation and time requirements (Coutts, 1999; Narayanan, 2007; Taro et al, 2003).
* The accepted definition therefore appears counter intuitive and exclusive to the possible majority of assessments conducted in a **clinical** setting

Clinical Observational Gait Analysis

* Terminology to differentiate between 'clinical gait analysis' and 'gait analysis conducted within most clinics' appears required, without beginning to discuss whether gait laboratories could actually be defined as 'clinics'.
* For the purpose of this presentation the term **'Clinical Gait Analysis' (CGA)** includes all gait analysis which requires computerised or videotaped recording or analysis, while **'Real Time Clinical Gait Analysis' (RTCGA)** pertains solely to gait analysis visually assessed and concluded upon without computerised or recorded aid.

Musculoskeletal Real Time Clinical Gait Analysis (MSK RTCGA)

“Live clinical gait analysis” as a definition was academically refused, as it does not differentiate between gait analysis conducted on dead people.

Musculoskeletal Clinical Gait Analysis (MSK CGA)

For the purpose of this day, I have kept the analysis equipment relatively simple:

1. Webcam and Tripod
2. Laptop
3. Gait Analysis Softwear (one commonly used)

Foot Function in Gait

An important recap

Current theories on normal foot function in gait

With the development of podiatric biomechanics and orthotic management, diverse theories of its application have evolved. This can lead to perplexity in both clinical and educational settings as to the most efficacious method of patient assessment and treatment

Harradine et al 2003

Current theories on normal foot function in gait

Theoretical Perspective	Foot Morphology Theory	Sagittal Plane Facilitation Theory	Tissue Stress Theory
Criteria for Normalcy	The STJ passes through neutral at key stages of the gait cycle	The foot functions as a pivot allowing adequate hip extension and correct posture	The foot functions in a way that does not result in abnormal tissue stress and injury
Casting Methodology	The foot is cast in STJN, unless large deformity contraindicates this.	Casting methods are not documented, although recent non-custom orthoses from this theory may mean casting is not required	The positive cast is modified when taken to supply the shell shape required to apply the correct forces to the foot
Orthoses aim	To prevent abnormal joint compensation and place the foot into its normal position for key stages of the gait cycle	To allow the foot to work successfully as a pivot and facilitate Sagittal plane motion	To reduce abnormal stress upon symptomatic structures

Harradine and Bevan, JAPMA, 2009.

But, rather than spend the day focussing on the way theories disagree and be incredibly negative (again)….

Can we unify what has gone before?

The importance of bringing together what can be agreed on… to unify the theory.

I am convinced that this is the only means of advancing science, of clearing the mind from a confused heap of contradictory observations, that do but perplex and puzzle the Student, when he compares them, or misguide him if he gives himself up to their authority; but bringing them under one general head, can alone give rest and satisfaction to an inquisitive mind.

Sir Joshua Reynolds

How do we walk?

Before understanding ABNORMAL, we must have an understanding of NORMAL

How do we walk?

What do we (think we) know now?

Normal lower limb function in walking gait

1. **The 1st (Heel) Rocker**
2. **Internal hip rotation with foot pronation**
3. **The reverse windlass**
4. **The 2nd (Ankle) Rocker**
5. **External hip rotation with foot supination**
6. **The 3rd (Digits) Rocker**
7. **The Windlass mechanism with medial column propulsion**
8. **Adequate hip and knee extension for normal posture and swing phase**

Normal lower limb function in gait

1. **The 1st (Heel) Rocker**

•Shock absorption

•Weight-bearing stability

•Preservation of progression

Diagrams adapted from Perry J: Gait analysis. Normal and Pathological Function. 1992

Normal lower limb function in gait

2. Internal hip rotation and foot pronation

- The medial longitudinal arch (MLA) lowers and lengthens initially during stance phase of walking gait. The rearfoot everts (pronates) and then inverts (supinates) through a normal stance phase. Eversion occurs for the first 50-60% of the stance phase, followed by inversion (Leardini et al, 2007).

- The hip internally rotates during contact and mid stance and externally rotates throughout the terminal stance phase (Kadaba et al, 1990).

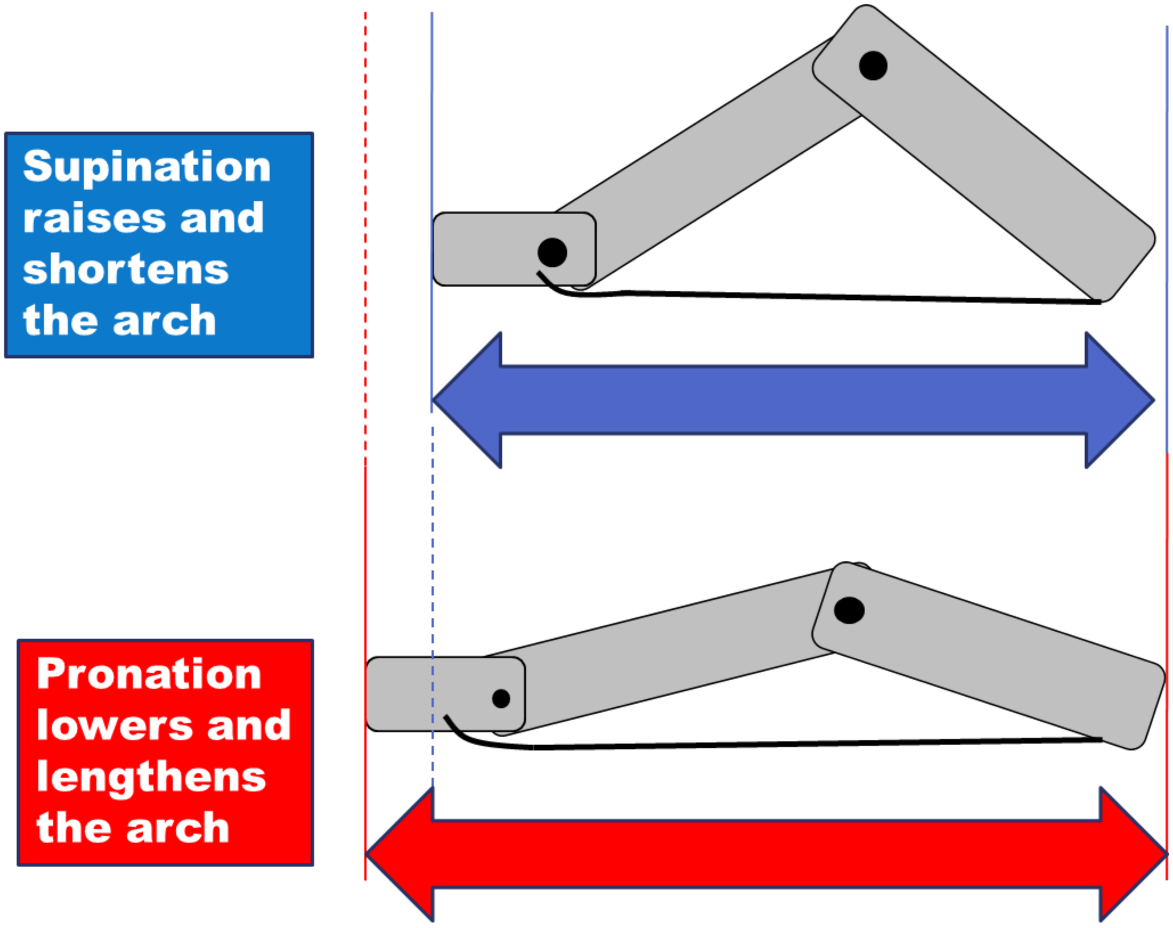
Normal lower limb function in gait

2. Internal hip rotation and foot pronation

- This motion has been proposed to couple with rearfoot complex pronation and supination, with pronation linked to internal rotation of the lower limb and supination with external rotation (Souza et al, 2010).

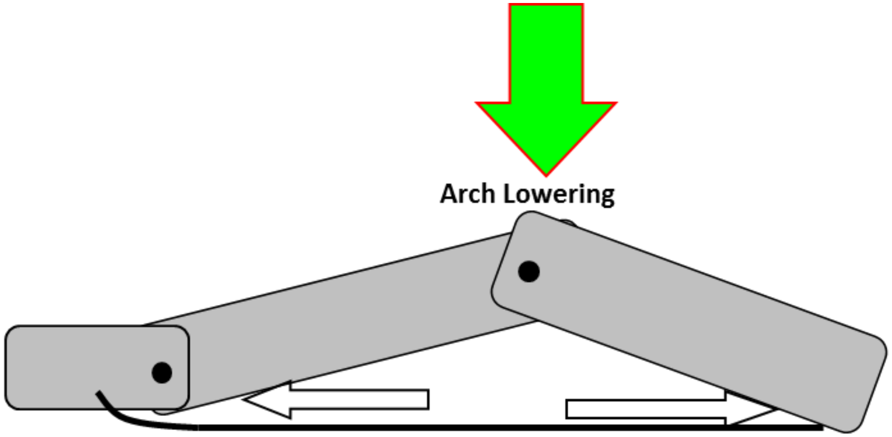
Normal lower limb function in gait

3.The reverse windlass



Normal lower limb function in gait

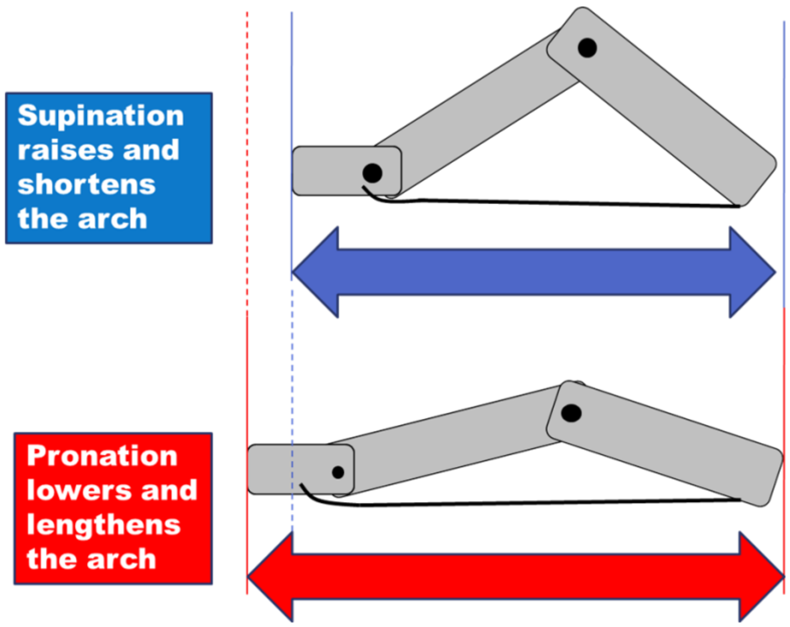
3.The reverse windlass



• As the arch lowers it becomes longer and the plantar structures (in this example the plantar fascia) become more taut. This in turn applies a compressive force longitudinally

Normal lower limb function in gait

3.The reverse windlass



We don't really want this to happen….

Midtarsal Joint Dorsiflexion

4. The 2nd (Ankle) Rocker

Normal lower limb function in gait

4. The 2nd (Ankle) Rocker

- The ankle is the 2nd rocker, used as the body progresses over the weightbearing limb
- Motion of the ankle in gait is predominantly in the sagittal plane, consisting initially of plantarflexion, then dorsiflexion (the 'second rocker'), and then plantar flexion again.
- In swing phase, the ankle dosiflexes to ensure ground clearance of the swing limb

Normal lower limb function in gait

5. External hip rotation and foot supination

- The medial longitudinal arch (MLA) lowers and lengthens initially during stance phase of walking gait. The rearfoot everts (pronates) **and then inverts** (supinates) through a normal stance phase. Eversion occurs for the first 50-60% of the stance phase, **followed by inversion** (Leardini et al, 2007).

- The hip internally rotates during contact and mid stance **and externally rotates throughout the terminal stance phase** (Kadaba et al, 1990).

- This motion has been proposed to couple with rearfoot complex pronation and supination, with pronation linked to internal rotation of the lower limb and **supination with external rotation** (Souza et al, 2010).

Normal lower limb function in gait

6. The 3rd (Digits) Rocker

- Dorsiflexion of the digits provides this third rocker, allowing the foot to pivot correctly and the lower limb to obtain normal hip and knee extension.

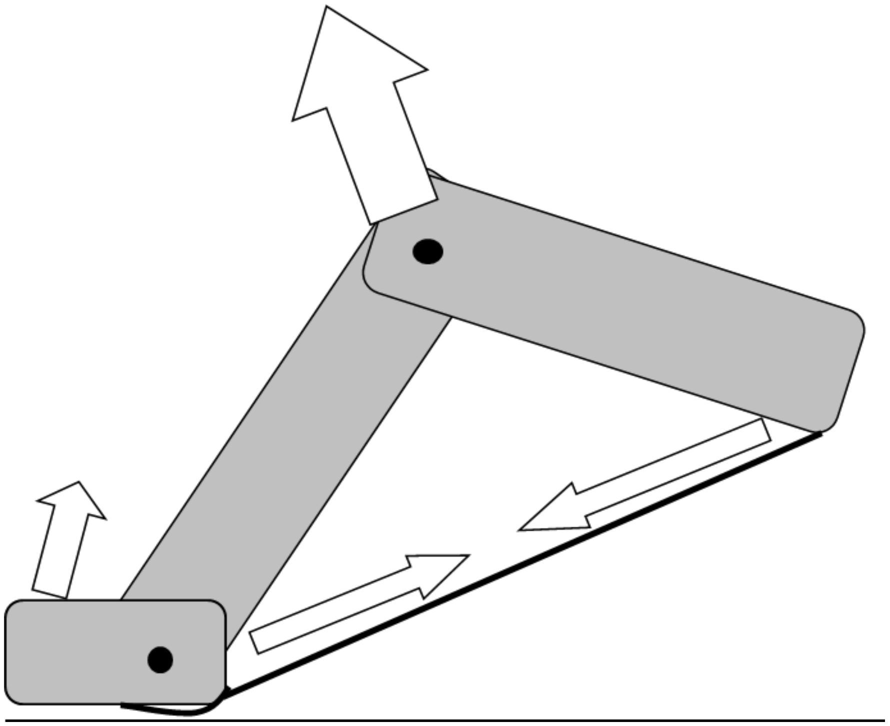
7. The Windlass mechanism with medial column propulsion

- Enough weight needs to pass medially through the foot to dorsiflex the hallux, and wind the windlass at heel lift. This increased tension in the medial and central bands of the plantar fascia maintains midfoot stability through the propulsive phase of gait (Harradine and Bevan, 2009)

Normal lower limb function in gait

7. The Windlass mechanism with medial column propulsion

- Enough weight needs to pass medially through the foot to dorsiflex the hallux, and wind the windlass at heel lift. This increased tension in the medial and central bands of the plantar fascia maintains midfoot stability through the propulsive phase of gait (Harradine and Bevan, 2009)



Normal lower limb function in gait

8. Adequate knee extension for normal posture and swing phase

- The knee is extended at heel strike, flexed during loading response and reaches the first flexion peak during early midstance.

- Thereafter, the knee begun extends until about 40% of stance phase and remains slightly hyperextended (average 3.5°) throughout the remaining midstance.

- Approximately halfway through the terminal stance the knee flexes again and the flexion continued throughout the pre-swing and peaked at toeoff when the stance phase ended. (Kozanek et al, 2009. Lafortune et al, 1992)

Normal lower limb function in gait

8. Adequate hip extension for normal posture and swing phase

- The total range of motion is around 20 -30 degrees, with contact phase flexion being approximately 10-15 degrees and maximum extension approximately 10-15 degrees also.
- This is measured from vertical to the floor, with half of this motion being stated to come from the hip itself, the other from a combination of pelvic rotation and anterior pelvic tilt (Bergmann et al, 2001. Foucher et al, 2012)

Normal 'lower limb' function in gait

8. AND the Lower back and Pelvis

- There is a large range of reported normal motion occurring in the back and pelvis in the asymptomatic population. There appears to be a general consensus on inclination of the trunk in the sagittal plane, a lateroflexion on each side per cycle in the frontal plane and a phase opposition between higher and lower trunk rotations in the horizontal plane. (Callaghan et al, 1999; Feipel et al, 2001; Lamoth et al, 2002; Ceccato et al, 2009)

Normal Lower limb function in gait

Normal 'lower limb' function in gait

8. AND the Upper Limb!

- The arm at the shoulder flexes and extends during each stride. Maximum extension is reached during ipsilateral heel contact, and peak flexion occurs with contralateral initial contact (Murray et al, 1967).

- Although considerable variation occurs amongst individuals, Perry and Burnfield (2010) quote Murray et als (1967) previous work that during moderate walking speed the average arc of motion is 32 degrees. A normal amount of extension to be 24 degrees and flexion to be 8 degrees. Faster walking increases the total arc of motion (Murray et al, 1967)

Normal ‘lower limb’ function in gait

8. AND the Upper Limb!

- Meynes et al (2013) concluded in a thorough literature review that arm swing should be seen as an integral part of human bipedal gait, and that arm swinging during normal bipedal gait most likely serves to reduce energy expenditure.

Normal lower limb function in gait - Recap

1. **The 1st (Heel) Rocker**
2. **Internal hip rotation with foot pronation**
3. **The reverse windlass**
4. **The 2nd (Ankle) Rocker**
5. **External hip rotation with foot supination**
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7. **The Windlass mechanism with medial column propulsion**
8. **Adequate hip and knee extension for normal posture and swing phase**

Abnormal Foot Function in Gait

" People do not limp because they hurt, rather they hurt because the limp"

Dananberg 1993

So what goes wrong?

The hip

- **Essentially, any structural or functional abnormality which may reduce the ability of the hip to extend. eg OA hip, tight iliopsoas, tight rectus femoris etc.**

Other Postural Adaptations

But what about The Foot too

- **Any structural or functional abnormality that will decrease the foots ability to act as a stable pivot during terminal single limb phase and so permit hip extension**

But what about The Foot too

Any structural or functional abnormality that will decrease the foots ability to act as a stable pivot during terminal single limb phase and so permit hip extension

- Un-Round undersurface of the calcaneus / heel
- Ankle equinus
- Structural hallux limitus
- Functional hallux limitus… to be looked at now in more detail.

Functional Hallux Limitus

It is the ability of the first MTPJ to react to the pull of the body over it which ultimately dictates the ability to advance the body over the weight bearing foot (Dananberg & Guiliano 1999)

- The foot and first MTPJ may look functionally and structurally normal both in non-weightbearing and stance examinations.
- During function no hallux dorsiflexion occurs, preventing windlass, calcaneo-cuboid close packing and hip/knee extension from occurring … and/or causing compensatory mechanisms to present

Functional Hallux limitus - What causes it?

- **The first ray must plantarflex to allow for hallux dorsiflexion. (Root 1977)**

- **Hallux dorsiflexory moments must be greater than Hallux plantarflexory moments at the 1st MTPJ**

Functional Hallux limitus - What causes it?

- **What would increase ground reaction forces under the first ray?**

- **What would cause increased plantarflexory moments of the hallux at the 1st MTPJ?**

Causes of FnHL…..

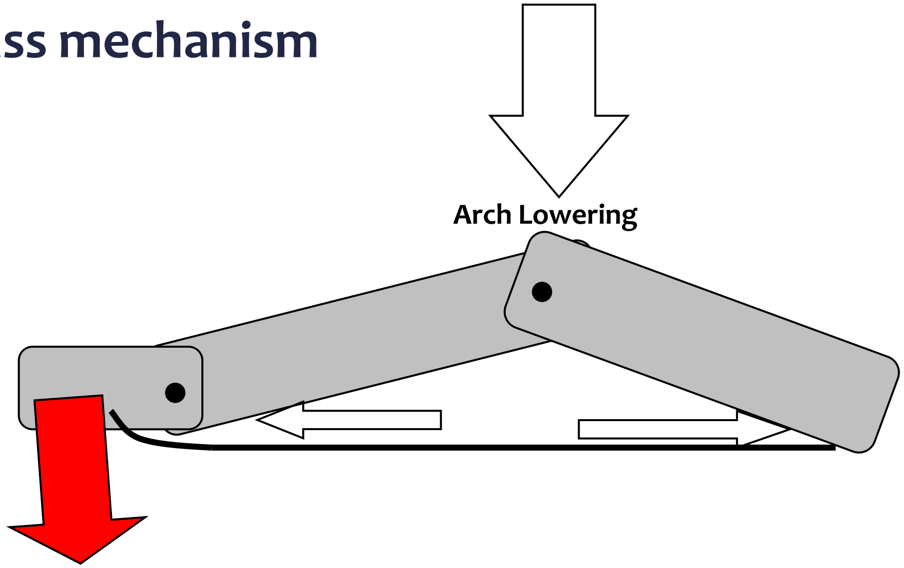
The most common are…..

- Plantarflexed first rays (Roukis et al, 1996)
- Prolonged reverse windlass (Aquino & Payne, 2000)

✓ Therefore, increased pronation will increase the presentation of FnHL (Harradine and Bevan, 2000)

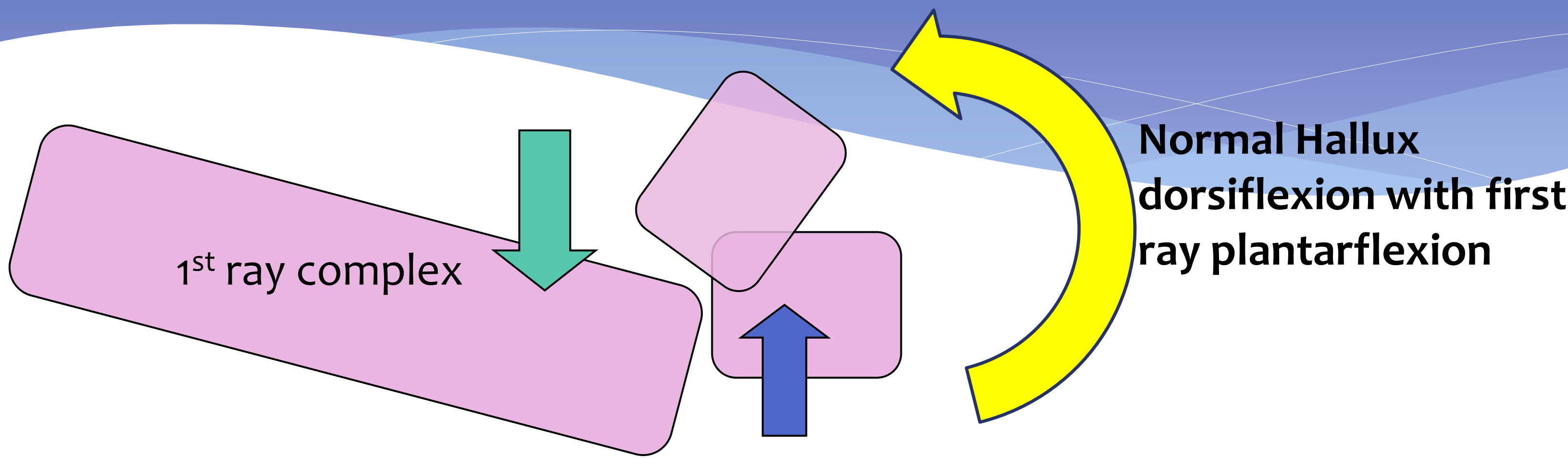
Increasing pronation limits hallux dorsiflexion via the pathological reverse windlass

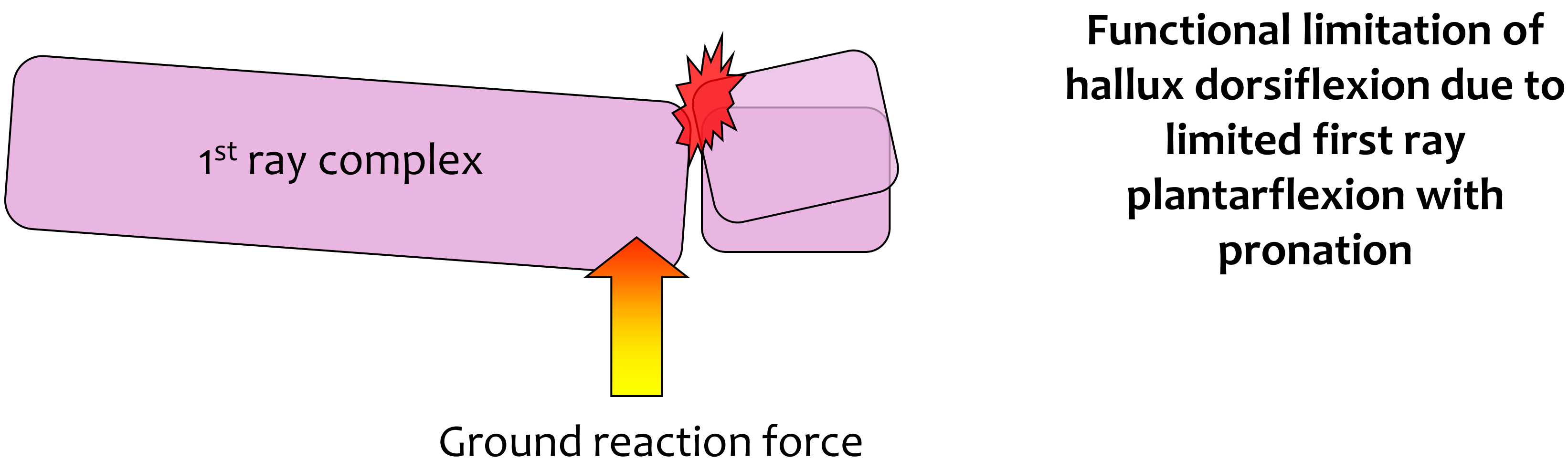
Simple model demonstrating the reverse windlass mechanism



- **As the arch lowers it becomes longer and the plantar structures (in this example the plantar fascia) become more taut pulling the digits DOWN (increasing plantarflexion moments of the hallux at the 1st MTPJ)**

Increasing pronation limits hallux dorsiflexion via the reverse windlass and……… **dorsiflexing the first ray**





Causes of FnHL…..

- Dorsiflexion of the first ray
- Due to a plantarflexed first ray morphology

Causes of FnHL…..

* **Dorsiflexion of the first ray**
* **Due to a Forefoot Valgus**

Causes of FnHL…..

- Prolonged reverse windlass
- Due to excessive pronation…
- Due to Ankle Equinus

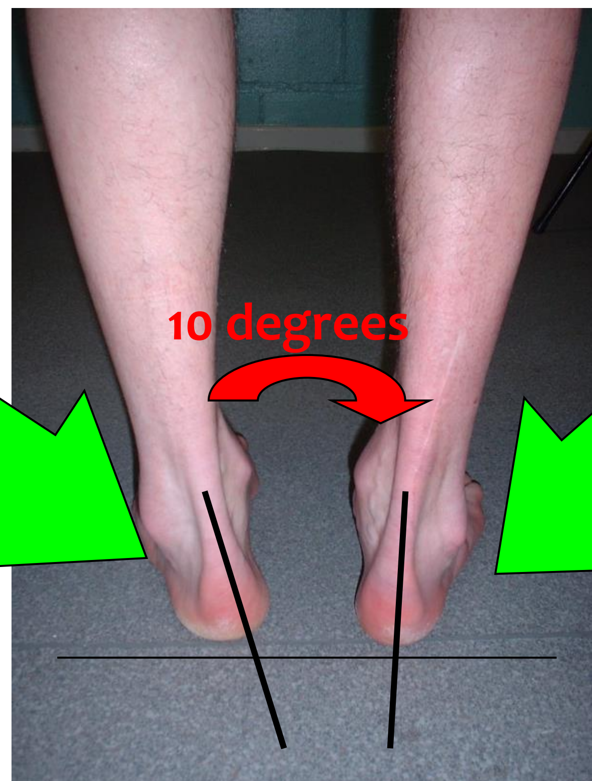
Causes of FnHL…..

* Prolonged reverse windlass
* Due to increased pronation….
* Due to Forefoot varus

Causes of FnHL

- Prolonged reverse windlass
- Due to increased pronation….
- Due to Rearfoot varus

Standing in 'neutral'



Standing relaxed, But maximally pronated!

MSK RTCGA / CGA

Putting it all together… when we assess Gait we look at:

1. Head Position
2. Arm Swing
3. Lower Back and Pelvis
4. Hip
5. Knee
6. Foot and Ankle

MSK RTCGA / CGA

Putting it all together

1. Head Position
2. Arm Swing
3. Lower Back and Pelvis
4. Hip
5. Knee
6. Foot and Ankle

- This is all very well… but what are we actually looking for.
- Can we look for specific gait patterns in the adult MSK injury population.
- And if so, can we be reliable in their assessment
- And would it be valid?

MSK RTCGA / CGA

“Pronation Patterns of Gait”

1. Excessive Pelvic Rotation
2. Vertical Heel Lift
3. Lack of Hip and Knee Extension
4. Reduced Arm swing
5. Abductory Twist
6. Lateral Propulsion
7. Lack of resupination
8. Side sway

These ‘patterns’ link into abnormal internal rotation (or lack of external lower limb rotation) and functional limitation of the 1st MTPJ.

Pronation patter gait dysfunction examples

- **excessive pelvic rotation**
- **flattened lordosis**
- **lack of hip extension**
- **vertical heel lift**
- **Abductory twist**
- **MTJ Dorsiflexion**
- **1st IPJ Dorsiflexion**
- **lateral column propulsion side sway**
- **Side sway**

Flattened lumbar lordosis, vertical heel lift, lack of hip and knee extension and arm swing

Hip motion/position

- **Frontal Plane**

- Different to stance angle?
- Wide or narrow base of gait?

- **Transverse Plane**

- Internally/externally positioned

- **Sagittal Plane**

- Adequate hip extension? Symmetrical?
- Hip flexion properly timed?

Knee motion / position

- **Transverse plane**

- Squinting patellae? symmetrical ?

- **Sagittal Plane**

- Correct flexion / extension timing? Symmetrical?

Arm Swing

- **Frontal Plane**

- Same position right/left relative to the body

- Hand position the same

- **Sagittal Plane**

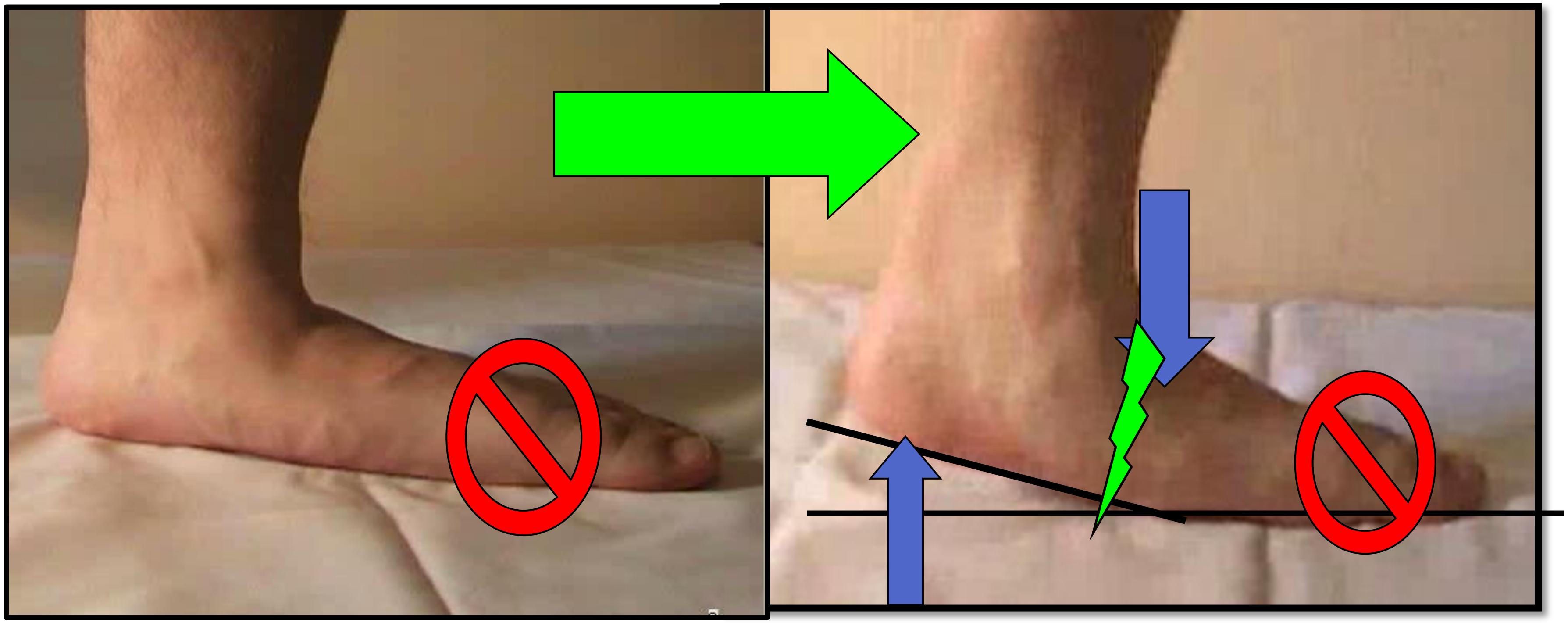
- Arm swing anterior / posterior symmetrical

- Occuring from shoulder or elbow

Pronation pattern gait dysfunction examples

- **excessive pelvic rotation**
- **flattened lordosis**
- **lack of hip extension**
- **vertical heel lift**
- **Abductory twist**
- **MTJ Dorsiflexion**
- **1st IPJ Dorsiflexion**
- **lateral column propulsion**
- **side sway**

FnHL and MTJ Dorsiflexion



Pronation pattern gait dysfunction examples

- excessive pelvic rotation
- flattened lordosis
- lack of hip extension
- vertical heel lift
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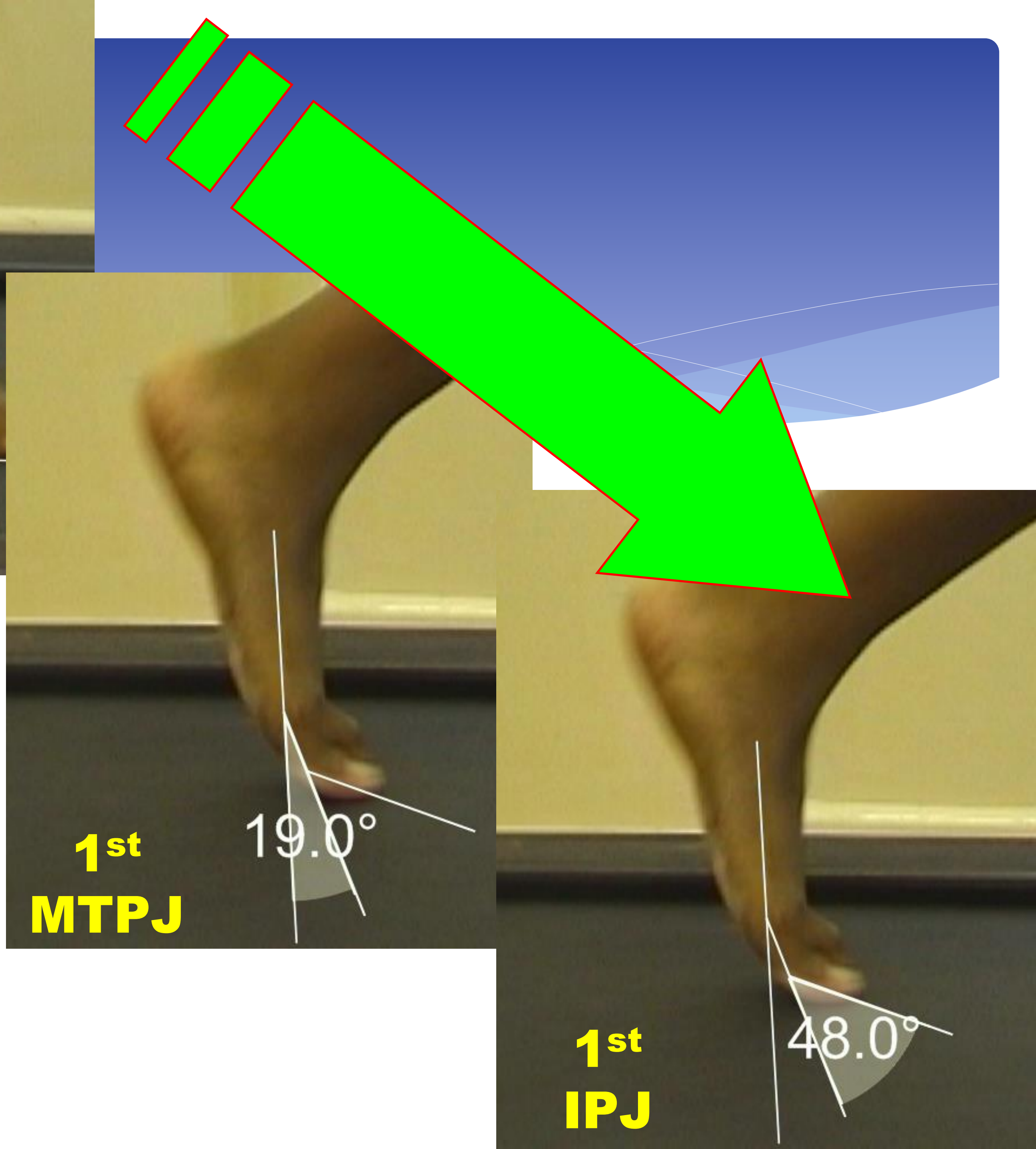
- side sway



Munuera et al. Hallux interphalangeal joint range of motion in feet with and without limited first metatarsophalangeal joint dorsiflexion. J Am Podiatr Med Assoc. 2012 Jan-Feb;102(1):47-53.

Pronation pattern gait dysfunction examples

- **excessive pelvic rotation**
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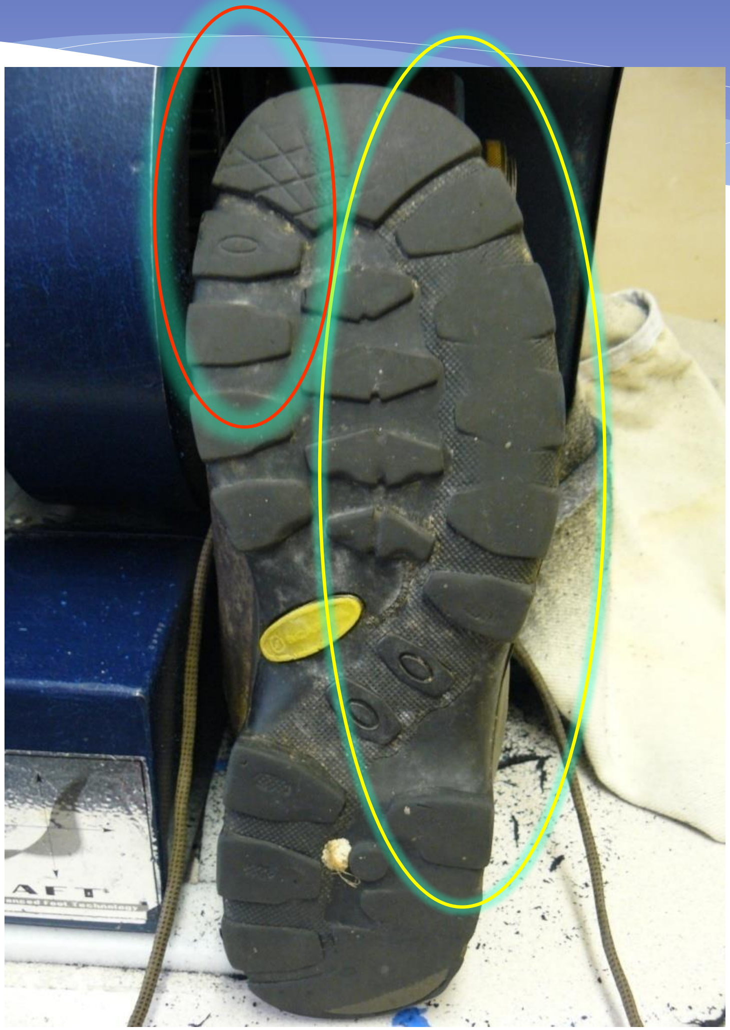
- **lateral column propulsion**
- **side sway**

Lateral column propulsion…Often seen as lateral shoe wear



Lateral Overloading……..(Harradine et al, 2004)

Pronation pattern gait dysfunction examples

- **excessive pelvic rotation**
- **flattened lordosis**
- **lack of hip extension**
- **vertical heel lift**
- **Abductory twist**
- **MTJ Dorsiflexion**
- **1st IPJ Dorsiflexion**
- **lateral column propulsion**
- **side sway**

Clinical Gait Analysis

Supination Patterns of Gait

1. Lack of Pronation at contact phase
2. Reduced Hip and knee extension
3. Lateral Propulsion

These 'patterns' Would link into a lack of internal lower limb rotation and an inability to use the medial column of the foot due to an inverted foot posture.

Additional Gait Analysis Points

- **Head Position**
- **Pelvic position and motion**
- **Foot function**

Head Motion / Position

- **Frontal Plane**
- - Is the head tilted to either side or facing left/right

- **Sagittal Plane**
- - Kyphosis?
- - Is the head tilted forward? Pt looking at the ground?

Shoulder Motion/Position

- **Frontal Plane**
- - Is one shoulder higher than the other?

Trunk Motion/Position

- **Sagittal Plane**

- Flattened lumber lordosis

- Increased lumber lordosis

Pelvic Motion/Position

- **Frontal Plane**

- Tilt?

- **Sagittal Plane**

- Very Difficult

Foot position / motion

- **Frontal Plane**

- Eversion ➡ Inversion

- **Transverse Plane**

- Abductory twist?

- **Sagittal Plane**

- Heel to toe motion?
- Delayed / early heel lift?
- Propulsive phase?

And don’t forget other reasons why people walk awkwardly…

- **Sometimes there’s something else on their mind……**
- **Shyness at assessment**
- **Wanting to please or denial of injury**
- **Holding in stomach / out chest**
- **Just one of them days…..**

Diagnosis and treatment of common injuries with additional relation to running and running footwear

Runners…. . . . .

What should we be doing for the runner?

- Who treats the injured runner these days?
- Where do we & gait analysis fit in?

Who initially treats the injured runner?

First hits searching running injuries….

Google | running injuries

All Images News Shopping Videos More ▾ Search tools

About 132,000,000 results (0.47 seconds)

The Big 7 Body Breakdowns | Runner's World
www.runnersworld.com/health/the-seven-most-common-**running-injuries** ▾
3 Feb 2011 - About 40 percent of **running injuries** are knee injuries. And 13 percent of runners suffered knee pain in the past year, according to 4,500 ...

The 5 Most Troublesome Running Injuries | Competitor.com
running.competitor.com/.../**injury**.../the-top-5-most-troublesome-**running**... ▾
10 Jul 2014 - Mario Fraioli takes a look at the top-5 most troublesome **running injuries** and how to treat them.
2. Achilles Tendinitis - Injury Prevention Is An ART - 3. IT Band Syndrome

Running Injuries A-Z - Beating Injury - Runner's World
www.runnersworld.co.uk/beating-**injury**/**running-injuries**-a-z/199.html ▾
If you want to know more about **running injuries**, you're in the right place. For the most common injury warning signs be sure to read upon our expert guide on ...

These Websites….

1. List common injuries. Most frequently knee pain, achilles pain, plantar fasciitis, shin splints and hamstring injuries

2. Some general but often good advice from professionals. Commonly initial recommended treatment is:

- Rectification of training error, including relative rest
- Go to a running shoe store to check you have the right trainers **<u>and have your gait assessed</u>**

It appears gait analysis is commonly initially provided by running outlets / Sports stores

Gait analysis is commonly initially provided by running outlets / sports stores

- Concerns of this may include limited training, commercial interest or lack of qualification
- However, there may be a lot of experience in these settings (possibly assessing running gait up to 20 times a day), and clients are likely to feed back errors…

Gait analysis is commonly initially provided by running outlets / sports stores

- **Running store / Footwear store outcomes seem to be one of 3 main options**

1. The Injured runner receives the correct footwear
2. The Inured runner receives incorrect footwear
3. The Injured runner receives no footwear

1) The injured runner receives correct footwear

1. And symptoms improve

2. And symptoms don’t improve, as the injury is not due to the patients footwear

3. And symptoms do not improve as footwear cannot correct gait dysfunction adequately

* Outcomes 2. or 3. often result in referral to the GP, Physio or Podiatrist

2) The injured runner receives incorrect footwear

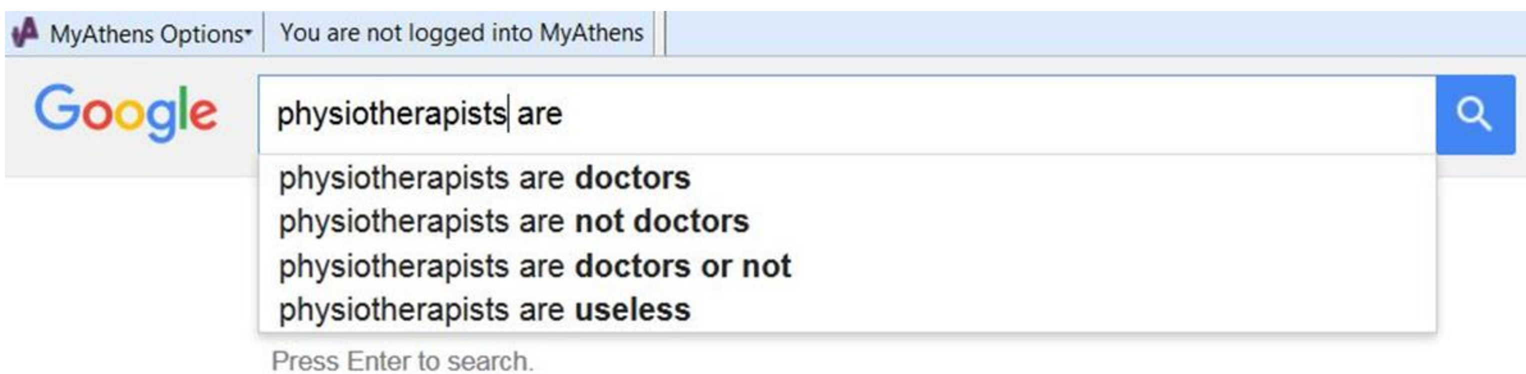
1. And symptoms do not improve
2. And Primary symptoms improve, but other symptoms appear

* 1. And 2. above often result in Referral to the GP, Physio or Podiatrist

3) The injured runner receives no footwear

1. The assessing staff member feels further referral is required rather than the provision of new footwear.

Whether referred by a retail outlet or referred on again by the GP, these patients often end up with Physiotherapists or Podiatrists



And what do we then do……..physio

And what do we then do… .Podiatry?

And what do we then do……..

Gait Analysis and the injured runner

- A limited clinical, available evidence based approach to gait analysis is possible within the limitations of available research and equipment.
- From here, research into reliability, validity and worth can be initiated
- Treadmill or overground?
- Observational or instrumented?

Treadmill or Overground… does it matter?

Evaluation of running and walking biomechanics is frequently completed on a treadmill. But is this valid?

1. Decreased peak and range of knee flexion during both walking and running on a treadmill (Matsas et al, 2000; Riley et al, 2007 & 2008; Sinclair et al, 2013)

2. Inconsistent differences for hip flexion during running with both increased (Alton et al, 1998) and decreased (Sinclair et al, 2013) peaks on a treadmill

3. Decreased ankle dorsiflexion range of motion and velocity (Fellin et al, 2010; Sinlciar et al, 2013) when running on a treadmill

4. Greater rearfoot/ankle eversion during running on a treadmill(Nigg et al, 1995; Fellin et al, 2010; Sinclair et al, 2013)

5. Magnitude of Navicular motion is higher both walking and running on a treadmill compared to over ground (Barton et al, 2015)

Observational or 2D instrumented… does it matter?

Gait analysis – Posterior view

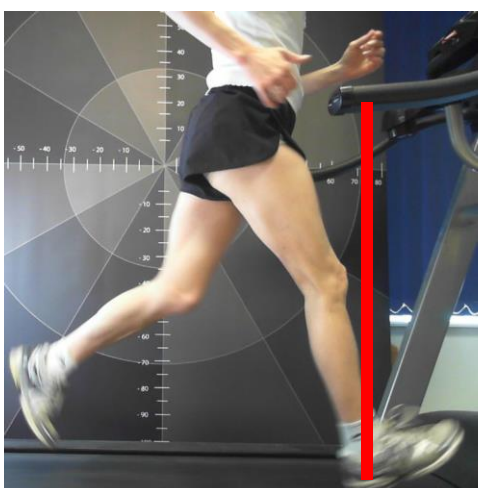
Gait Analysis – side view

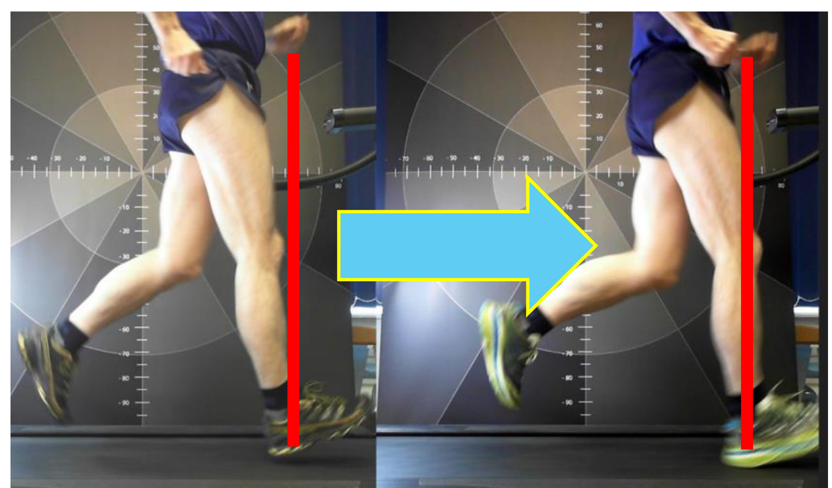
Side view analysis

1. Overstriding
2. Cadence
3. Vertical Displacement
4. Trunk Lean
5. Hip Extension
6. Knee Flexion
7. Tibial Vertical Alignment during loading
8. Ankle angle at contact
9. Foot strike pattern

1) Overstriding

- Stride length vrs Overstriding
- Overstriding is “reaching”
- Hip flexion is increased to a point where the initial contact occurs more anterior to the runners centre of mass
- Overstriding is linked to increased knee extensor moment, and total peak and rate of vertical ground reaction force (Wille et al, 2013; Schubert et al, 2014, Lieberman et al, 2015)





2) Cadence

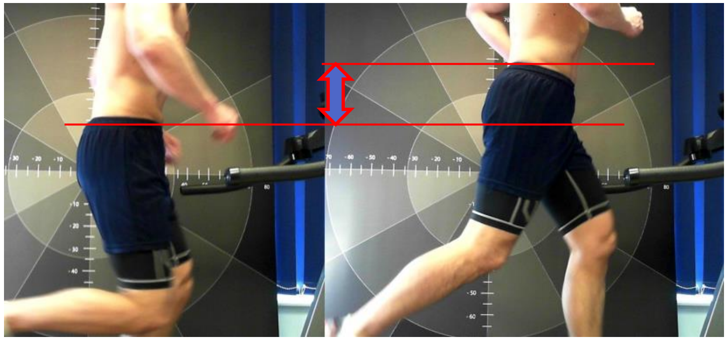
- Distance runners are often advised to use 90 strides min(-1), and to avoid "overstriding"

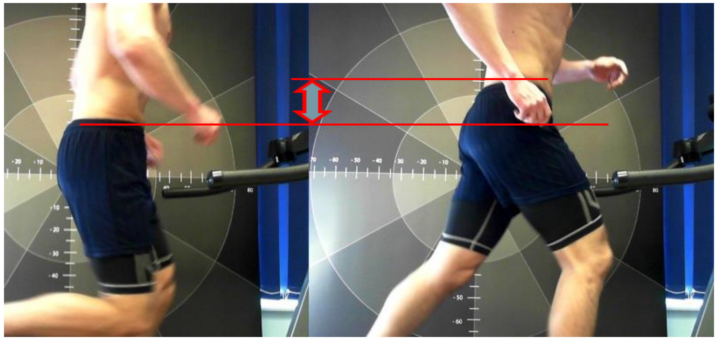
- A recent study (Lieberman et al, 2015) found that by increasing cadence, the position of the foot at landing relative to the hip decreased. This linked to lower magnitudes of posteriorly directed braking forces and lower magnitudes and rates of loading of the vertical ground reaction force impact peak.
-
- The mean metabolically optimal stride frequency was 84.8±3.6 strides min(-1), with 50.4% of the variance explained by the trade-off between minimizing braking forces versus maximum hip flexor moments during swing.

- The results suggest that distance runners may benefit from a stride frequency of approximately 85 strides min(-1) and by landing at the end of swing phase with a relatively vertical tibia.

3) Vertical Displacement

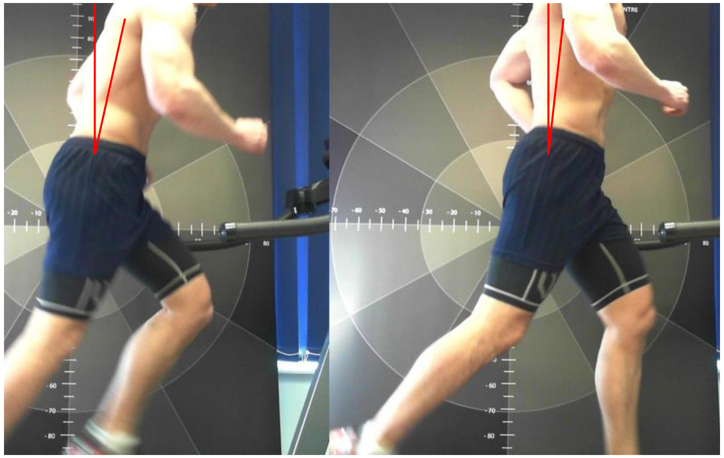
- No normative data
- Measured between highest point of the airborne phase and lowest point of the stance phase
- Reducing vertical displacement may have a beneficial effect on fatigue (Halvorsen et al, 2012), reduce peak knee extensor moment, peak vertical ground reaction force and the breaking impulse (Wille et al, 2014).
- Significant decrease was achieved in one study via a 10% increase in cadence (Heiderscheit et al, 2011)





4) Trunk lean

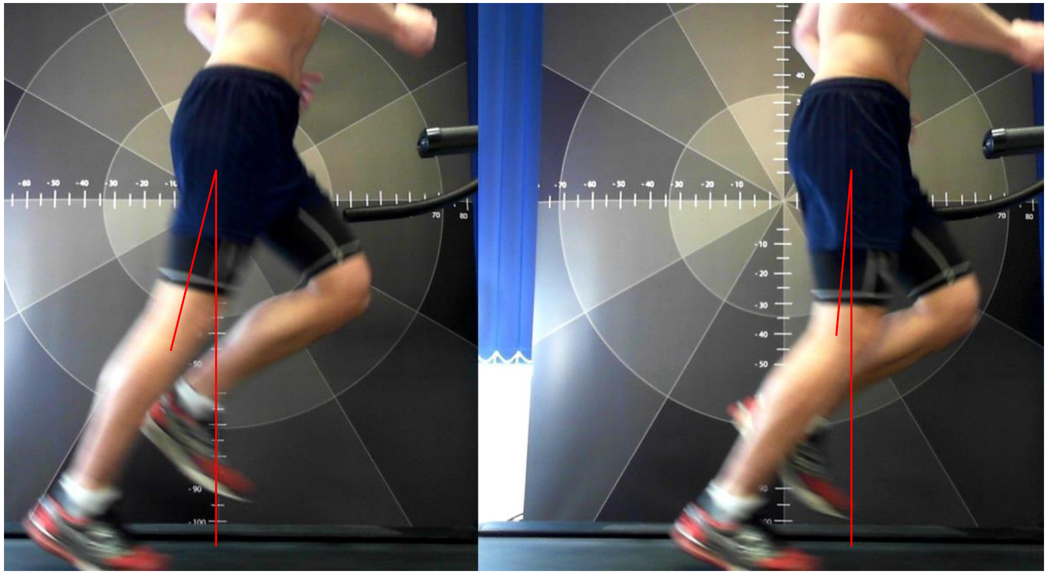
- No normative data
- Popular area in specific running styles such a ‘Chi Running’, Pose technique, Newton footwear etc.
- Teng & Powers found in 2015 that increased anterior trunk lean reduces knee loading without increasing the biomechanical demand at the ankle plantarflexors.
- In 2014 they also concluded incorporation of a forward trunk lean may be an effective strategy to reduce PFJ stress during running.



5) Hip Extension

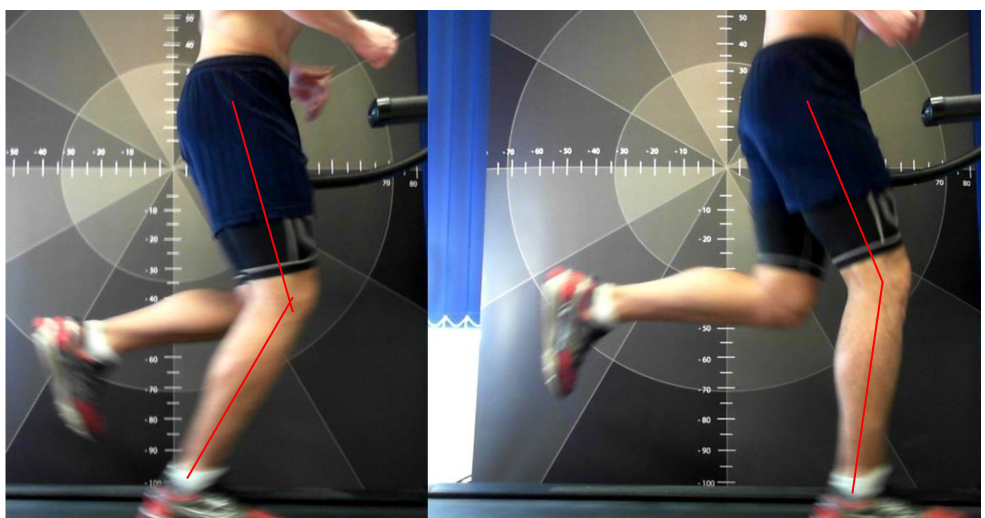
- No Normative data
- Hip hypomobility may link to other factors which can be linked to injury:

1. Increased vertical displacement
2. Over-striding
3. Increased Cadence



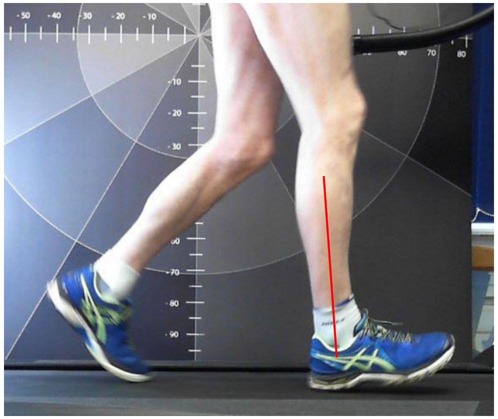
6) Knee Flexion

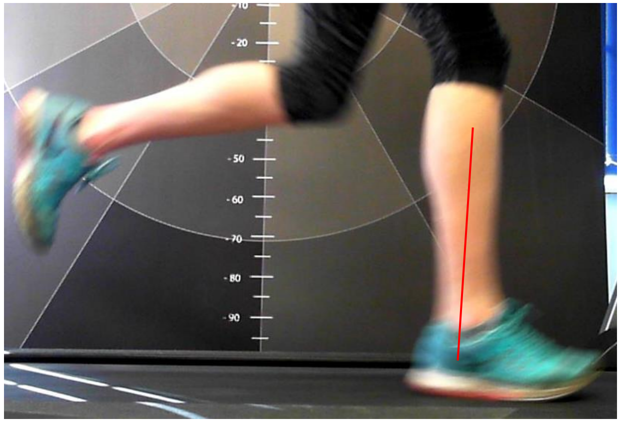
- No Normative data
- Increased knee flexion is coupled with increased pronation (McClay and Manal, 1998)
- However reduced flexion (less than 40 degrees) is also linked to AKPS (Dierks et al, 2011).
- Knee ‘stiffness’ running may link to TSF (Milner et al, 2006)



7) Tibial Vertical Alignment during loading

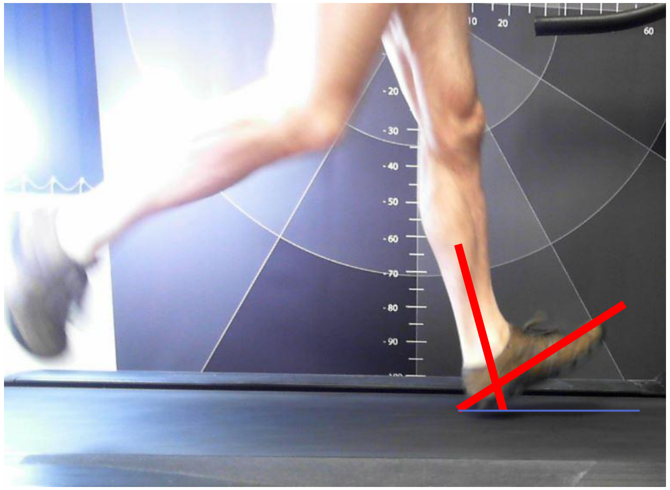
- The tibial may be extended, vertical or flexed
- In isolation, lacking research on importance.
- A more extended Tibia at contact may link to overstriding. If injuries link to impact, a more ‘flexed’ tibia may be recommended.

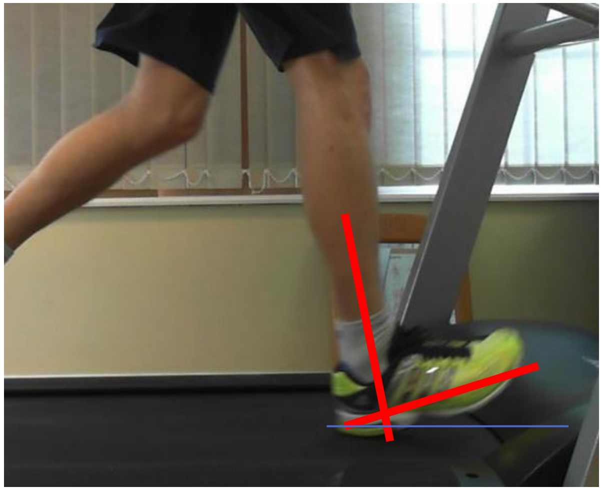




8) Ankle Angle

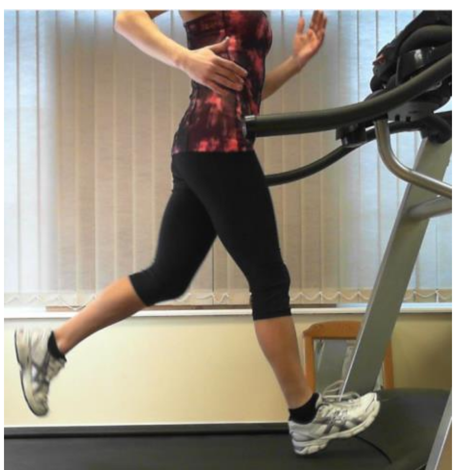
- Only Applicable for heel strike patterns of running
- No normative data
- Higher levels may be indicative of higher peak knee extension moments, higher peak vertical ground reaction force and greater breaking impulse (Wille et al, 2014)

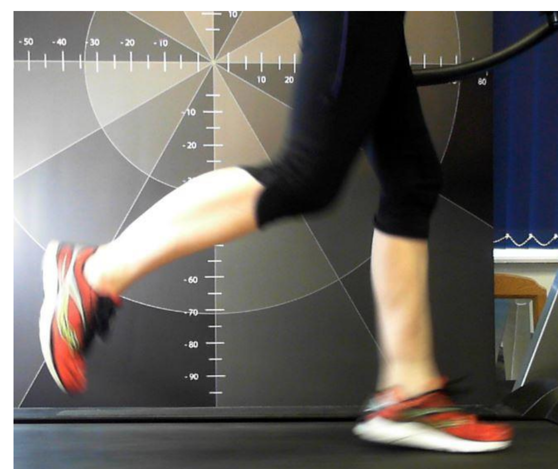




9) Foot Strike Pattern

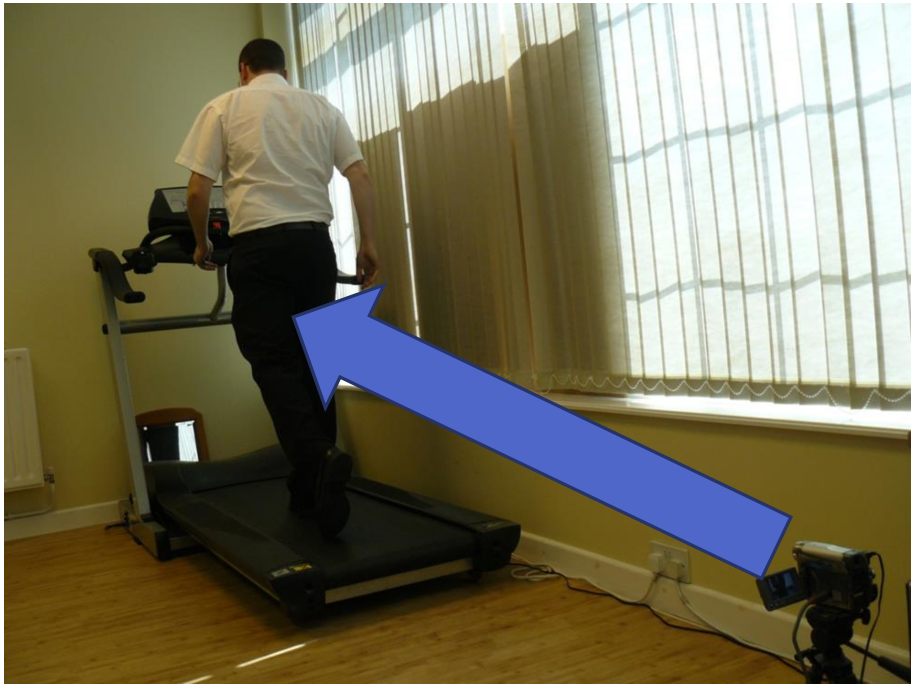
- Much discussion on which is best!
- Rearfoot, Midfoot or forefoot
- Awareness of joint loading to each pattern linking to injury may be of use to clinicians (Yong et al, 2014; Rooney and Derrick 2013; Kulmala et al 2013).





Posterior view Analysis

1. Pelvic Drop
2. Abductory Twist
3. Foot Progression Angle
4. Rearfoot Eversion
5. Base of gait

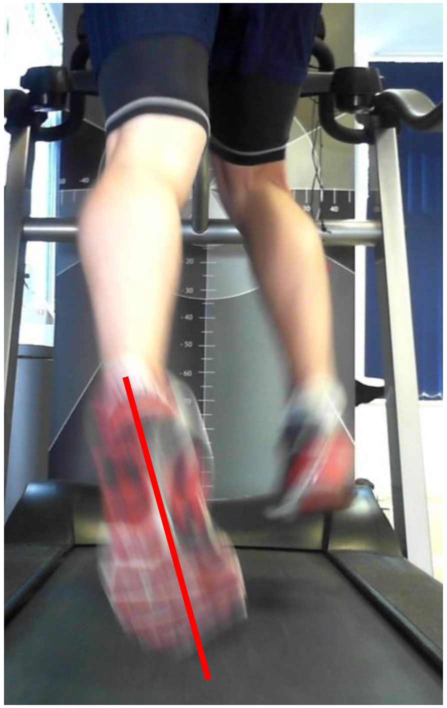


1) Pelvic Drop

- No Normative data
- Linked to increased hip adduction, which in itself has been cited in running injuries such as Iliotibial band syndrome and PatelloFemoral pain syndrome (Foch et al, 2015; Willson & Davis 2008; Noehren et al, 2007)

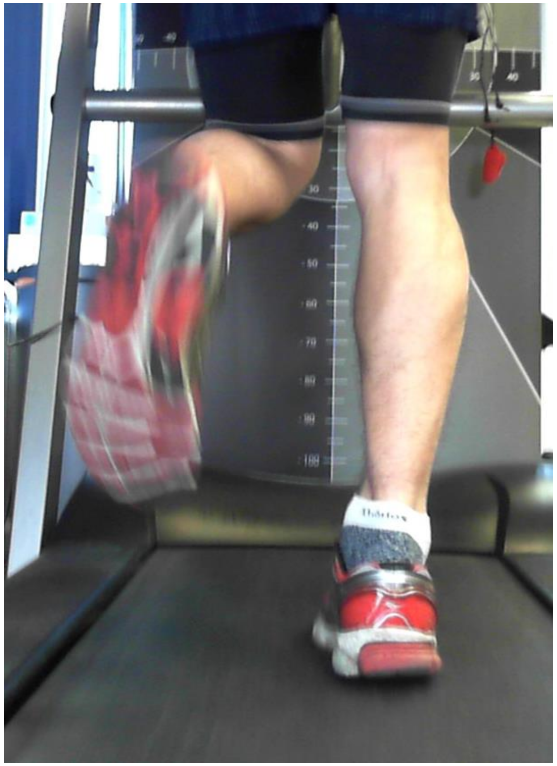
2) Abductory twist / Heel whip

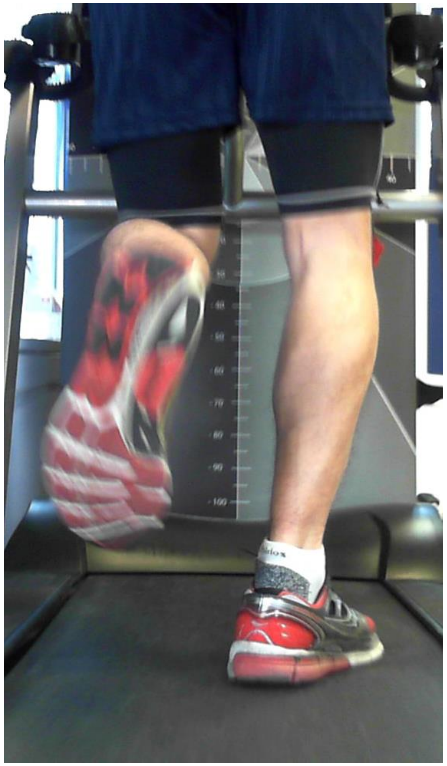
- No Normative data
- No link to injury
- May link to internal rotation through propulsion, which can be multifactorial



3) Foot Progression Angle

- No Normative Data
- No researched link to injury
- Infra or supra patella aetiology may be important.





4) Rearfoot Eversion

- **No normative data!!!**
- Velocity and extent of pronation may be assessed
- Linked into a variety of injuries, including Medial tibial stress syndrome (Reshef & Guelich, 2012; Akiyama et al 2015) , tibial stress fractures (Millner et al, 2010) and patellofemoral pain (Barton et al, 2010)

5) Base of gait

- No normative data
- Running limb varus
- A narrow base of gait has been linked to injuries such as Iliotibial band syndrome (Meardon et al, 2012) and tibial stress fractures (Meardon and Derrick, 2014)

That's a lot of information….

Lets put this into a clinical example – Medial Tibial Stress Syndrome

The ‘Syndrome’…..

- Clinical presentation of symptoms include:

1. Diffuse tenderness along the distal medial two thirds of the medial aspect of the tibia.
2. The pain typically intensifies at the initiation of the exercise session, but may subside during exercise in the early stages.
3. Normally a gradual worsening of pain, with no one traumatic event (the exception being a rapid and dramatic increase in miles)
4. Pain generally ends with ceasing running
5. No neurological type symptoms
6. ‘Pain’ generally does not continue for walking.

Clinical Diagnosis

Br J Sports Med. 2017 Feb 8. pii: bjsports-2016-097037. doi: 10.1136/bjsports-2016-097037. [Epub ahead of print]

Medial tibial stress syndrome can be diagnosed reliably using history and physical examination.

Winters M[1], Bakker EW[2], Moen MH[3,4,5], Barten CC[6], Teeuwen R[7], Weir A[8,9].

Author information

Abstract

BACKGROUND: The majority of sporting injuries are clinically diagnosed using history and physical examination as the cornerstone. There are no studies supporting the reliability of making a clinical diagnosis of medial tibial stress syndrome (MTSS).

AIM: Our aim was to assess if MTSS can be diagnosed reliably, using history and physical examination. We also investigated if clinicians were able to reliably identify concurrent lower leg injuries.

METHODS: A clinical reliability study was performed at multiple sports medicine sites in The Netherlands. Athletes with non-traumatic lower leg pain were assessed for having MTSS by two clinicians, who were blinded to each others' diagnoses. We calculated the prevalence, percentage of agreement, observed percentage of positive agreement (Ppos), observed percentage of negative agreement (Pneg) and Kappa-statistic with 95%CI.

RESULTS: Forty-nine athletes participated in this study, of whom 46 completed both assessments. The prevalence of MTSS was 74%. The percentage of agreement was 96%, with Ppos and Pneg of 97% and 92%, respectively. The inter-rater reliability was almost perfect; k=0.89 (95% CI 0.74 to 1.00), $p<0.000001$. Of the 34 athletes with MTSS, 11 (32%) had a concurrent lower leg injury, which was reliably noted by our clinicians, k=0.73, 95% CI 0.48 to 0.98, $p<0.0001$.

CONCLUSION: Our findings show that MTSS can be reliably diagnosed clinically using history and physical examination, in clinical practice and research settings. We also found that concurrent lower leg injuries are common in athletes with MTSS.

What hurts in MTSS?

- There is now a general view that medial tibial stress syndrome is not solely an inflammatory process of the periosteum but also a bone stress reaction that has become painful (Gaeta et al, 2006).

- It is an injury involving underlying cortical bone microtrauma, although in most cases it is also characterised by diffuse tibial anteromedial or posteromedial surface subcutaneous periostitis. It is not clear if the soft tissue or cortical bone reaction occurs first. (Franklyn & Oakes, 2015)

- Probably the bone AND periosteum, although there is no consensus on if it is more one or the other.

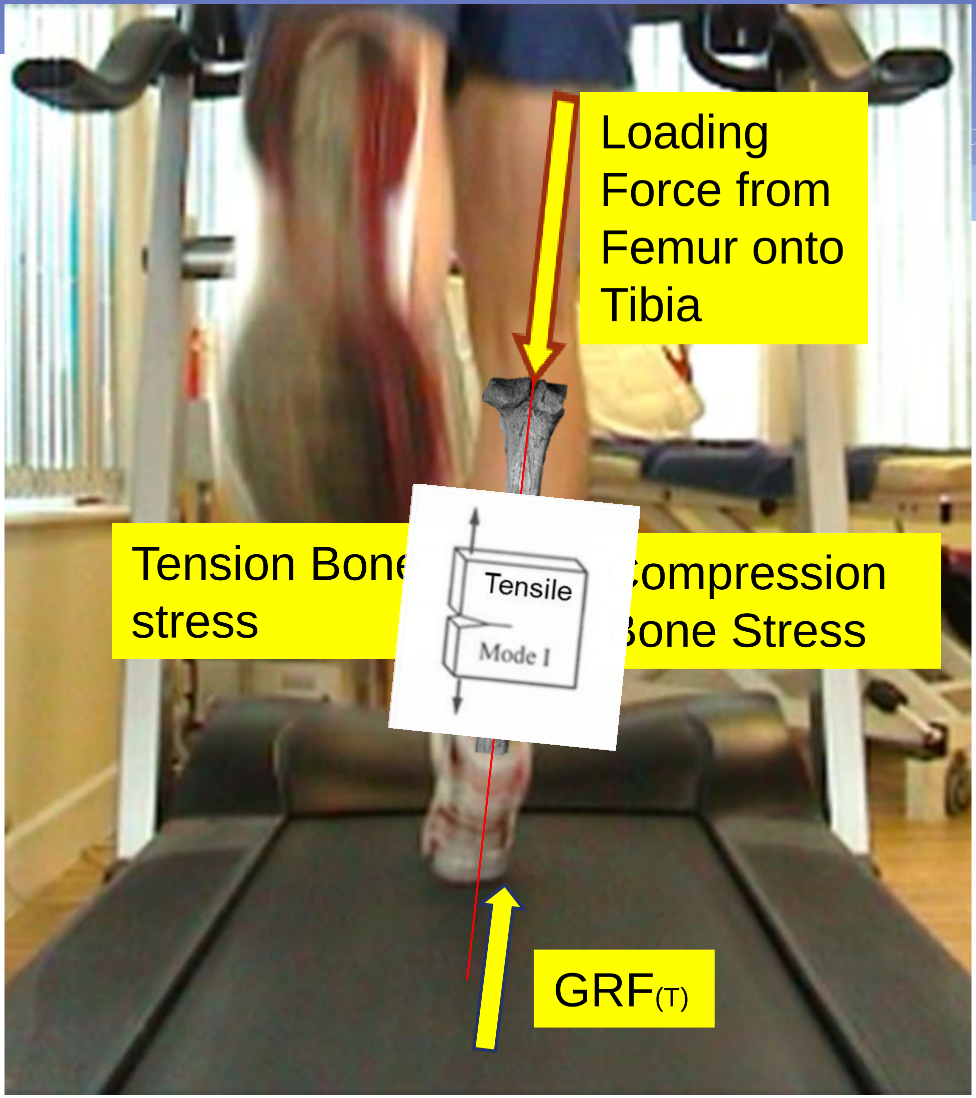
Briefly Linking the risk factors to the injury

Bone is strongest in compression…

…..followed by tension…

….and weakest in shear.

Why does it hurt there?



Why does it hurt there?

- Pronation causes increased tension in the fascia attachments on the medial tibial aspect of the:

✓ Posterior Tibial (Saxena et al, 1990)

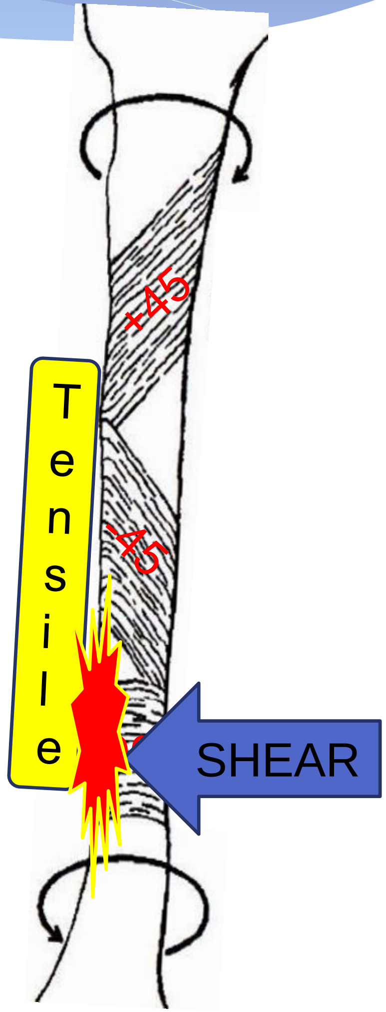
✓ Flexor Digitorum Longus (Garth & Miller, 1989)

✓ Soleus (Michael and Holder, 1985)

✓ Posterior Tibial and Flexor Digitorum longus (Bouch & Johnston, 2007)

This crural-fascial strain increases to tensile stress to the medial aspect of the tibia and causes tensile stress to the subcutaneus periosteum.

Why does it hurt there?



Pronation and running injury including MTSS

J Sci Med Sport. 2017 Apr 15. pii: S1440-2440(17)30371-7. doi: 10.1016/j.jsams.2017.04.001. [Epub ahead of print]

Medial shoe-ground pressure and specific running injuries: A 1-year prospective cohort study.

Brund RBK[1], Rasmussen S[2], Nielsen RO[3], Kersting UG[4], Laessoe U[5], Voigt M[4].

Author information

Abstract

OBJECTIVES: Achilles tendinitis, plantar fasciopathy and medial tibial stress syndrome injuries (APM-injuries) account for approximately 25% of the total number of running injuries amongst recreational runners. Reports on the association between static foot pronation and APM-injuries are contradictory. Possibly, dynamic measures of pronation may display a stronger relationship with the risk of APM-injuries. Therefore, the purpose of the present study was to investigate if running distance until the first APM-injury was dependent on the foot balance during stance phase in recreational male runners.

DESIGN: Prospective cohort study.

METHODS: Foot balance for both feet was measured during treadmill running at the fastest possible 5000-m running pace in 79 healthy recreational male runners. Foot balance was calculated by dividing the average of medial pressure with the average of lateral pressure. Foot balance was categorized into those which presented a higher lateral shod pressure (LP) than medial pressure, and those which presented a higher medial shod pressure (MP) than lateral pressure during the stance phase. A time-to-event model was used to compare differences in incidence between foot balance groups.

RESULTS: Compared with the LP-group (n=59), the proportion of APM-injuries was greater in the MP-group (n=99) after 1500km of running, resulting in a cumulative risk difference of 16%-points (95% CI=3%-point; 28%-point, p=0.011).

CONCLUSIONS: Runners displaying a more medial pressure during stance phase at baseline sustained a greater amount of APM-injuries compared to those displaying a lateral shod pressure during stance phase. Prospective studies including a greater amount of runners are needed to confirm this relationship.

MTSS Aetiological Factors

1. **Decreased Tibial Bone Mineral Density** (Magnusson et al, 2001 & 2003; Franklyn and Oakes, 2015)
2. **Decreased Tibial Cross sectional Area** (Milgrom et al, 1989; Becks et al, 1996; Franklyn and Oakes, 2015)
3. **Increased BMI** (Hamstra-Wright and Bliven, 2015)
4. **Increased Pronation** (Bennett et al, 2001. Tweed et al, 2008. Raissi et al, 2009. Reshef & Guelich 2012; Rathleff et al, 2012; Kudo and Hatanaka, 2015; Hamstra-Wright and Bliven, 2015)
5. **Increased Tibial Loading**. (Clements et al, 1981; Epperly and Fields, 2001; Yates and White, 2004)
6. **Increased vertical loading rate** (Zadpoor and Nikooyan, 2010; Hobara et al, 2012; van der Worp et al, 2016)

MTSS Gait Analysis

- 1. **Posterior View.**
- Rearfoot maximum eversion
- Rearfoot Eversion Velocity

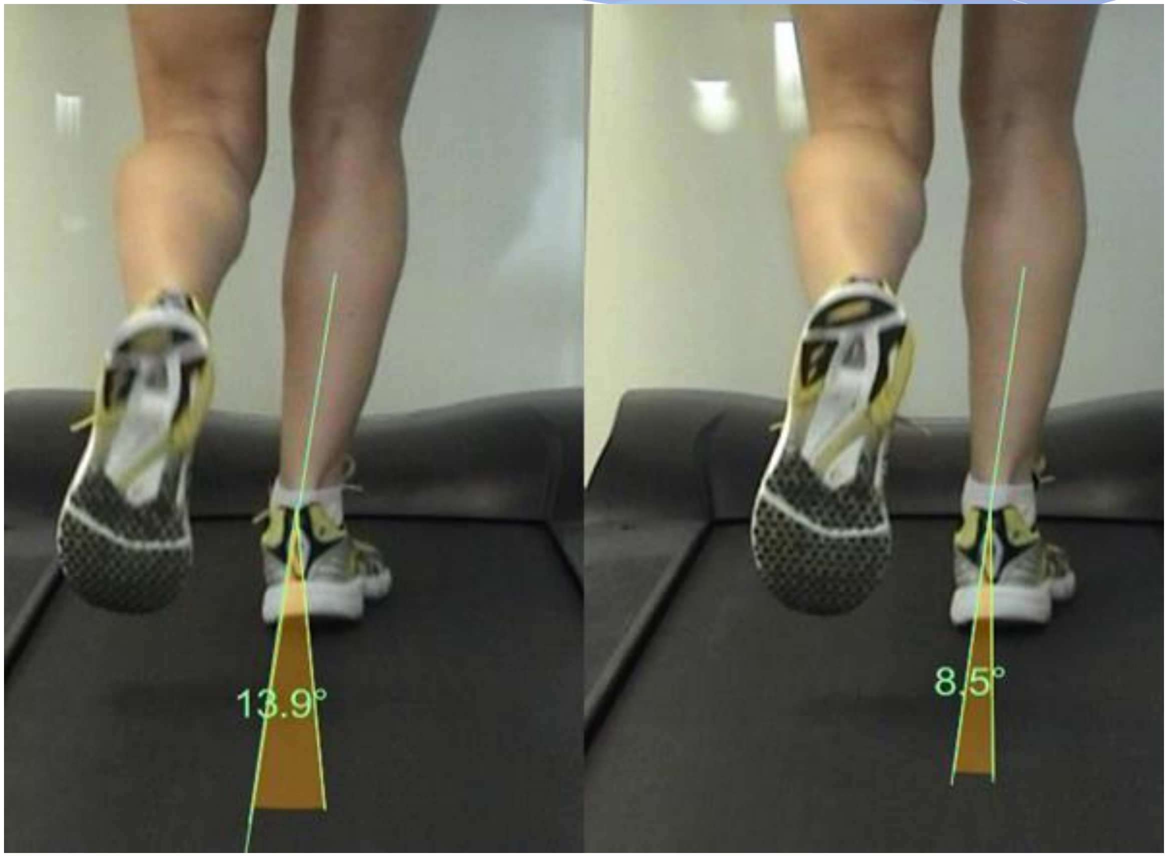
- 2. **Side View**
- Vertical Displacement
- Tibia Angle at Loading response
- Ankle Angle at contact
- Foot Strike pattern
- Overstriding
- Cadence

Treatment option outcomes:

1. Methods to reduce pronation?
2. Specific Trainers…or no trainers?
3. Running style coaching?

1) Methods to reduce pronation….

Medially wedged orthotics been shown to significantly decrease pronation velocity, Peak Pronation and Magnitude of pronation in runner (Rodrigues et al, 2012)



1) Reduce pronation

Aiming to strengthen lateral rotators and so reduce pronation (Snyder et al, 2008)

Aiming to reduce Ankle Equinus and reduce compensatory pronation(Radford et al, 2006)

Aiming to strengthen the Tibialis Anterior and reduce pronation (Galbraith & Lavallee, 2009)

1)Reduce pronation

Taping such as low dye or high dye to reduce pronatory moments with mechanical and / or proprioceptive aims

1) Correct footwear and pronation

‘Stability’ or ‘Motion Control’ Trainers

Footwear designed to reduce pronation was concluded in a recent systematic review to be effective in reducing the pronation magnitude (Cheung et al, 2011)

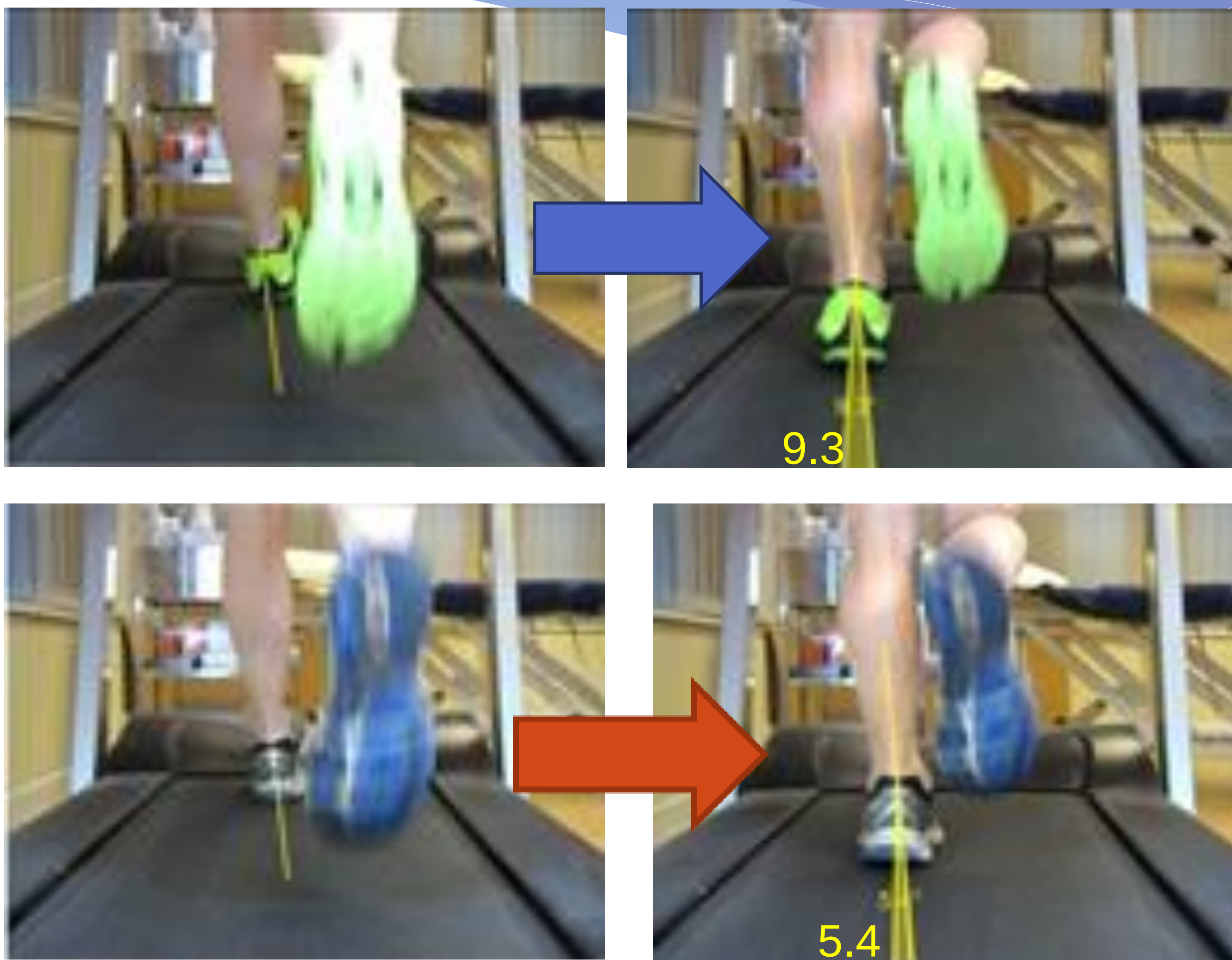
Increased medial sole EVA density (or similar) provides ‘dynamic varus wedging’

Decent ‘upper’ stiffness

And don’t let them get old!

2) Specific trainers….or no trainers?

Not as easy as it sounds…..? (Hamill et al, 2011)



‘minimalist’ running footwear

‘stability’ running footwear

3) Running style coaching

- Changing running style is complicated and requires an experienced coach
- Varied and often connected to running and triathlon clubs
- Not my area of expertise and limited time to expand upon today
- I use two running coaches (one athletic, one more endurance based)

The Coach… another part of the team?

Med Sci Sports Exerc. 2017 Mar 3. doi: 10.1249/MSS.0000000000001245. [Epub ahead of print]

RUNNING TECHNIQUE IS AN IMPORTANT COMPONENT OF RUNNING ECONOMY AND PERFORMANCE.

Folland JP[1], Allen SJ, Black MI, Handsaker JC, Forrester SE.

Author information

Abstract

Despite an intuitive relationship between technique and both running economy (RE) and performance, and the diverse techniques employed by runners to achieve forward locomotion, the objective importance of overall technique and the key components therein remain to be elucidated.

PURPOSE: To determine the relationship between individual and combined kinematic measures of technique with both RE and performance.

METHODS: Ninety-seven endurance runners (47 female) of diverse competitive standards performed a discontinuous protocol of incremental treadmill running (4 min stages, 1 km.h increments). Measurements included three-dimensional full body kinematics, respiratory gases to determine energy cost, and velocity of lactate turnpoint (vLTP). Five categories of kinematic measures (vertical oscillation, braking, posture, stride parameters and lower limb angles) and locomotory energy cost (LEc) were averaged across 10-12 km.h (the highest common velocity <vLTP). Performance was measured as Season's Best Time (SB Time) converted to a sex-specific z-score.

RESULTS: Numerous kinematic variables were correlated with running economy and performance (LEc 19 variables; SB Time 11 variables). Regression analysis found three variables (pelvis vertical oscillation during ground contact normalised to height, minimum knee joint angle during ground contact, minimum horizontal pelvis velocity) explained 39% of LEc variability. In addition, four variables (minimum horizontal pelvis velocity, shank touchdown angle, duty factor, trunk forward lean) combined to explain 31% of the variability in performance (SB Time).

CONCLUSIONS: This study provides novel and robust evidence that technique explains a substantial proportion of the variance in RE and performance. We recommend that runners and coaches are attentive to specific aspects of stride parameters and lower limb angles in part to optimise pelvis movement, and ultimately enhance performance.

The Coach… another part of the team?

Br J Sports Med. 2016 May;50(9):513-26. doi: 10.1136/bjsports-2015-095278. Epub 2016 Feb 16.

Running retraining to treat lower limb injuries: a mixed-methods study of current evidence synthesised with expert opinion.

Barton CJ[1], Bonanno DR[2], Carr J[3], Neal BS[4], Malliaras P[5], Franklyn-Miller A[6], Menz HB[2].

⊕ **Author information**

Abstract

IMPORTANCE: Running-related injuries are highly prevalent.

OBJECTIVE: Synthesise published evidence with international expert opinion on the use of running retraining when treating lower limb injuries.

DESIGN: Mixed methods.

METHODS: A systematic review of clinical and biomechanical findings related to running retraining interventions were synthesised and combined with semistructured interviews with 16 international experts covering clinical reasoning related to the implementation of running retraining.

RESULTS: Limited evidence supports the effectiveness of transition from rearfoot to forefoot or midfoot strike and increase step rate or altering proximal mechanics in individuals with anterior exertional lower leg pain; and visual and verbal feedback to reduce hip adduction in females with patellofemoral pain. Despite the paucity of clinical evidence, experts recommended running retraining for: iliotibial band syndrome; plantar fasciopathy (fasciitis); Achilles, patellar, proximal hamstring and gluteal tendinopathy; calf pain; and medial tibial stress syndrome. Tailoring approaches to each injury and individual was recommended to optimise outcomes. Substantial evidence exists for the immediate biomechanical effects of running retraining interventions (46 studies), including evaluation of step rate and strike pattern manipulation, strategies to alter proximal kinematics and cues to reduce impact loading variables.

SUMMARY AND RELEVANCE: Our synthesis of published evidence related to clinical outcomes and biomechanical effects with expert opinion indicates running retraining warrants consideration in the treatment of lower limb injuries in clinical practice.

MTSS Gait Analysis

1. **Posterior View.**

* Rearfoot maximum eversion
* Rearfoot Eversion Velocity

2. **Side View**

* Vertical Displacement
* Tibia Angle at Loading response
* Ankle Angle at contact
* Foot Strike pattern
* Overstriding
* Cadence

Treatment option outcomes:

1. Methods to reduce pronation?
2. Specific Trainers…or no trainers?
3. Running style coaching?

Added to clinical history taking treatment options of:

1. Compression running socks
2. Female athlete issues
3. Correct graded running rehab

And then you repeat the gait analysis later and check things have "improved"… (in the absence of normative data).

Conclusion

- Observational clinical gait analysis is still really in its infancy
- Although widely used, the lack of research in terms of reliability and validity must always be considered.
- However, it seems an important part of our clinical assessment in diagnosing and treating various MSK injuries
- **Best results may be obtained when the analysis is used in specific relation to symptoms and required outcomes**
- Much, much more research is required.

Bringing it all together

Real time assessment, treatment (within limitations), evidence and immediate outcomes

Live Practical Plan

- Examples will hopefully include

1. Hallux Limitus
2. Metatarsalgia
3. Dorsal interoseous compression Syndrome
4. Plantar Fasciitis
5. Lateral impingement syndrome
6. Posterior tibial tendon dysfunction
7. OA foot / Ankle or knee pain
8. Patellofemoral pain syndrome
9. Mechanics lower back pain (LBP)

Paediatric Pes Planus, Rheumatoid foot pain and Diabetic related Gait Dysfunction may not be present….but I have slides for these (and the above if needed)

Patient Assessment in relation to case examples

1. First example will include recap slides on the assessment criteria
2. Other examples will then become quicker, and more of an example of a normal clinical assessment
3. We can use examples current orthotics to assess outcomes, plus tape and felt etc.
4. I'll need to jump around my slides to pick out the relevant ones to each case…. please be patient!
5. Questions are welcome!

Volunteers

- Examples will hopefully include

1. Hallux Limitus
2. Metatarsalgia
3. Dorsal interosseous compression Syndrome
4. Plantar Fasciitis
5. Lateral impingement syndrome
6. Posterior tibial tendon dysfunction
7. OA foot / Ankle or knee pain
8. Patellofemoral pain syndrome
9. Mechanical Lower back pain (LBP)

Please only volunteer if you really want to. We will be assessing you in shorts laying, walking and (if normal for you) running. We may ask to look at your back. We will be asking medical history questions. We may laugh at your silly walk.

Paediatric Pes Planus, Rheumatoid foot pain and Diabetic related Gait Dysfunction may not be present….but I have slides for these (and the above if needed)

Example 1 please (examples need to be able to see the screen)

- Ideally the first couple of examples should not be runners (so we can add running later to assessment)
- Hallux limitus (or metatarsalgia… or both!) would be a great start

Example 1 please (examples need to be able to see the screen)

- Brief History
- Clinical Symptom assessment
- Static Non weight bearing assessment
- Static weight bearing assessment
- RTCGA (Walking and running if required)
- CGA (Walking and running if required)
- Treatment / intervention
- Outcome assessment

Recap

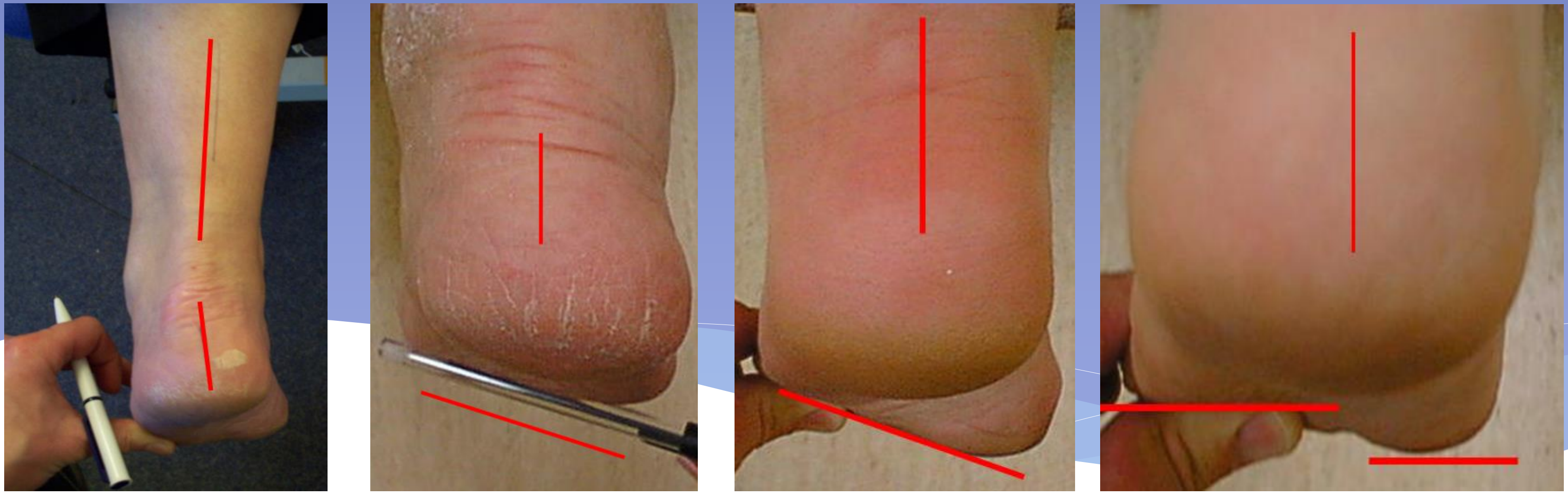
Static Non WeightBearing Assessment

Non weightbearing assessment

- Foot Morphology
- Ankle Dorsiflexion
- Hallux dorsiflexion

Classic Foot Morphology

Rearfoot Varus
Forefoot Varus
Forefoot Valgus
1st Ray Position



Classic Foot Morphology

Rearfoot Varus
Forefoot Varus
Forefoot Valgus
1st Ray Position

We are no longer trying to categorise "normal" or "abnormal" to foot morphology, but more the effect the present foot morphology may have on stance, gait and symptoms.

By recognising foot morphology (including asymmetry) we can be SENSIBLE in beginning to understand the role of the foot in the patients symptoms

Non weight bearing assessment (inc. Foot Morphology)

↓

Static weight bearing assessment

↓

Dynamic assessment

↓

(Activity Specific Assessment)

Classic Foot Morphology

- BUT lets be sensible… there are major issues in reliability, repeatability and validity with ALL these foot morphology ‘measurements’
- A 4 degree forefoot varus does NOT equate to exactly 4 degrees of pronation in stance and then gait..
- …who taught us / teaches us this?!

> It is hard to imagine a more stupid or more dangerous way of making decisions than by putting those decisions in the hands of people who pay no price for being wrong.
>
> Thomas Sowell

Classic Foot Morphology

Rearfoot Varus
Forefoot Varus
Forefoot Valgus
1st Ray Position

We are no longer trying to categorise "normal" or "abnormal" to foot morphology, but more the REALISTIC effect the present foot morphology may have on stance, gait and symptoms… .if any!

Jarvis H et al. 2017. Challenging the foundations of the clinical model of foot function: further evidence that the root model assessments fail to appropriately classify foot function. Journal of Foot and Ankle Research. 10:7

Foot Morphology and uniformity of assessment

The foot should be examined with:

- **The knee joint fully extended**
- **The foot at 90 degrees to the leg**
- **The STJ in ‘neutral’**
- **The MTJ fully pronated**

Why 'STJ Neutral' Foot Morphology for uniformity of assessment?

Critical Points….

- **It has moderate repeatability**
- **The 'normal' foot never passes through this position in gait**
- **Its not the actual STJ neutral, its talonavicular congruency**
- **But…it's all we have.**

Why a ‘fully pronated MTJ’ for Foot Morphology uniformity of assessment?

The foot should be examined with:

- **The knee joint fully extended**
- **The foot at 90 degrees to the leg**
- **The STJ in ‘neutral’**
- **The MTJ fully pronated**

Reference point for Foot Morphology (or our version of 0 in maths)

- **In STJN the rearfoot is parallel to the lower 1/3 of the leg**
- **The forefoot is perpendicular to the rearfoot.**

Classic Foot Morphology

Rearfoot Varus

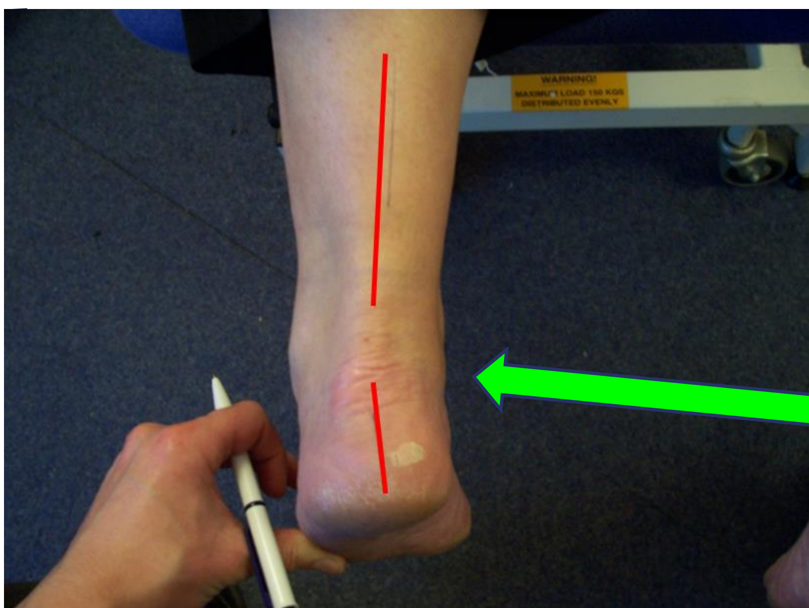
Forefoot Varus

Forefoot Valgus

1st Ray Position

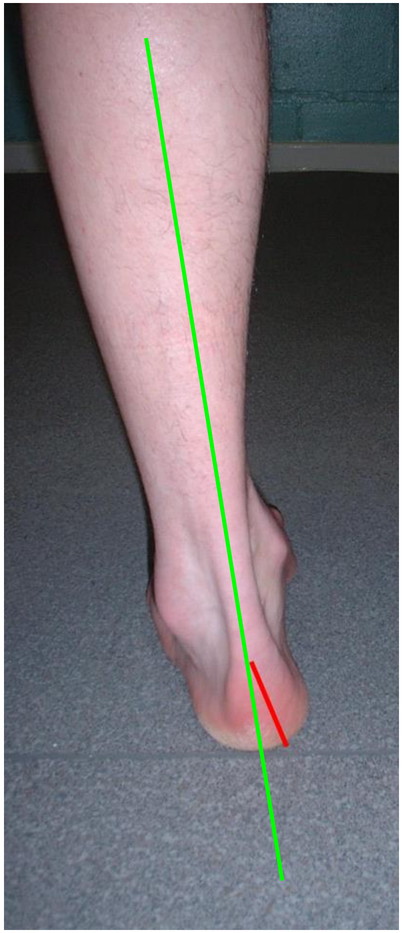
Rearfoot Varus

- **Where the rearfoot is inverted in relation to the lower 1/3 of the**



A Subtalar Varum

Rearfoot Varus



Tibial varum

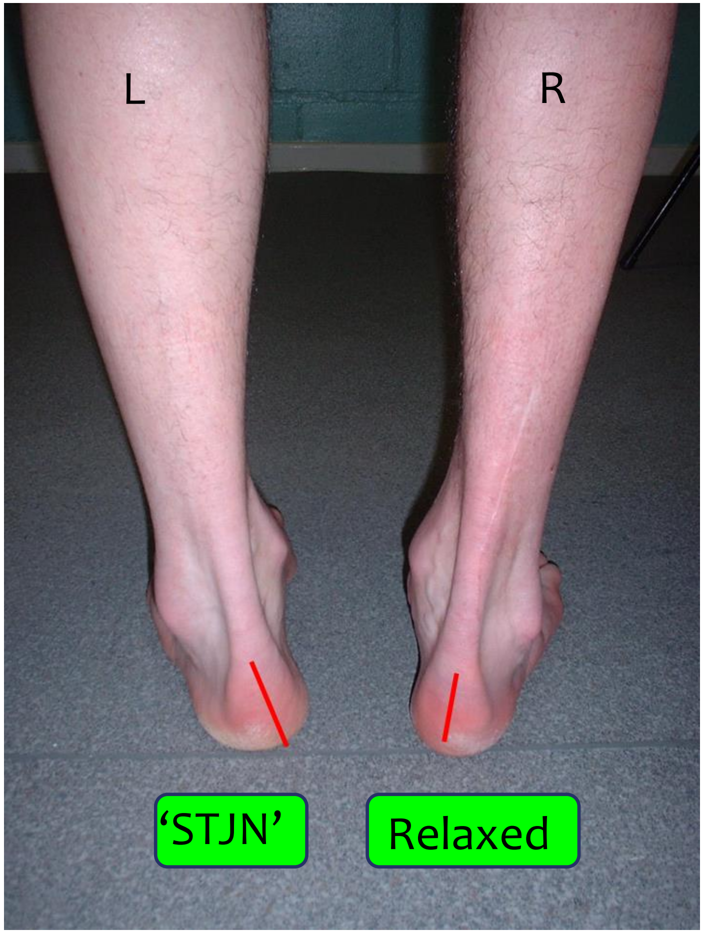
\+

Subtalar Varum

=

Rearfoot frontal plane calcaneal position in stance

Large Rearfoot Varus and understanding the STJ – A clinical point



Symmetrical lower limb morphology

The right side remains approximately 10 degrees INVERTED to the floor yet is maximally pronated

If the rearfoot is 20 degrees inverted in 'STJN', with 10 degrees eversion available…it will still be 10 degrees INVERTED in stance often with a "nice arch"

When relaxed the foot looks supinated, but is in fact MAXIMALLY PRONATED

Effect of a rearfoot varus on stance and gait

- A trend for increased pronation moments and magnitude from the contact phase

Forefoot Varus

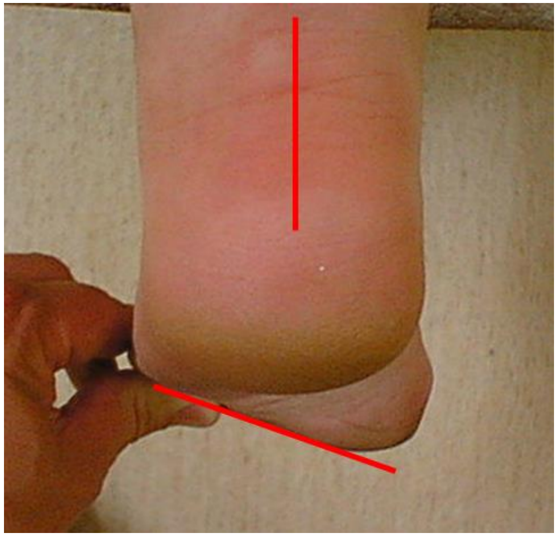
- **Where the forefoot is inverted in relation to the rearfoot**

Effect of a Forefoot varus on stance and gait

- A trend for increased pronation moments and magnitude from midstance (forefoot loading)

Forefoot Valgus

- **Where the forefoot is everted in relation to the rearfoot**



Left

Forefoot Valgus

- But, there are two foot shapes which will every the forefoot in relation to the rearfoot

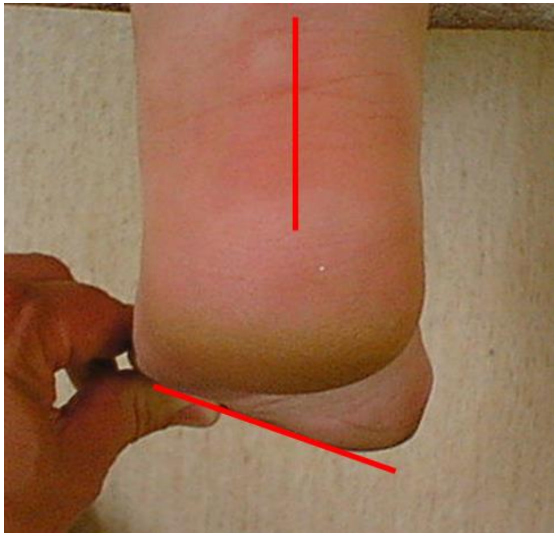
1) A Total forefoot valgus

2) A plantarflexed first ray

Forefoot Valgus

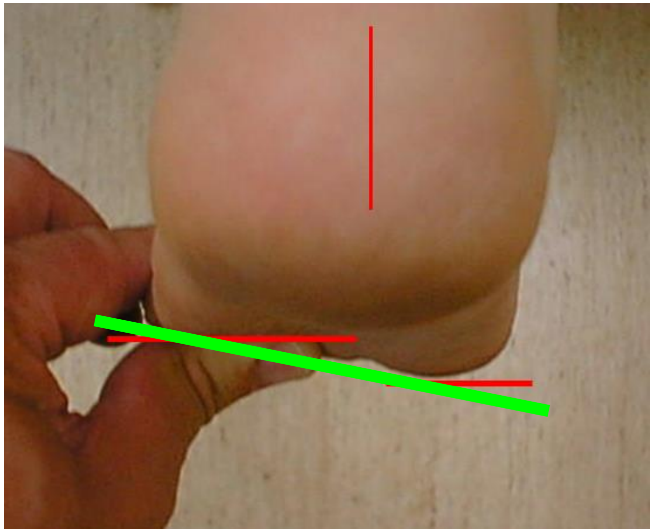
- **Where the forefoot is everted in relation to the rearfoot**

1) A total forefoot valgus



Left

2) A Plantarflexed 1st Ray



Left

Effect of a Forefoot valgus and / or plantarflexed first ray on stance and gait

A trend for increased Dorsiflexion moments on the 1^{st} ray

↓

If large enough, increased supination moments across the MTJ

↓

If large enough, increased supination moments across the STJ

Ankle Dorsiflexion

- Weight-bearing and non weight-bearing methods of measurement
- Lunge with knee extended most valid to ROM in gait (Kang and oh, 2017)
- Significant difference between weight-bearing and non weight-bearing methods (Rabin and Kozol, 2012)

Ankle Equinus

- **Where there is less than 10 degrees of dorsiflexion available at the ankle joint with the foot in STJN**

Ankle Equinus

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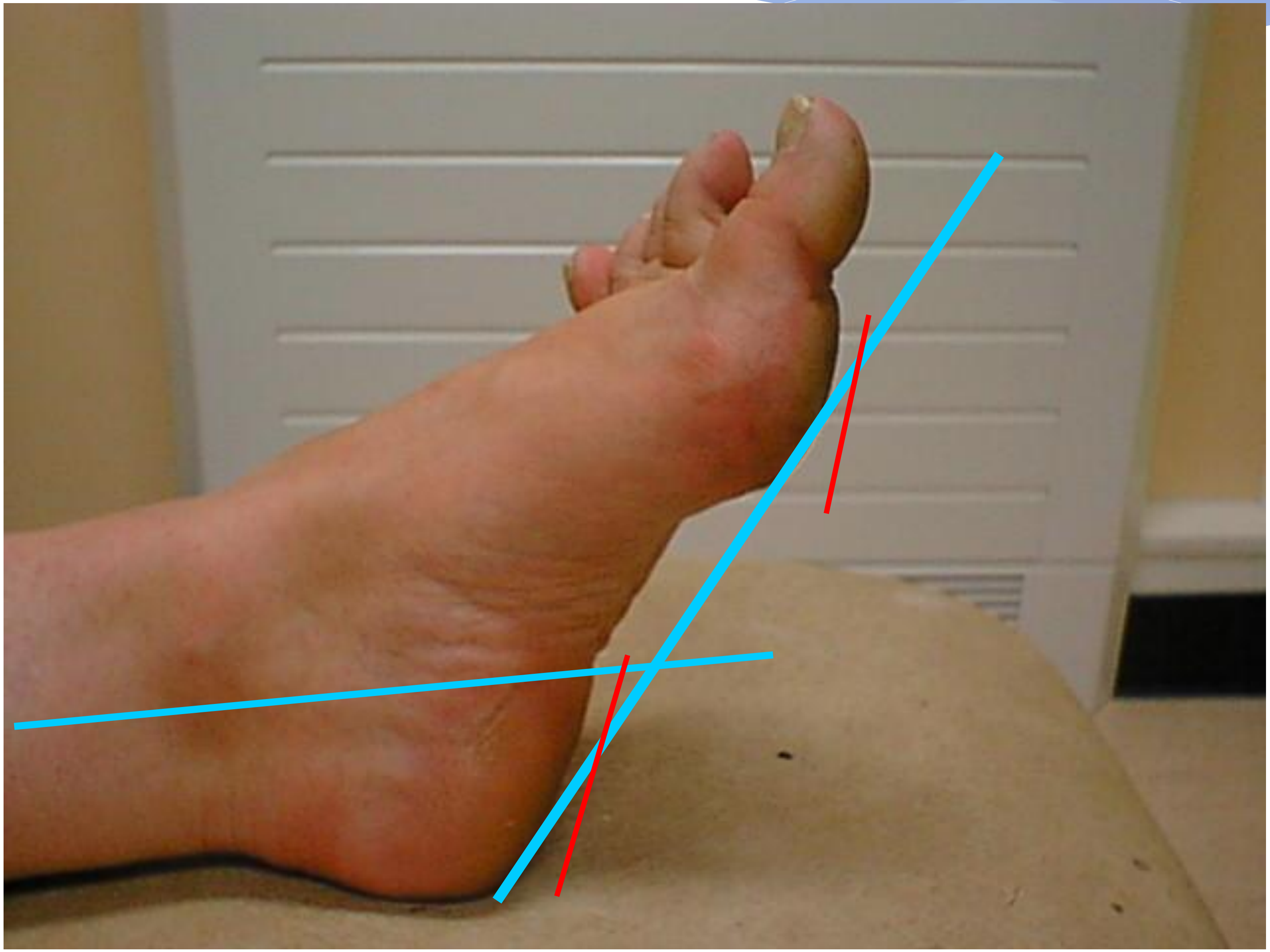
Ankle Equinus



Ankle Equinus - aetiology

- Soft tissue - Gastrocnemius / Soleus tightness
- Osseous - Osteophytic lipping of the Anterior aspect of the Tibia (an anterior tibial spur, or “footballers ankle”)
- Osseous - Arthritis

Effect of an ankle equinus on stance and gait

- A trend for increased Pronation moments from midstance

- Rules of compensation:

1. Joint closest
2. Motion in the required direct
3. Subject to the same directional forces
4. Supplied enough ROM (to fully compensate)

Structural Hallux Limitus

- Required range of motion for walking gait varies in literature between 55 and 65 degrees

Recap

static Weightbearing Assessment

Routine static weight-bearing assessment

- International Musculoskeletal Foot and Ankle Assessment (IMFAA) and 5 additional tests .

- IMFAA is a core set of MSK foot and ankle assessment derived via expert agreement (Gates et al, 2015)

- It includes observation for Ankle Joint Dorsiflexion, 1st MTPJ Dorsiflexion and the Foot Posture Index

- Five additional tests often used are the Supination Resistance Test, the Maximum Pronation Test, Navicular Drop Test, Hubscher Test and Observation of Position of Subtalar Joint Axis (STJA)

Routine static weight-bearing assessment

- Ankle Joint Dorsiflexion
- FPI-6
- Supination Resistance Test
- Maximum Pronation Test
- Navicular Drop Test
- Hubscher Test
- Observation of Position of Subtalar Joint Axis (STJA)

Ankle Dorsiflexion

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The Foot Posture 6 Index (FPI-6)

	FACTOR	PLANE	SCORE 1 Date___________ Comment_________		SCORE 2 Date___________ Comment_________		SCORE 3 Date___________ Comment_________	
			Left (-2 to +2)	Right (-2 to +2)	Left (-2 to +2)	Right (-2 to +2)	Left (-2 to +2)	Right (-2 to +2)
Rearfoot	Talar head palpation	*Transverse*						
Rearfoot	Curves above and below lateral malleoli.	*Frontal/ trans*						
Rearfoot	Inversion/eversion of the calcaneus	*Frontal*						
Forefoot	Bulge in the region of the TNJ	*Transverse*						
Forefoot	Congruence of the medial longitudinal arch	*Sagittal*						
Forefoot	Abd/adduction of forefoot on rearfoot (too-many-toes).	*Transverse*						
	TOTAL							

Reference values
Normal = 0 to +5
Pronated = +6 to +9, Highly pronated 10+
Supinated = -1 to –4, Highly supinated –5 to -12

https://www.leeds.ac.uk/medicine/FASTER/z/pdf/FPI-manual-formatted-August-2005v2.pdf

The Foot Posture 6 Index (FPI-6)

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- Good inter and intra tester reliability noted (Evans et al 2003, Cornwall et al, 2008)

- Gives a standing static foot posture score allowing comparison to previous notes:

➢ 0-5 Normal
➢ +5 to +12 Pronated (the greater the positive number, the greater the pronation)
➢ -1 to -12 Supinated (the greater the negative number, the greater the supination)

The Supination Resistance Test

Used to assess the amount of force required to resupinate the STJ

With the patient in relaxed bipedal stance two or three fingers are placed under the navicular area and the examiner exerts a steady force to try to supinate the STJ

The Supination Resistance Test

Grade	Finding	Foot function clinical 'assumption' / possible cause
Easy	With moderate effort, the foot is easily supinated onto its lateral border	Abnormally small pronatory forces
Moderate	With moderate effort, the foot is supinated slightly	Normal
Hard	With moderate effort, the foot cannot be supinated	Abnormally large pronatory forces

The Supination Resistance Test

Reliability

- Noakes H, Payne C.J Am Podiatr Med Assoc. 2003 May-Jun;93(3):185-9.**The reliability of the manual supination resistance test.**

* The test had good reliability overall, with an intertester intraclass correlation coefficient of 0.89. For the two more experienced clinicians, the intratester intraclass correlation coefficients were good (0.82 and 0.78), but for the two inexperienced clinicians they were poor (0.56 and 0.62). The supination resistance test **may** be clinically useful in the prescription of foot orthoses, but more work is needed to determine its validity and its relationship to gait.

The Supination Resistance Test

Validity

- Griffiths IB, McEwan IM.. **Reliability of a new supination resistance measurement device and validation of the manual supination resistance test.** J Am Podiatr Med Assoc 2012 Jul-Aug;102(4):278-89.

- In this study, the force required to supinate a foot was independent of its posture, and approximately 12% of it was explained by body weight. Further work is required with a much larger sample size to build regression models that sufficiently predict supination resistance force and that will be of clinical use

The Maximum Pronation Test

Used to assess reserve of pronation, and therefore if the patient is maximally pronated irrespective of arch height

With the patient in relaxed bipedal stance, ask the patient to "roll down their arches" while assessing for calcaneal eversion. The knees should be prevented from flexing

The Maximum Pronation Test

Grade	Finding	Foot function clinical 'assumption' / possible cause
Maximally Pronated	Less than 2 degrees rearfoot eversion	No reserve of pronation, therefore abnormally pronated
Not maximally pronated	Greater than 2 degrees rearfoot eversion	Reserve of pronation, therefore not maximally pronated

The Maximum Pronation Test

Reliability and Validity

No papers forthcoming on either reliability or validity

BUT:

Javier Pascual Huerta, Juan Manuel Ropa Moreno, and Kevin A. Kirby Static Response of Maximally Pronated and Nonmaximally Pronated Feet to Frontal Plane Wedging of Foot Orthoses. J Am Podiatr Med Assoc 2009. 99: 13-19.

1. This paper did not test for reliability of the maximum pronation test

2. This paper found that a 10 degree valgus wedge with a maximally pronated foot caused a mean further calcaneal eversion of 3.9 degrees....**validity????**

The Navicular Drop Test

Indicates the amount of pronation relevant to the STJ, not the arch height

With the patient standing, record the height of the navicular tubecle in talo-navicular congruency and then relaxed

The Navicular Drop Test

Reliability and validity

Used in research to link to certain injury (e.g. ACL) (Jenkins, 2008)

Slight discrepancy on the definition of normal and abnormal, because some authors have used seated talo-navicular congrueny to standing relaxed.

General consensus at present is a ND of over 10mm (to 15mm) is classed as 'abnormal pronation'

Foot size issues

The Navicular Drop Test

Reliability

McPoil TG et al. Reliability and normative values for the foot mobility magnitude: a composite measure of vertical and medial-lateral mobility of the midfoot. J Foot Ankle Res. 2009 Mar 6;2:6

Navicular drop has high levels of intra-rater reliability, poor to moderate levels of inter-rater reliability and a lack of normative data from a large cohort of healthy individuals

The Hubscher Test

Used to assess the available dorsiflexion of the hallux in closed kinetic chain

With the patient in relaxed bipedal stance, passively attempt to dorsiflex the hallux via the distal phalanx

The Hubscher Test

Grade	Hallux dorsiflexion	Effect on proximal structures	Foot function clinical 'assumption' / possible cause
0	Nil	Nil	Marked FnHL
1	Slight	Nil	FnHL
2	Yes, with resistance	Slight arch raising with limited external leg rotation	Normal
3	Yes, with limited resistance	Complete arch raising with obvious external leg rotation	Possible supinator

The Hubscher Test

No Reliability testing on the current grading system

For validity:

Halstead J, Redmond AC.Weight-bearing passive dorsiflexion of the hallux in standing is not related to hallux dorsiflexion during walking. J Orthop Sports Phys Ther. 2006 Aug;36(8):550-6

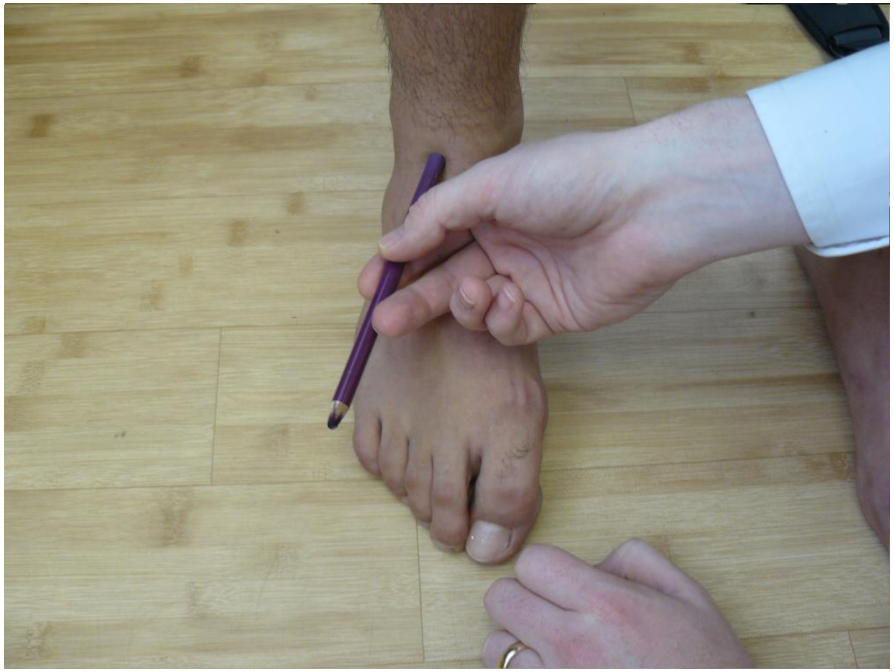
Useful for quick orthotics checks possibly?

Subtalar Joint Axis (STJA) Position

- Reliability and validity
- Payne C et al. **Position of the subtalar joint axis and resistance of the rearfoot to supination.** J Am Podiatr Med Assoc. 2003 Mar-Apr;93(2):131-5.
- The more medial the axis, the greater the force required to supinate the STJ
- The model on which determination of the subtalar joint axis is based may not be valid, but it might help determine how much force is needed to supinate a foot using foot orthoses.
- No relation established to gait or injury…

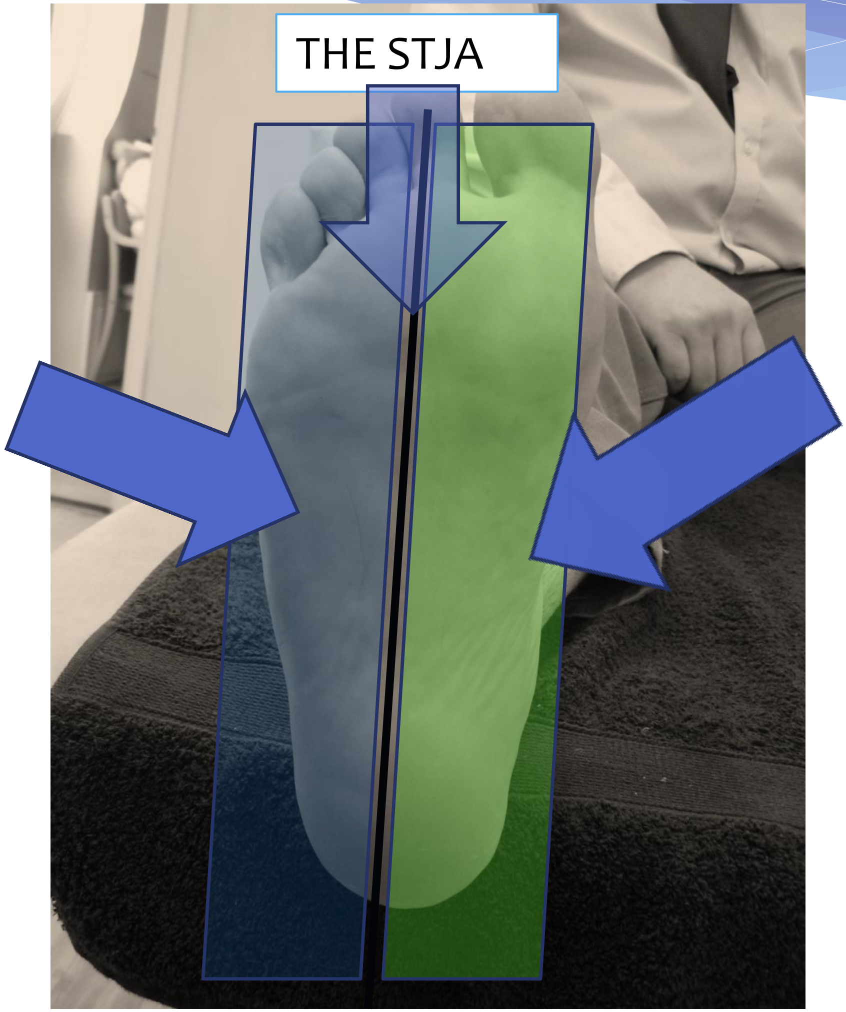
STJA POSITION

This is tricky, and you can't jam a sharpened knitting needle in the talar neck after a quick ice spray….



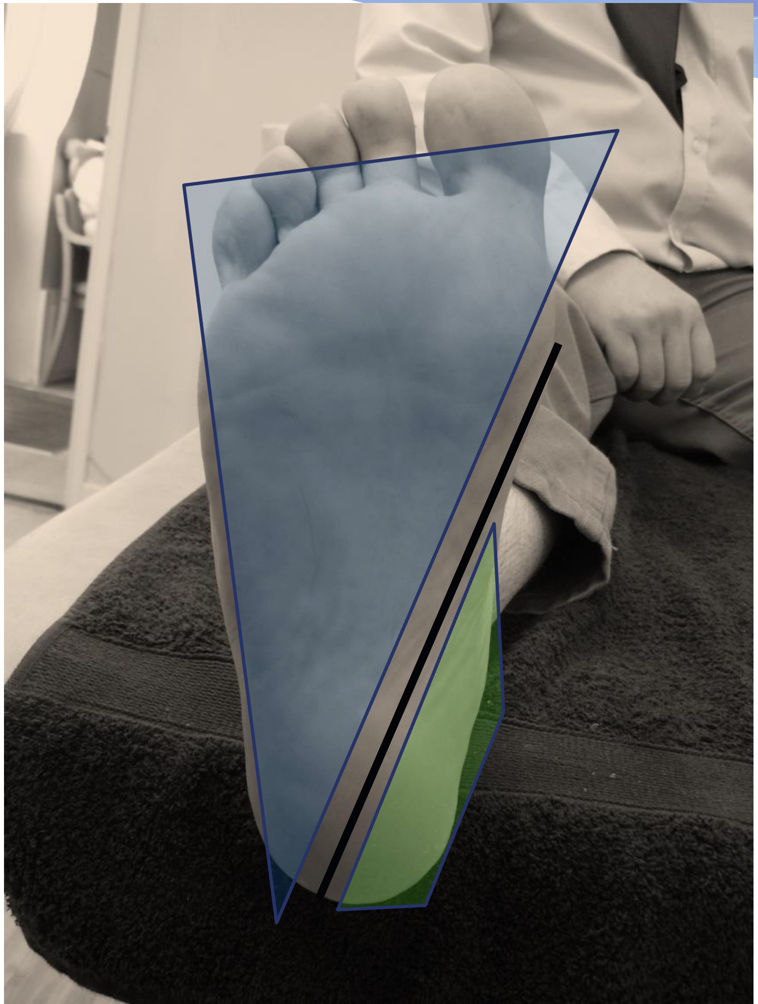
Normal STJ and Foot Function

Lateral to the STJA



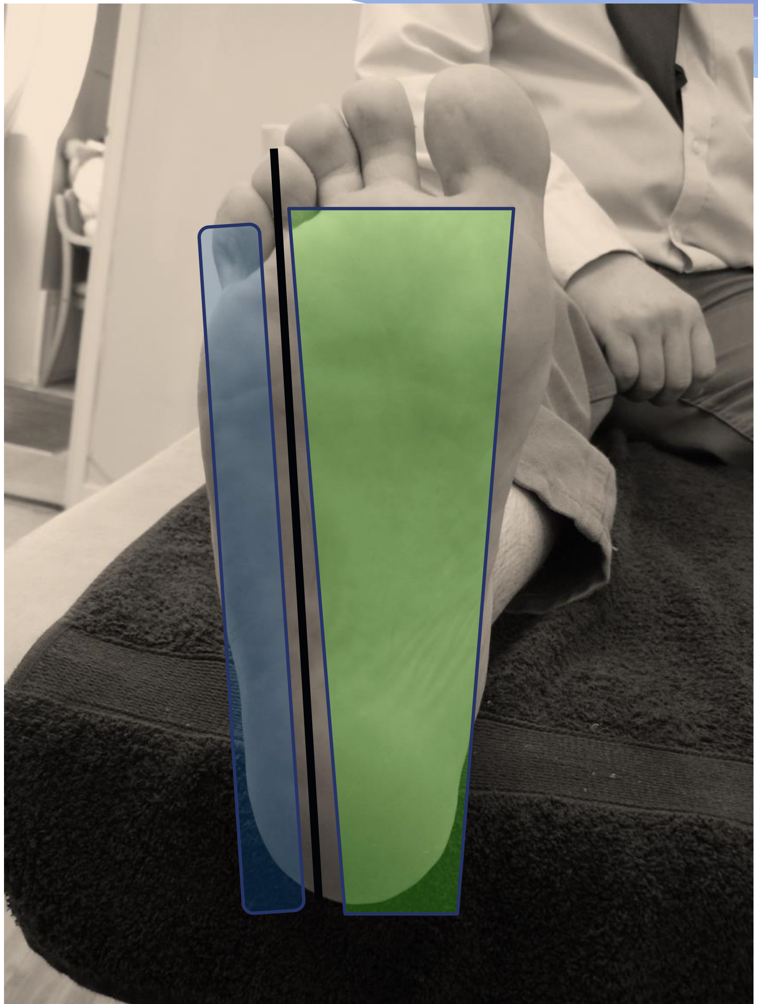
Medial to the STJA

But what if the axis was NOT in the 'middle'.....



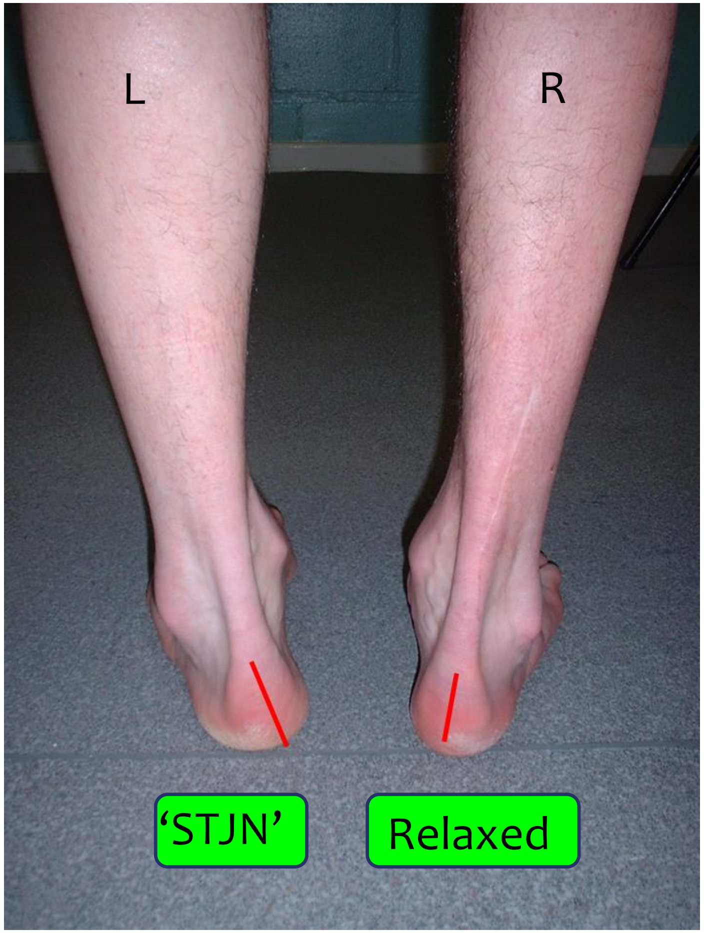
- But had instead moved medially......

But what if the axis was NOT in the 'middle'.....



- But had instead moved or laterally......

Large Rearfoot Varus and understanding the STJ – A clinical point



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Why aren't we talking about Arch Height?

African Americans have significantly lower Calcaneal pitch (lower arches) than Caucasians ($p < 0.0001$) and Hispanics ($p < 0.0016$). (Castro-Aragon et al, Foot Ankle Int, 2009).

There is no significant incidence of foot injury or ability associated with any of these ethnic groups

Practical Weightbearing static examination

- Ankle Joint Dorsiflexion
- FPI-6
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FPI-6

Foot Posture Index Datasheet

Patient name	***ID number***

	FACTOR	PLANE	SCORE 1 Date________________ Comment___________		SCORE 2 Date________________ Comment___________		SCORE 3 Date________________ Comment___________	
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Recap

Normal Foot Function in Standing

Normal Foot Function in Standing

- Many people spend more time standing than walking.
- Often a day is combined between both, with prolonged episodes of standing

Normal Foot Function in Standing

- In standing, the foot needs to provide a stable base for which relaxed bipedal stance can occur
- While in this position, ideally the foot should rest in equilibrium

Normal Foot Function in Standing

- Structures which oppose supination or pronation moments should not be placed under excessive stress which may result in injury
- Pressure should not be raised to a point where skin lesions or plantar joint irritation can occur
- Joint compression should not be increased to cause injury

Recap

Abnormal Foot Function in Standing

Abnormal Foot Function in Standing

- Structures which oppose supination or pronation moments should not be placed under stress which may result in injury

Abnormal Foot Function in Standing

- In Stance, this may be prolonged resulting in Creep past the point of Tissue Elasticity

deformation

Constant load

Abnormal Foot Function in Standing

- Foot and ankle structures which may reduce pronation moments include, and therefore may become symptomatic in standing with increased pronation include:

- 1) Plantar fascia
- 2) Plantar foot ligaments which cross the midtarsus
- 3) Posterior Tibial Muscle and Tendon

Abnormal Foot Function in Standing

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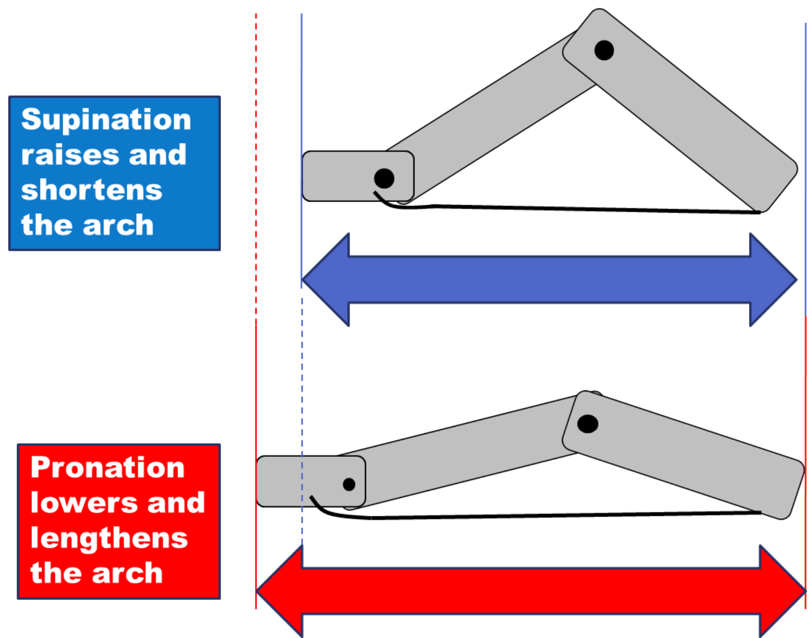

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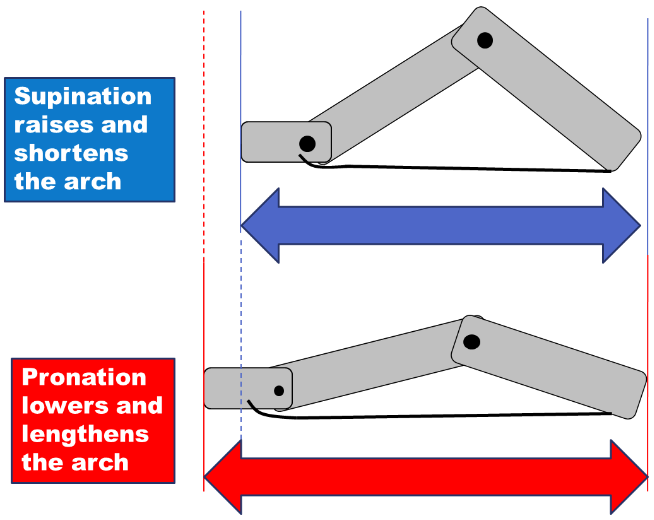


Abnormal Foot Function in Standing

- Foot and ankle structures which may reduce pronation moments, and therefore may become symptomatic in standing with increased pronation, include:

- 3) Posterior Tibial Muscle and Tendon

Abnormal Foot Function in Standing

- Foot and ankle structures which may reduce supination moments include:

- 1) Lateral ankle ligaments
- 2) Peroneal muscle Group

Abnormal Foot Function in Standing

Pressure should not be raised to a point where skin lesions or plantar joint irritation can occur

Abnormal Foot Function in Standing

Joint compression should not be increased to cause symptoms. Increased pronation increases dorsal midfoot interosseous compression forces

LEG LENGTH DIFFERNCE (STRUCTURAL)

Structural Leg Length Difference

- There is a broad range of "functional" and "structural" causes of LLD, and combinations of both
- These vary across professions and terminology
- For today, we can't discuss all the various combinations and clinical methodologies and terminologies!

Structural Leg Length Difference (SLLD)

- “Structural, anatomical or actual LLD are synonymous terms and are diagnosed when either the femur or tibia is longer in one leg than in the other, as shown on X-ray.” (Mannello 1992)

Incidence of SLLD

- With combining available ‘accurate’ imaging research:

1. The mean SLLD = 5.23mm (n=573)

Incidence of SLLD

- With combining available ‘accurate’ imaging research:

1. The mean SLLD = 5.23mm (n=573)
2. The right leg is anatomically shorter more often (n=272)
3. There is no effect of gender (n=116)
4. There appears no correlation with height (n=247)

Incidence of SLLD

- With combining further imaging papers which looked at ranges of SLLD rather than mm increments (n= 2,978):

1. 41.3% had a SLLD of 0-4mm
2. 37.4 % had a SLLD of 5-9mm
3. 20% had a SLLD of 10mm
4. 15% had a SLLD of 10-14mm
5. 6.4% had a SLLD of greater than 14mm

(Knutson, 2005)

Incidence of SLLD

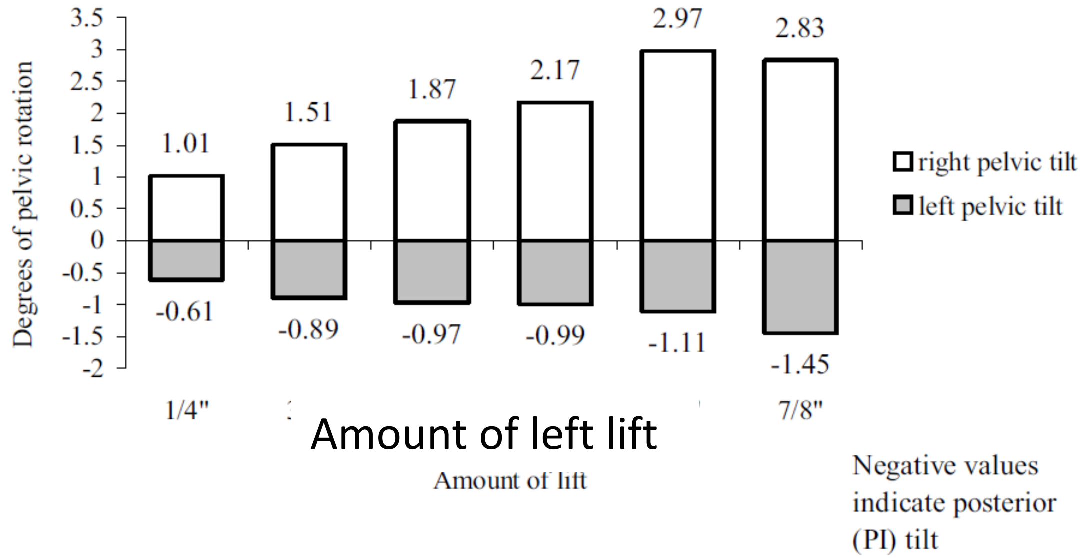
- 90% of the population have a SLLD of some amount (Korpelain et al, 2001)

- It has been calculated that in a population of 2.68 million, larger SLLD (in excess of 20mm) is present in 1/2000 of the population. (Guichet et al, 1991)

Effect of SLLD

- The most common effect stated is that of "pelvic torsion" in the frontal and sagittal planes (Knutson 2005)
- Cummings, 1993, found an almost linear relationship between imposed "foot lifts" and pelvic rotation. Motion was anterior on the shorter side.

Effect of SLLD



Cummings, 1993

- A later literature review (Cooperstein & Lew 2009) agreed with these findings. They concluded that across varying methodologies for measuring LLD and pelvic torsion, a consistent, dose-related pattern was identified in which the innominate rotates anteriorly on the side of a shorter leg and posteriorly on the side of the longer leg.

Effect of SLLD

- Walsh et al (2000) found that pelvic obliquity was the most common method of compensating for SLLD up to 22 mm. With larger amounts of leg length inequality, subjects begin to develop flexion of the knee in the long leg

Effect of SLLD – What about Scoliosis?

* Postural Scoliosis is often stated in the literature (Giles 1981, Merriman & Tollafield 1994, Subotnik 1999).

* Raczkowski et al 2010, diagnosed a functional scoliosis as one which develops due to a SLLD, and totally or partially resolves when leg length is equalised

* In their paper they treated 374 children with a SLLD under 2cm and a scoliosis, but also comment that SLLDs of less than 2cm "seldom cause a problem".

Effect of SLLD – Scoliosis?

- One paper from 1982 (Papaioannou et al) of adults (mean age 28) with large SLLD since childhood (mean 29.1 mm) found Lumbar scoliosis was minor in those less than 22 mm

- This value of around 20mm seems quite common in the theme of the clinical relevance of SLLD….

Effect of SLLD

- Needham R et al (2012) concluded in their paper that it is a common assumption that SLLD causes LBP by creating pelvic torsion and lumbar scoliosis

- BUT, in induced SLLD of 1,2 and 3cm differences in ROMs and patterns of movement for the pelvis and spine were “minimal”

How much SLLD is clinically significant

- If the effect of a SLLD is pelvic torsion and other effects such as scoliosis….does this link to lower back pain (LBP) or other lower limb pains?

- And if so, how much?

How much SLLD is clinically significant?

- Mannello (1992) concisely concluded that clinical significance is dependent on several factors, including the degree of inequality, the ability of the pelvis and spine to compensate and associated conditions or problems.

Clinical significance of SLLD and Symptoms

- Using the incidence studies, there was a combination of symptomatic (n=347) and non-symptomatic (n=165) samples.
- The mean SLLD in symptomatic was 5.1mm (SD 3.9)…… and for asymptomatic 5.2mm (SD 4.2)
- From this, can we begin to infer that SLLD is actually not linked to lower back pain in this sample?

Clinical significance of SLLD and LBP

- When discussing the clinical significance SLLD, Friberg's 1983 study is most often cited
- Friberg collected data on 1,157 subjects; 798 with chronic LBP and a control group of 359 with no LBP
- His sample was **active military personnel**

Clinical significance of SLLD and LBP

- Friberg concluded "LLI was 5 mm or more in 75.4% of the patients with LBP and 43.5% of the controls. The difference is statistically significant."

- However, if chronic LBP is caused by a 5mm SLLD, over 50% of the population would be expected to present with LBP? (Rather than 21%, Anderson 1999)

Clinical significance of SLLD and LBP

- In replying to letters to the editor highlighting a similar point, Friberg (1992) wrote, "... I have always pointed out that LLI of less than 5 mm has no relationship with lumbar scoliosis or back pain. I have also emphasized that even marked LLI *per se* neither produces LBP nor contributes to its development if a person is not continually exposed to prolonged standing or gait, e.g., during daily work, military training, and sporting activities"

- So, Friberg notes that 'normal' SLLD may only be clinically significant relative to certain conditions such as prolonged and/or repetitive loading, as in a military population

Clinical significance of SLLD and LBP

- These findings are supported by a recent study by Rannisto et al, 2015. Leg-length discrepancy is associated with low back pain among those who must stand while working. *BMC Musculoskeletal Disorders.*

"Our study found a significant association between LLD of 6 mm or more and low back symptoms. The association was apparent among meat cutters, who stand while working, but not among customer service workers, who mostly sit while working."

Clinical significance of SLLD and lower OA

- Murray & Azari. Leg length discrepancy and osteoarthritis in the knee, hip and lumbar spine. *J Can Chiropr Assoc 2015*

"There is a significant body of literature linking LLD and knee OA, and to a lesser extent hip OA. However, there is little research attention that has been paid to date to the relationship between mild LLD and OA of the lumbar facet joints or lumbar disc degeneration"

Clinical significance of SLLD and lower limb pain

- Golighty et al. Symptoms of the knee and hip in individuals with and without limb length inequality. *Osteoarthritis and Cartilage (2009)*

"LLI was moderately associated with chronic knee symptoms and less strongly associated with hip symptoms. LLI may be a new modifiable risk factor for therapy of people with knee or hip symptoms."

Clinical significance of SLLD and lower limb pain

- HOWEVER…..

Goss et al. Comparison of injury rates between cadets with limb length inequalities and matched control subjects over 1 year of military training and athletic participation. *Mil Med. 2006*

OBJECTIVES: To compare lower-limb overuse injury and low back pain incidence among cadets with and without limb length inequality (LLI) over 1 year of military training and athletic participation.

METHODS: A total of 1,100 cadets were screened for LLIs; 126 of 1,100 were identified to have a LLI of > 0.5 cm and were assigned a matched control cadet. Injury rates, numbers of visits to sick call, and numbers of days spent on medical excusal during a 1-year period were then compared for the 252 cadets.

RESULTS: There was no difference in prevalence of injury between the groups and no significant differences ($p > 0.05$) between the groups in injury rates, visits to sick call, or number of days spent on medical excusal.

CONCLUSIONS: These findings do not support any increased incidence of injuries in a young, healthy, athletic, military population with mild LLIs, compared with matched control subjects without LLIs, over 1 year.

Clinical significance of SLLD and LBP

- Although Friberg may present 5mm SLLD as clinically significant in an active population, other authors question if less than 30mm has any clinical significance (McCaw & Bates,1991. Reid & Smith,1984).

- The general lack of consensus is confusing clinically, but not exactly surprising when the complexity of the problem and symptoms linked to it are taken into account

Clinical significance of SLLD and LBP

- Soukka et al (1991), in a study of 247 working age men and women, examined and compared statistically matched groups with and without LBP.

- Their results showed no increased risk of back pain with a SLLD of 10–20 mm, and the relationship between SLLD of more than 20 mm and back pain was not conclusive.

Clinical significance of SLLD and LBP

- These results differ markedly from that of Friberg, prompting the letter-to-the-editor noted earlier.

- Both Friberg and Souka agree that the significance of SLLD may depend on the amount of prolonged and repetitive loading

How about adult onset SLLD

- Post THR, SLLD not only is associated with patient dissatisfaction, but also is the most common reason for litigation.

- SLLD after THR has been associated with complications including sciatic, femoral, and peroneal nerve palsies, low back pain, abnormal gait and dislocation (Meermans et al, 2011).

Research on adult onset SLLD

Hip Int. 2013 Jan-Feb;23(1):6-14. doi: 10.5301/HIP.2013.10631.

A review of symptomatic leg length inequality following total hip arthroplasty.

McWilliams AB[1], Grainger AJ, O'Connor PJ, Redmond AC, Stewart TD, Stone MH.

Author information

Abstract

Leg length inequality (LLI) following total hip replacement is a complication which features increasingly in the recent literature. The definition of LLI is complicated by lack of consensus regarding radiological measurement, clinical measurement and the incomplete relationship between LLI and associated symptoms. This paper reviews 79 reports relating to LLI post hip replacement, detailing definitions and classification and highlighting patient populations prone to symptomatic LLI. While there is no universal definition of LLI, there is a broad consensus that less than 10 mm of difference on AP view plain radiographs is clinically acceptable. There are few techniques described that consistently produce a postoperative LLI of less than this magnitude. Where postoperative LLI exists, lengthening appears to cause more problems than shortening. In cases of mild LLI, non-surgical management produces adequate outcomes in the majority of cases, with functional LLI cases doing better than those with true LLI. Operative correction is effective in half of cases, even where nerve palsy is present, and remains an important option of last resort. Poor outcomes in patients with LLI may be minimised if individuals at risk are identified and counselled appropriately.

So, does LLD link to LBP?

- It appears it may do ONLY in specific active populations or following surgery
- The significant amount in this population can be as little as 5mm, while other authors state less than 20mm is not significant

And these studies have all used ‘accurate’ imaging. Using imaging to measure SLLD is not ‘clinical’!

- How can **we** clinically measure SLLD, before even worrying if its linked to the patients symptoms.

- Are our methods”

1. Reliable?
2. Accurate enough (compared to imaging)

Structural Leg Length Difference

Methods of measurement

* Those with adequate research to include are:

1. Tape measure
2. Block standing

Structural Leg Length Difference

Methods of measurement

* An ideal measurement method should be reliable and accurate.
* Reliability is the variation between observers and within a single observer in obtaining the measurement
* Accuracy refers to the variation in measurement using a technique compared with the actual measurement

Structural Leg Length Difference

Methods of measurement

The use of accurate and reliable clinical and imaging modalities for quantifying SLLD is vital for planning appropriate treatment.

(Sabharwal & Kumar 2008)

Structural Leg Length Difference

Tape measure

* A tape measure is typically used to measure the length of each lower extremity by measuring the distance between the anterior superior iliac spine (ASIS) and the medial malleolus.
* It is referred to as the "direct" clinical method for measuring LLD

Direct SLLD measurement

However, differences in the girth of the two limbs, difficulty in identifying bony prominences and height differences in structures distal to the ankle mortise can contribute to errors using this clinical measurement tool.

Direct structural LLD measurement

- In a thorough review of reliability and validity in 2008, Sabharwal & Kumar concluded the direct method was a useful screening tool, but not as accurate as imaging

- Most papers concluded moderate accuracy, with ranges of error ranging from -3mm to +8mm commonly.

Direct structural LLD measurement

- However, (where studied) these same papers all show moderate to good inter and intra tester reliability
- It may therefore by fair to conclude we are often reliably inaccurate?

Structural Leg Length Difference

Block Standing

- Another method to measure SLLD is to level the pelvis of the standing patient by placing blocks of known height under the short limb. This is referred to as the “indirect” clinical method for measuring SLLD

Indirect Structural LLD measurement

Is it any better than the tape measure?

- Jonson & Gross (1997) reported good reliability, with the mean absolute difference in measurement being 1.7 mm for intraobserver and 2.2 mm between the two observers.

Indirect Structural LLD measurement

Is it any better?

- Hanada et al (2001) also found good reliability, BUT this method tended to underestimate LLD by an average of 5.1 mm.

Indirect Structural LLD measurement

Is it any better?

- In one of the largest studies yet, Lampe et al (1996) compared the agreement in measuring LLD between use of a tape measure and standing blocks with orthoroentgenograms in 190 children attending a limb lengthening clinic.

- 95% of the measurements using the wooden boards were within <u>-14 and +16 mm</u> of the results obtained using radiography.

- <u>In this paper, the tape measure had significantly less agreement.</u>

Indirect Structural LLD measurement

Is it any better?

- Harris et al (2005) compared assessment of SLLD using direct and indirect methods, and compared to CT scan measurement in 35 adults following femoral shaft fracture.

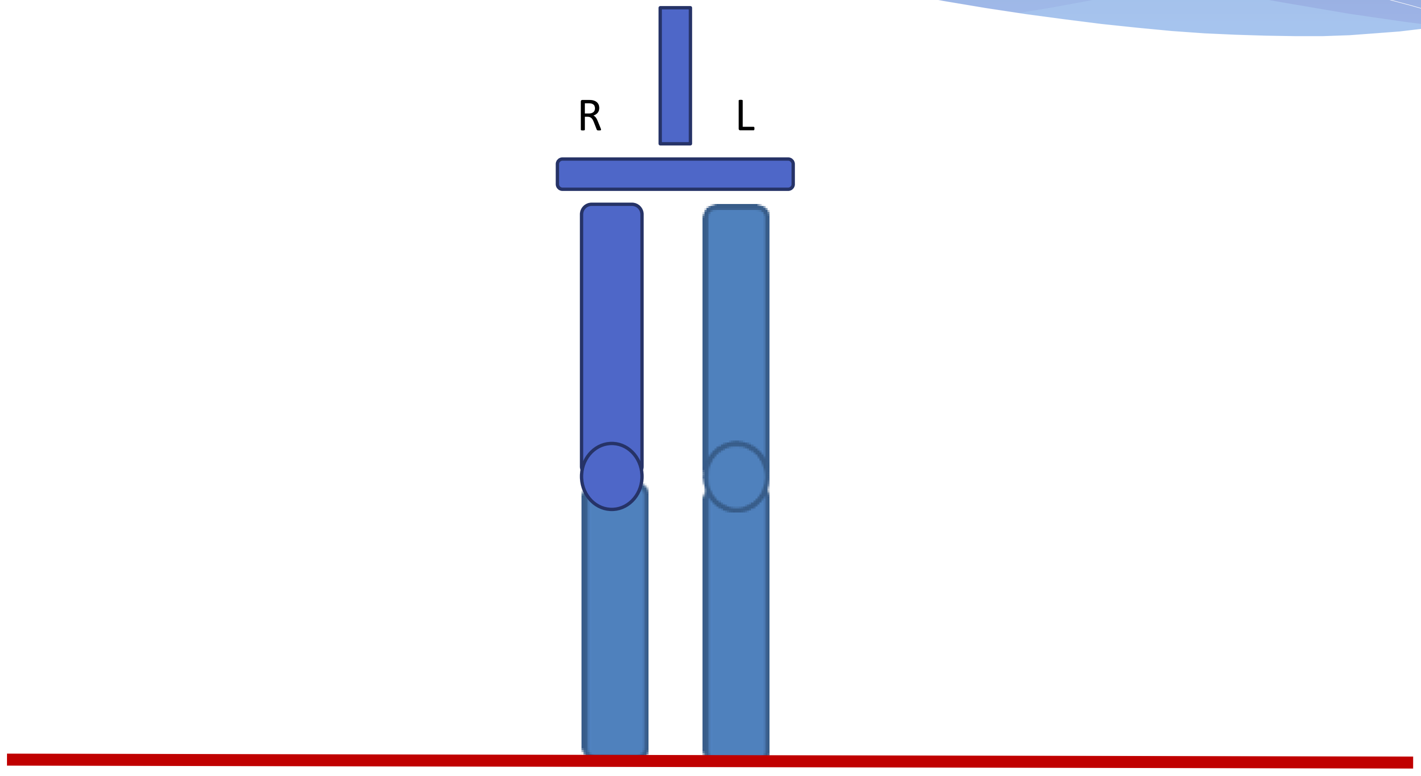
- There was a strong correlation between the two clinical methods ($p = 0.003$). There was no correlation between the CT scanogram and the two clinical methods with a mean absolute difference of 7.2 mm

Clinical measurement of SLLD

- This appears to show that for both the tape measure and block method, we tend to agree with ourselves and each other on clinical measurement….but that this clinical measurement may still not be actually accurate enough to base treatment on?
- We seems reliably inaccurate….

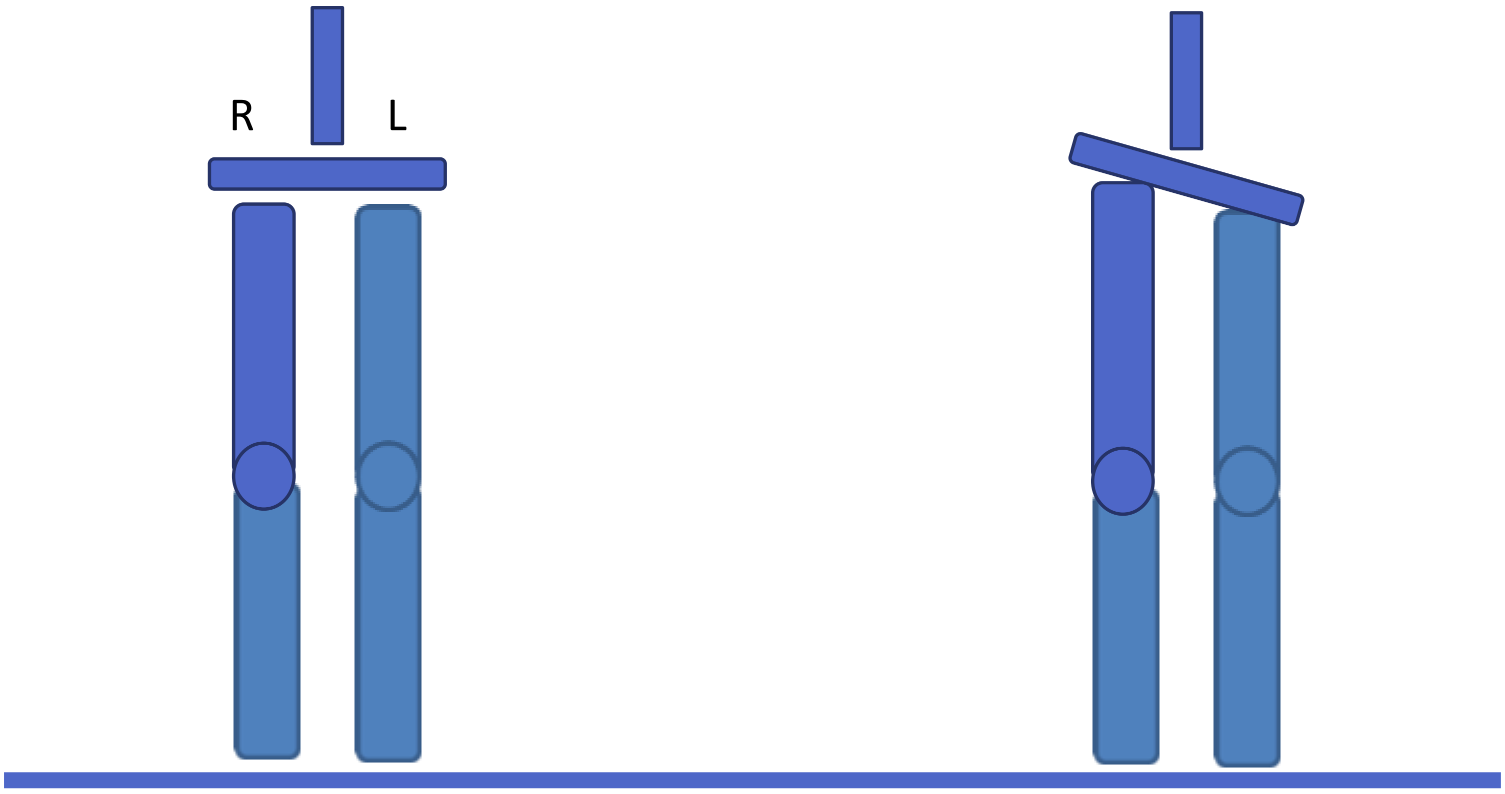
We appears reliably inaccurate….could we be ‘under thinking’ this?!

Clinical Presentation of SLLD when standing



No SLLD

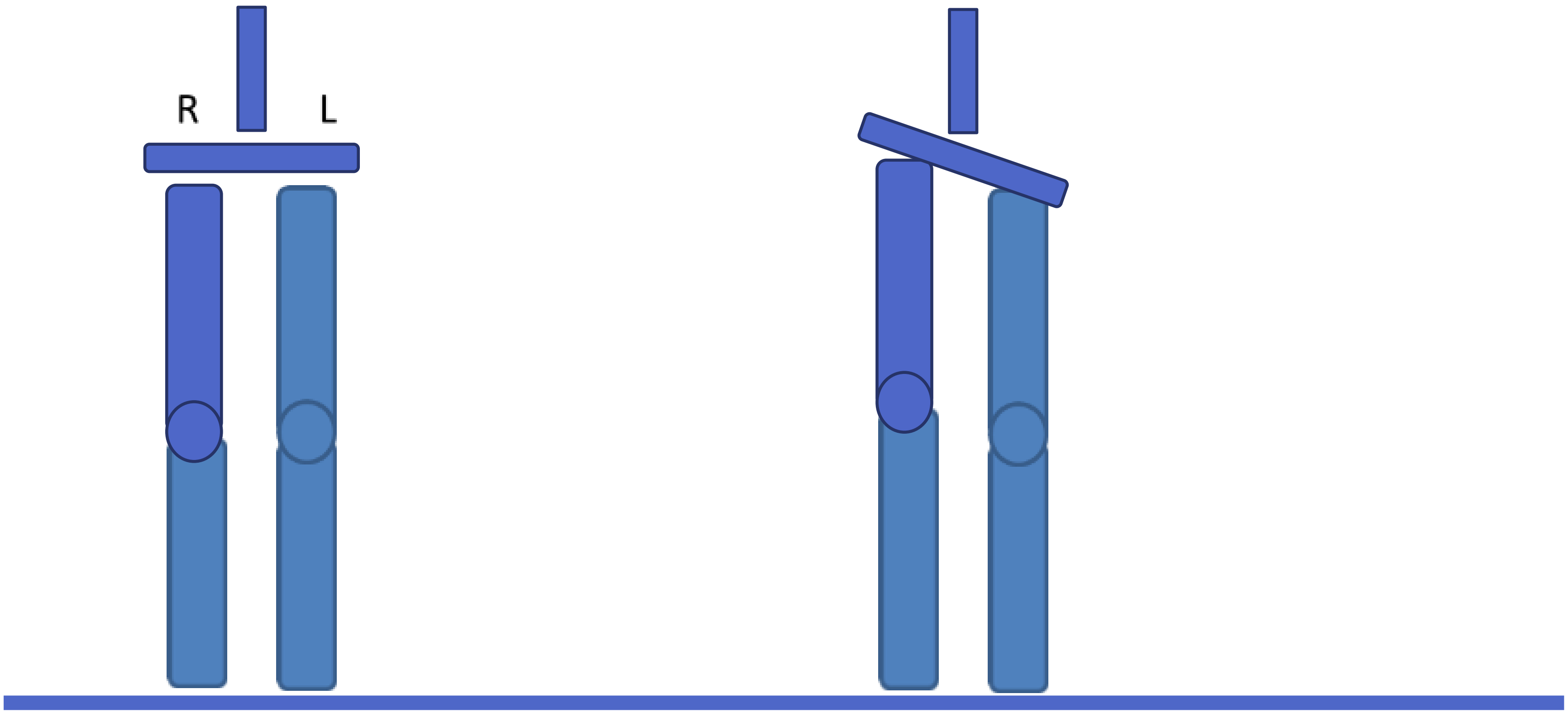
Types of SLLD



No SLLD

Longer Right Femur

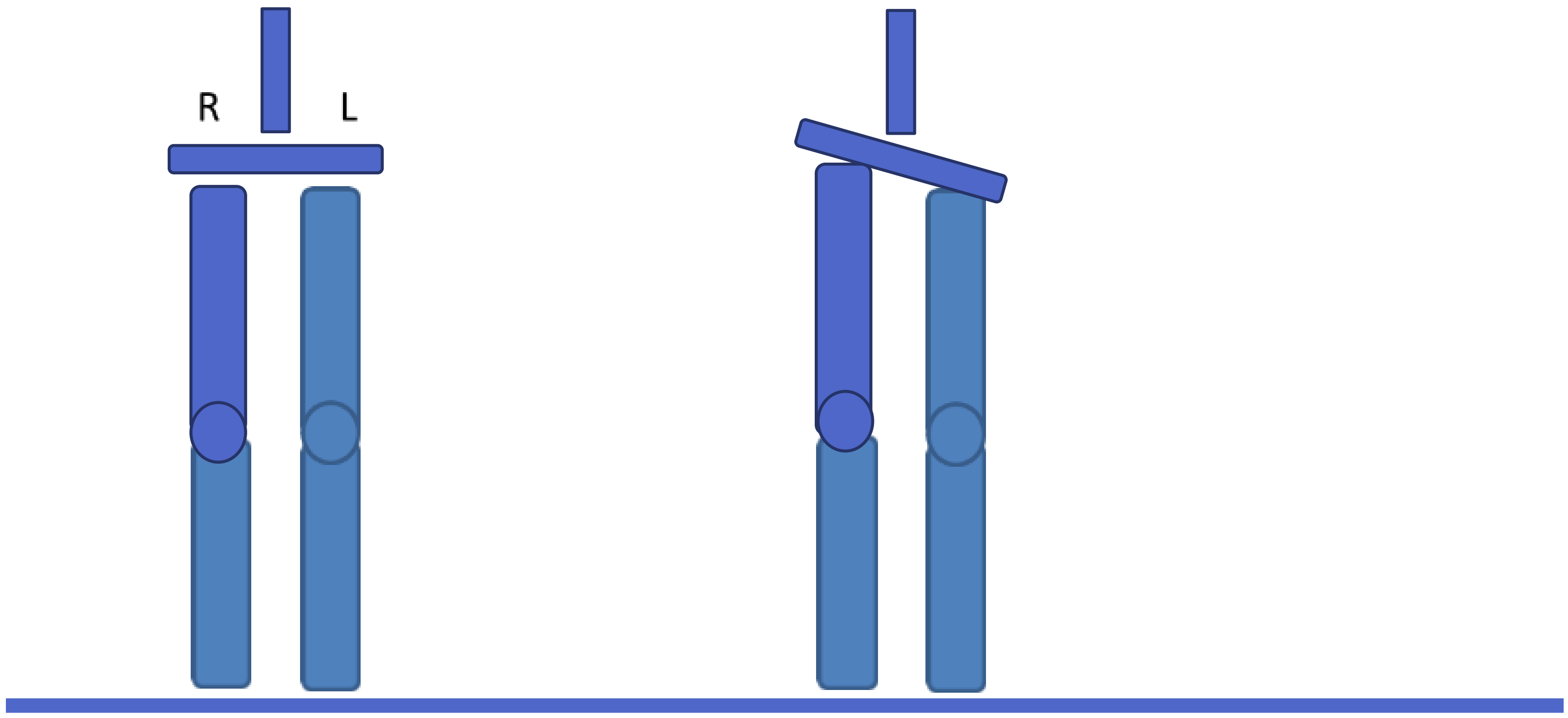
Types of SLLD



No SLLD

Longer Right Tibia

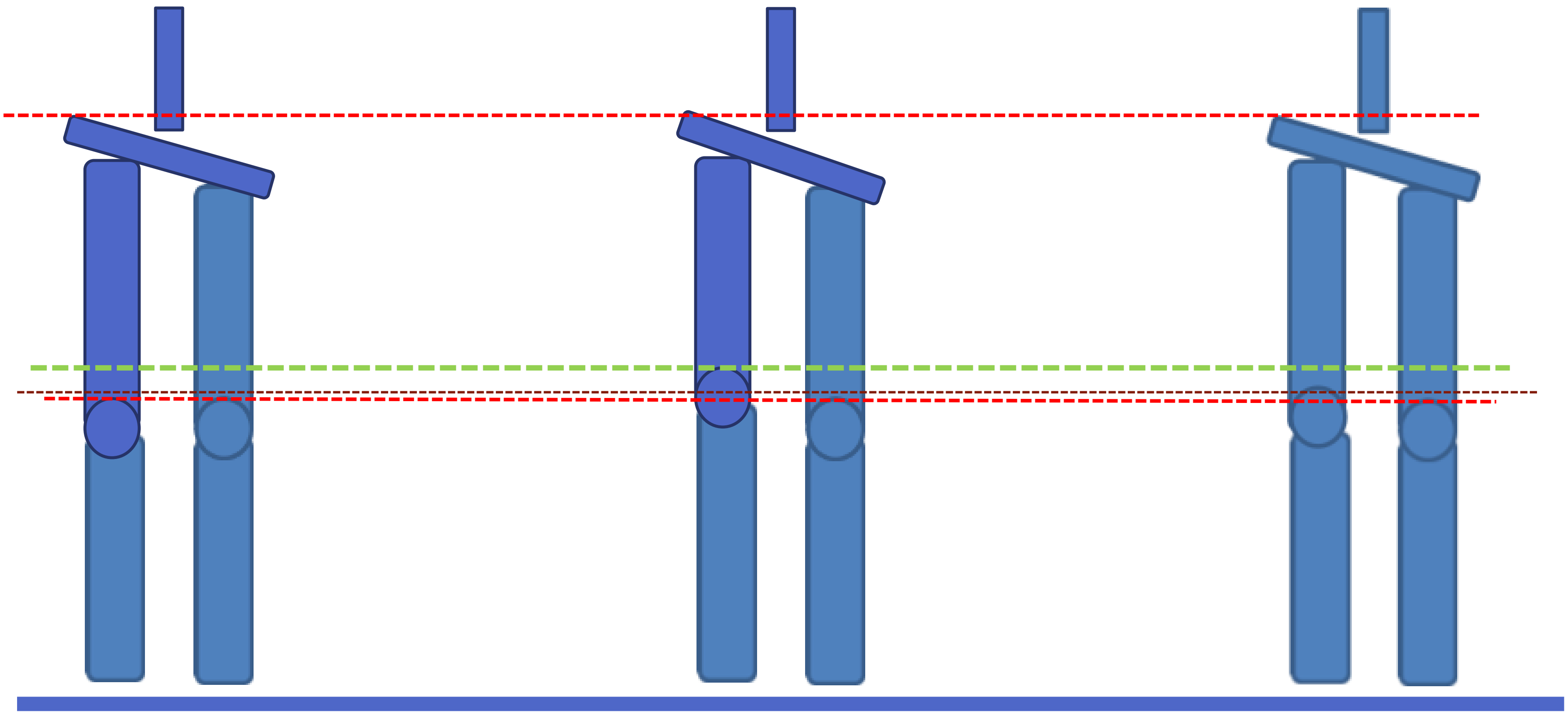
Types of SLLD



No SLLD

Longer Right Femur & Tibia

Types of SLLD

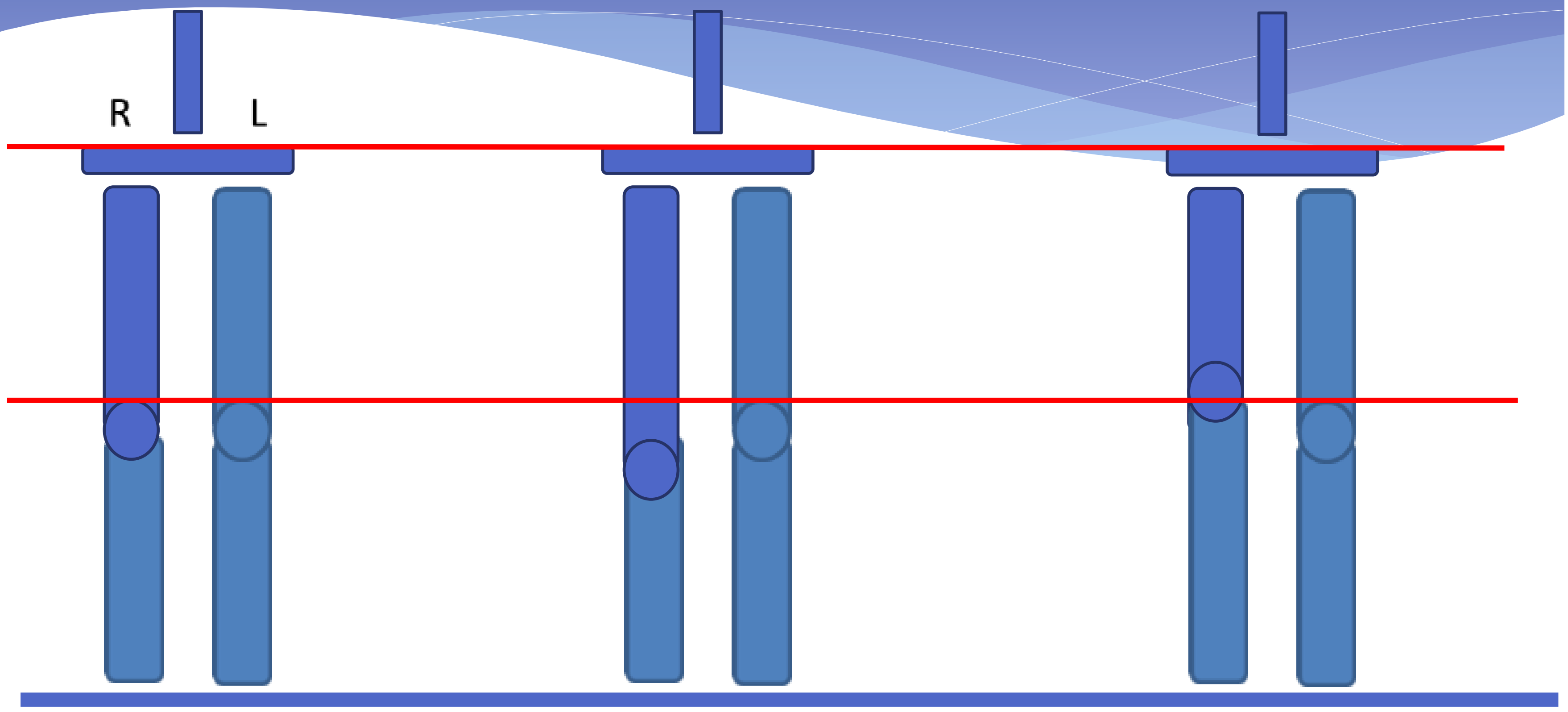


Longer Right Femur

Longer Right Tibia

Longer Right Femur & Tibia

How about these ones though…. Not within the scope of today!

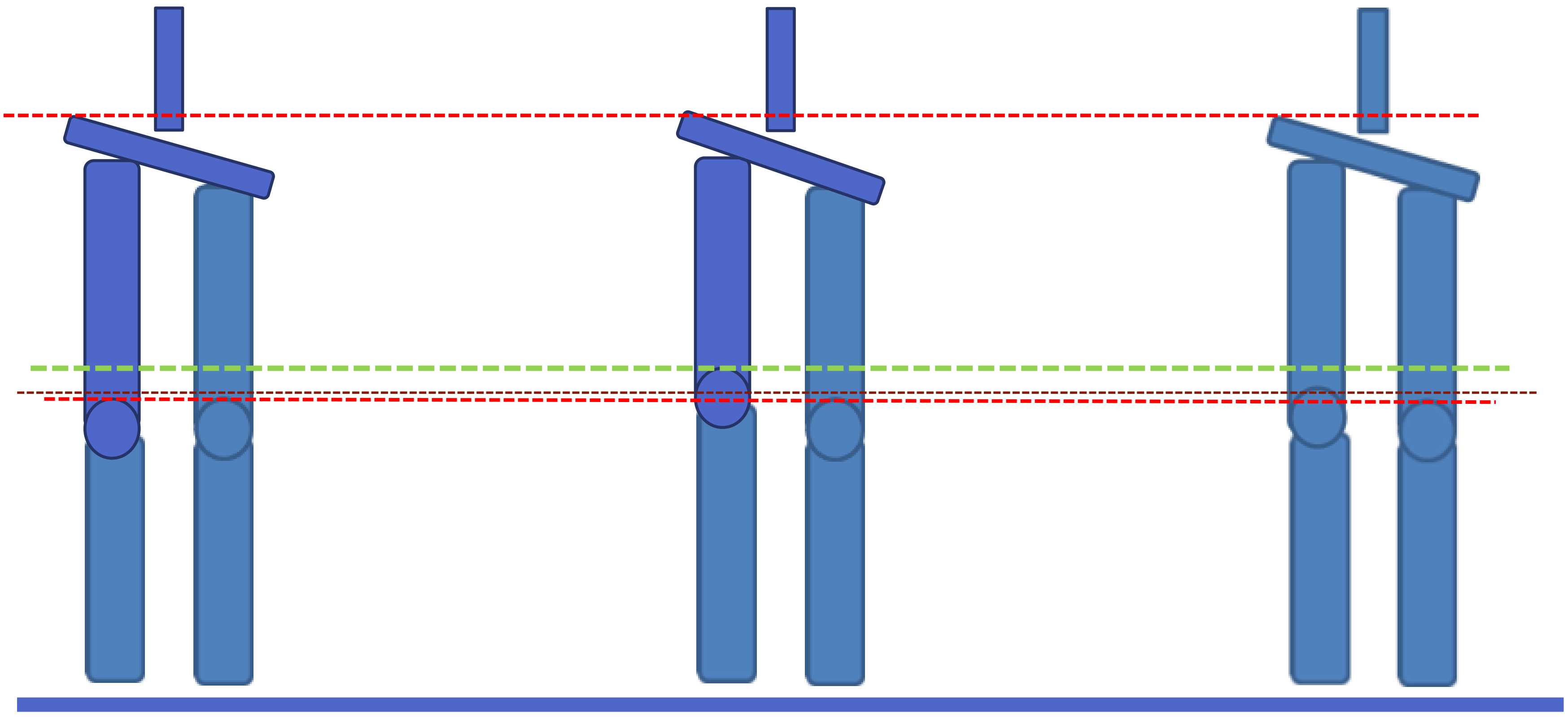


No SLLD

Long right Femur but short right Tibia

Long right Tibia but short right Femur

Types of SLLD



Longer Right Femur

Longer Right Tibia

Longer Right Femur & Tibia

What common conservative treatments do we use?

Treatment options:

- Heel raise
- Total foot raise

But, if there is a link to symptoms…is there a treatment?!

J Orthop Sports Phys Ther. 2007 Jul;37(7):380-8.

Changes in pain and disability secondary to shoe lift intervention in subjects with limb length inequality and chronic low back pain: a preliminary report.

Golightly YM[1], Tate JJ, Burns CB, Gross MT.

⊕ Author information

Abstract

STUDY DESIGN: Preassessment and postassessment of treatment intervention.

OBJECTIVE: To determine the changes in pain and disability secondary to shoe lift intervention for subjects with chronic low back pain (LBP) who have a limb length inequality (LLI).

BACKGROUND: Previous reports have suggested that LLI may be a cause of LBP Most prior studies of lift therapy for management of LLI in patients with LBP have lacked clear guidelines for clinicians regarding the implementation of shoe lift intervention.

METHODS AND MEASURES: Twelve subjects (6 male, 6 female) between the ages of 19 and 62 years with LLI (6.4-22.2 mm) and chronic LBP (1-30 years) participated. Visual analog scale pain ratings and disability questionnaire scores were acquired before and after lift intervention. Subjects determined their lift height based on resolution of LBP symptoms.

RESULTS: Subjects experienced relief of general pain symptoms (P = .0006) and pain associated with standing (P= .002) following lift intervention, with minimally clinically important (MCID) reductions in general pain for 9 of 12 subjects and MCID reductions in standing pain for 8 of 10 subjects. Subjects also had less disability on the disability questionnaire (P = .001) following the intervention, with 9 of 12 subjects experiencing MCID reductions in disability.

CONCLUSION: Shoe lifts may reduce LBP and improve function for patients who have chronic LBP and an LLI. Randomized controlled trials are needed to assess the efficacy of this intervention.

But, if there is a link to symptoms…is there a treatment?!

Arch Phys Med Rehabil. 2005 Nov;86(11):2075-80.

Conservative correction of leg-length discrepancies of 10mm or less for the relief of chronic low back pain.

Defrin R[1], Ben Benyamin S, Aldubi RD, Pick CG.

Author information

Abstract

OBJECTIVE: To study whether conservative correction in a leg-length discrepancy (LLD) of 10mm or less in patients with chronic low back pain (CLBP) can relieve pain.

DESIGN: Randomized, controlled intervention study, with a mean follow-up duration of 10 weeks.

SETTING: Physical therapy clinic of the national health services.

PARTICIPANTS: Thirty-three patients with CLBP were screened for an LLD of 10mm or less, which was measured with ultrasound. Patients were randomly divided into intervention and control groups.

INTERVENTION: In 22 patients, LLD was corrected by applying individually fitted shoe inserts. In 11 patients, LLD was not corrected.

MAIN OUTCOME MEASURES: Chronic pain intensity (visual analog scale) and disability score (Roland-Morris Disability Questionnaire).

RESULTS: Shoe inserts significantly reduced both pain intensity ($P<.001$) and disability ($P<.05$). A moderate positive correlation was found between LLD and the degree of pain relief after wearing shoe inserts ($r=.47$).

CONCLUSIONS: Shoe inserts appear to reduce CLBP and functional disability in patients with LLDs of 10mm or less. Shoe inserts are simple, noninvasive, and inexpensive therapeutic means that can be added to the treatment of CLBP.

Is there any research that they help?

- Larger samples and RCTs are still missing (samples in both papers are less than 25)

- But, even if used correctly and they 'equalise' the SLLD, then at least they can't do any harm?! Are we sure?!

J Am Osteopath Assoc. 2007 Sep;107(9):415-8.

Chronic psoas syndrome caused by the inappropriate use of a heel lift.

Rancont CM[1].

⊕ **Author information**

Abstract

Heel lifts are commonly recommended for patients to manage the pain and discomfort of leg length discrepancies. However, used inappropriately, orthotics can create additional pain instead of alleviating it. In the case described, a 79-year-old male physician used a recommended heel lift for a perceived leg length discrepancy after right hip arthroplasty. Six months postsurgery, chronic, intractable pain developed in his hip and groin. He underwent a battery of tests to locate the pain, but its source remained elusive. Osteopathic evaluation and radiographic examination revealed an absence of leg length discrepancy and the presence of chronic psoas syndrome. Osteopathic manipulative treatment was prescribed and heel lift therapy discontinued, and the patient reported complete remission from pain.

Is there any research that they help?

But what if even prescribed on the short side?!

J Am Osteopath Assoc. 2007 Sep;107(9):415-8.

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Abstract

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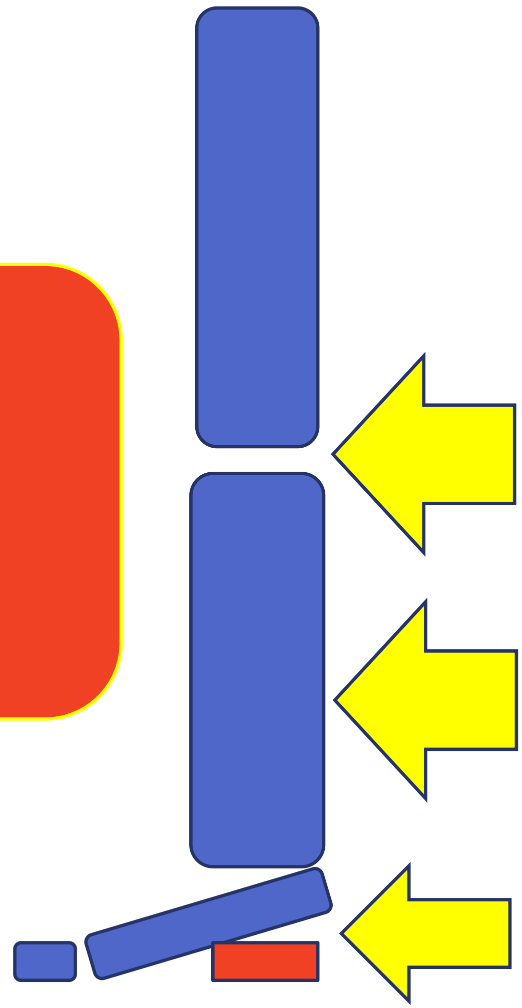
Complications of heels raises?

And after heel lift what happens?!



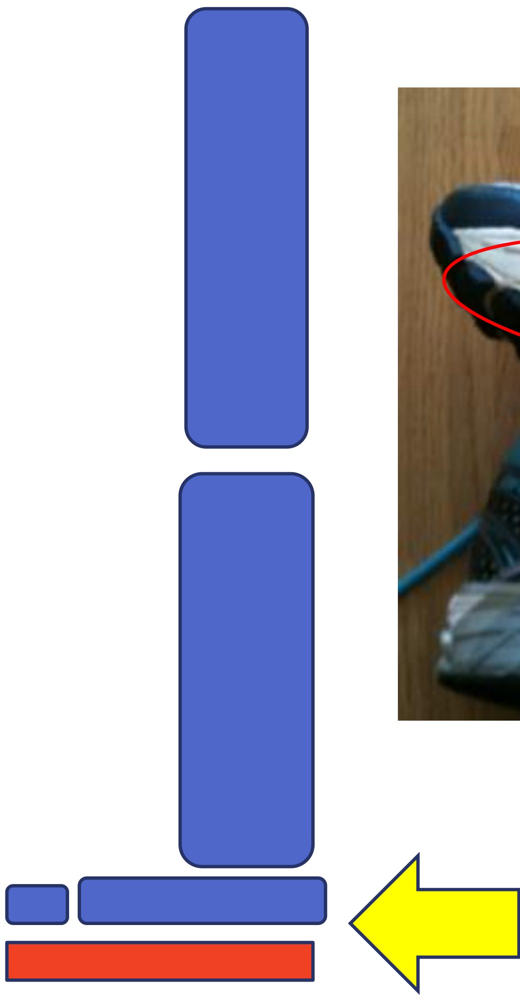
Asymmetrical increase in knee flexion moment resulting in possible:

1. Asymmetrical knee flexion in gait / function
2. Increased load on knee extensors
3. Resultant muscle balance and proximal insertion issues

Form follows function, meaning over time there may be asymmetrical posterior calf shortening

Heel raise causes ankle plantarflexion

Complications of total sole raise

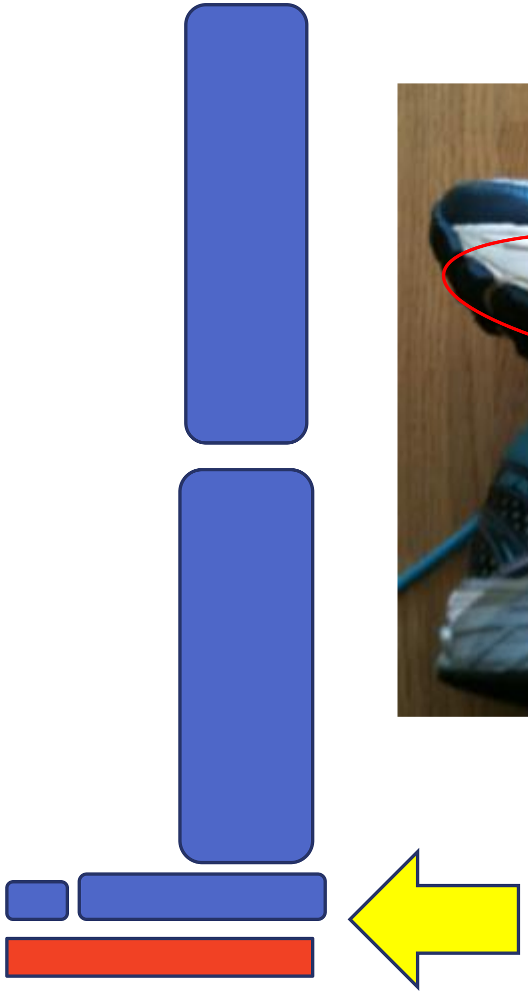


But, this right shoe with a 15mm heel raise is TWICE AS HEAVY as the left shoe. This may cause issues with:

1) Movement asymmetry
2) Asymmetrical fatigue

No Heel raise, no increase in ankle plantarflexion

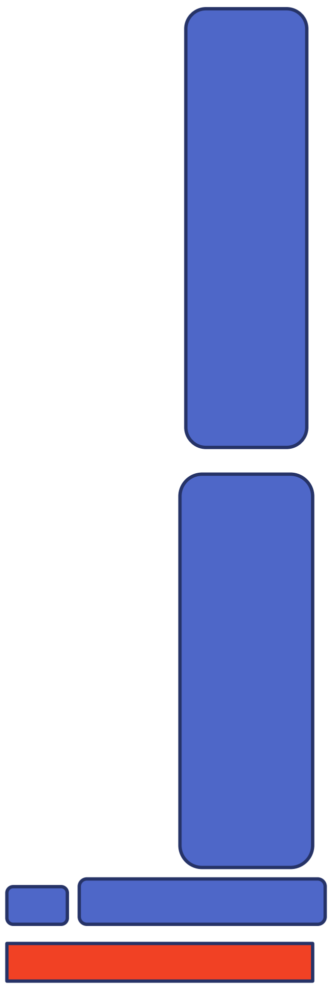
Complications of a total sole raise



With the additional cushioning, there may be asymmetrical proprioception

No Heel raise, no increase in ankle plantarflexion

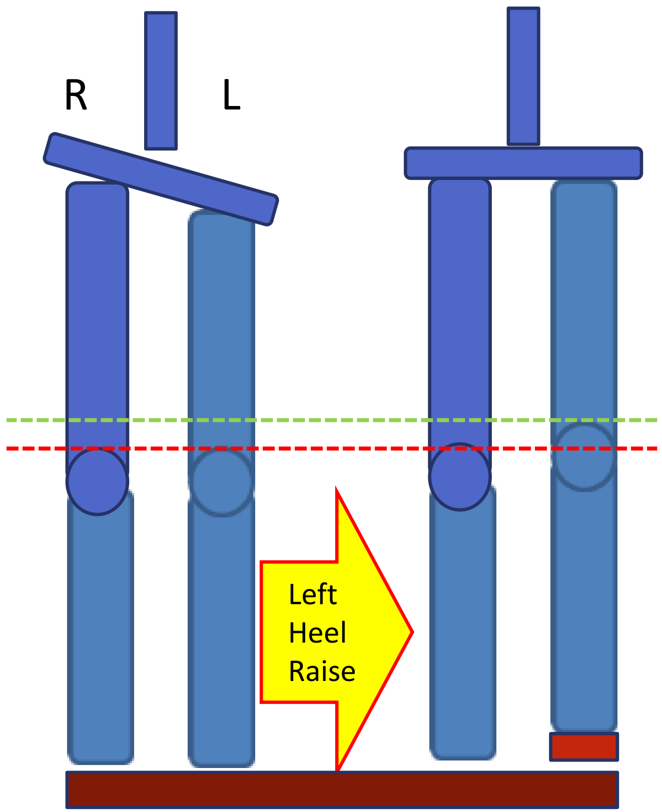
Complications of a total sole raise



With the increased cross sectional thickness of the forefoot sole, the toe box is stiffer, creating a functional limitation to using the third rocker. This will result in asymmetrical compensatory mechanisms

No Heel raise, no increase in ankle plantarflexion

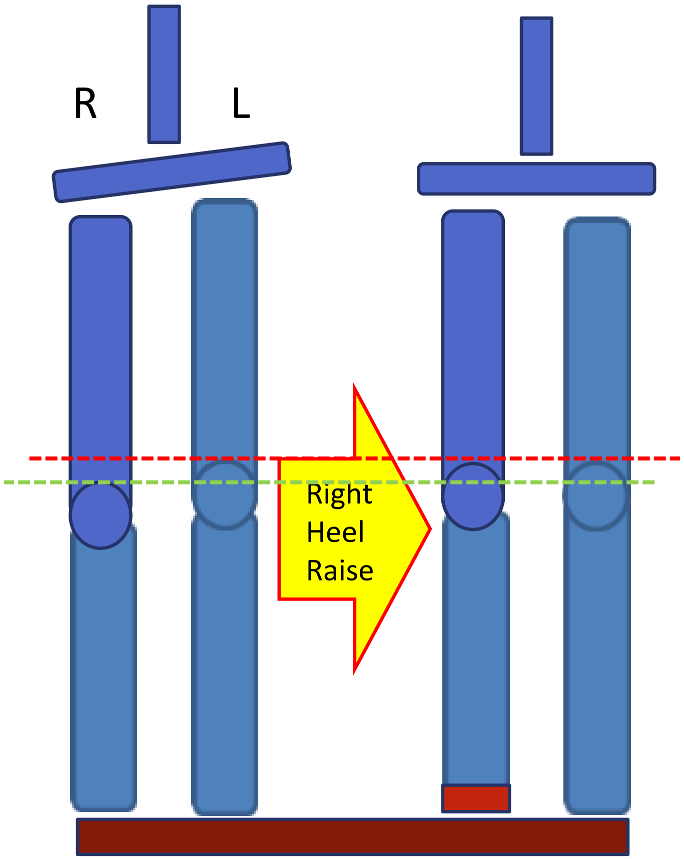
General Complications of non surgical treatment.



Having one knee higher than the other is another asymmetry that will effect the bending moment, torque and so muscle balance of the lower limb. Certain movements such as squatting, as well as running / walking, may be linked to adverse effects of this.

However, the above effect would be REDUCED if the patient had a short left tibia, possible meaning greater benefit in treating SLLD due to a short tibia rather than short femur. There is no research on this.

General Complications of non surgical treatment.



Longer Left tibia

Having one knee higher than the other is another asymmetry that will effect the bending moment, torque and so muscle balance of the lower limb. Certain movements such as squatting, as well as running / walking, may be linked to adverse effects of this.

However, the above effect would be REDUCED if the patient had a short left tibia, possible meaning greater benefit in treating SLLD due to a short tibia rather than short femur. There is no research on this.

Complications of non surgical treatment.

- Using heel or total sole raises do not therefore normalise patients gait with a leg length difference
- Although the compensatory mechanism due to the SLLD may reduce, others will be caused
- These may cause other chronic musculoskeletal conditions….but relieve the original one??

Where does this leave us?

1. A SLLD of approximately 5mm is mean in most studied populations

2. There is at present no strong link between SLLD and chronic LBP, and the kinematics of a SLLD are still uncertain.

3. We are **reliably inaccurate** when we measure it. If we do measure it clinically, we must accept margins of error in our treatment plan

So, lets be less negative about the clinical perspective of SLLD… because we've managed to get a CT scan measurement

1. BUT, we still have to be sure symptoms link to the SLLD
2. And if we are, the treatment we use WILL cause other gait / functional issues.
3. Patients must be aware of this.

Clinically, what can we conclude?

- In patients with a SLLD, take into account activity level and other factors which could be increasing its influence on symptoms

- If possible, get an imaging measurement

- Even then you need to weigh up the benefits and possible adverse effects to amount and choice of heel raise

Clinically, what can we conclude?

- As a rule of thumb, do as little raise as possible to improve the postural adaption and movement dysfunction you think links to LBP
- Combine heel and sole raise if required
- Check gait / movement has not worsened
- Build up slowly, not only to allow adaption, but to decrease the chance of 'doing too much'

CORE STABILITY

And Proximal assessment

Starting at the top.....

- Hip musculature plays an important role in controlling transverse-plane and frontal plane motions of the femur.
- More specifically, weakness of the gluteus medius muscle is believed to increase hip adduction, internal rotation and knee valgus angles.

The lateral rotator / Gluteal complex

- Additionally, weakness of the "deep 6" hip external rotators(piriformis, obturator internus and externus, gemellus superior and inferior, and quadratus femoris) is also proposed to Increase hip internal rotation and knee valgus angles.

- Althoughthe gluteus maximus is most commonly thought to control sagittal-plane motion at the hip and trunk, researchers have reported that the upper portion of the gluteus maximus functions like the gluteus medius during walking; therefore, the gluteus maximus may play a role in controlling frontal-plane and transverse-plane motions of the hip during functional tasks.

The lateral rotator / Gluteal complex

- ‘Based on the functions of these muscles, weakness of the hip muscles may lead to malalignment of the lower limb due to excessive movements of the femur via excessive internal rotation.’

Bowling MC, et al. 2009

Lets take it from the top........

- Weak lateral rotators lead to greater internal rotation
- Internal hip rotation is coupled with STJ pronation
- Therefore weakness of the gluteal complex leads to increased pronation via internal leg rotation with concomittant pronation

Bowling MC, et al. 2009. Snyder et al, 2009. Souza et al, 2010

Is there a core stability problem?

- Tests outlined by Carter, Harradine and Bevan, BJP, 2003

The Thomas Test

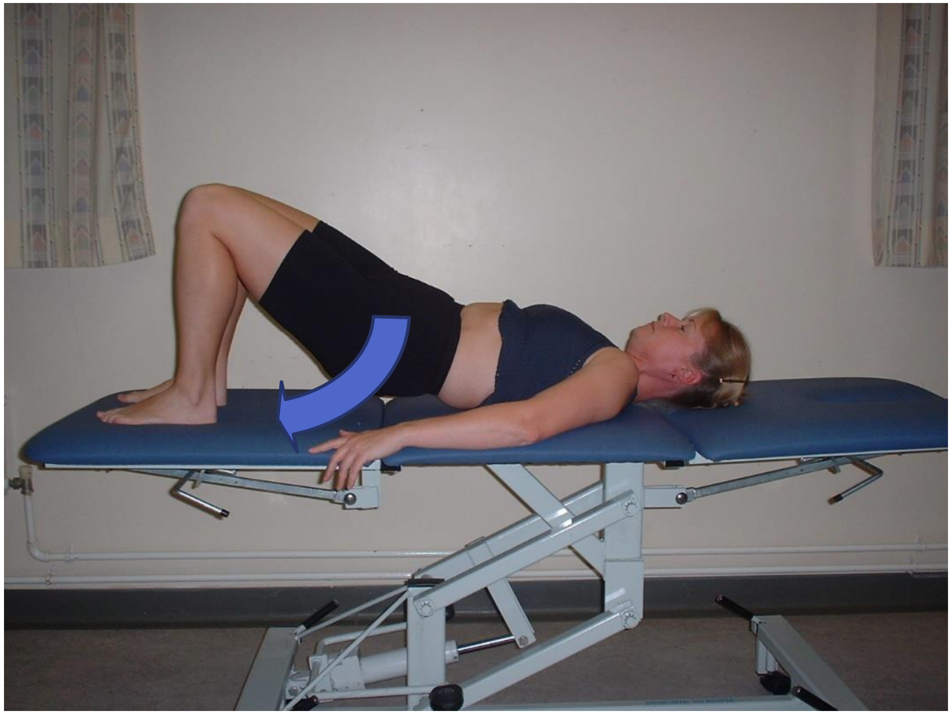
Lateral Rotator Strength Assessment

Single limb stance (leading to single limb mini squat)

Lateral Rotator Strength Assessment

Side lying hip abduction

Is there a core stability problem?



Bridge Testing

ORTHOSES AND OTHER FOOT BASED TREATMENT OPTIONS

Introduction to insoles, taping and orthoses

Foot Based Treatment Options

- **Exercises**
- **Taping / Padding**
- **Prefabricated Orthotics**
- **Customisable Prefabricated Orthotics**
- **Custom Orthotics**

Taping / padding / Felt

- **Any tape that reduces pronatory moments without impinging on 1st ray function. Eg:**

- Modified Low Dye Taping
- Modified High Dye Taping
- Mulligans Plantar Fasciitis Taping

Practical on Exercise Therapy / Manipulation and Taping

- Always be aware of contraindications. Give patients advice that treatment may cause other problems / issues and make sure they fully understand any risk before supplying treatment.

Practical on Exercise Therapy / Manipulation and Taping

- Exercise Therapy

1. If symptoms are made worse by exercises, advise them to stop and contact you

2. If secondary symptoms occur, do the same.

3. Check they are doing them properly at each review!

Practical on Exercise Therapy / Manipulation and Taping

- Manipulation therapy contraindications include

1. Osteoporosis
2. Surgical Site
3. Joint degeneration / exostosis
4. Hypermobility
5. Connective Tissue Disorder
6. Inflammatory joint disiease

Practical on Exercise Therapy / Manipulation and Taping

- Taping

1. If symptoms are made worse by taping, advise them to remove this and contact you

2. If secondary symptoms occur, do the same.

3. Tape allergy, if it itches… take it off!

In-shoe appliances….But how do they work?

- By reducing pronatory moments via applying force optimally

- By facilitating medial column propulsion

General unifying consensus?!

Theoretical Perspective	**Foot Morphology Theory**	**Sagittal Plane Facilitation Theory**	**Tissue Stress Theory**
Criteria for Normalcy	The STJ passes through neutral at key stages of the gait cycle	The foot functions as a pivot allowing adequate hip extension and correct posture	The foot functions in a way that does not result in abnormal tissue stress and injury
Casting Methodology	The foot is cast in STJN, unless large deformity contraindicates this.	Casting methods are not documented, although recent non-custom orthoses from this theory may mean casting is not required	The positive cast is modified when taken to supply the shell shape required to apply the correct forces to the foot
Orthoses aim	To prevent abnormal joint compensation and place the foot into its normal position for key stages of the gait cycle	To allow the foot to work successfully as a pivot and facilitate Sagittal plane motion	To reduce abnormal stress upon symptomatic structures

Harradine and Bevan, JAPMA, 2009.

Temporary orthoses

- **Any padding / felt liners that reduces pronation moments without impinging on 1st ray function. E.g.:**

- Felt Medial Heel Wedges
- Felt 1st Ray Cut outs



Instant Orthoses not from impressions

When should they be prescribed?

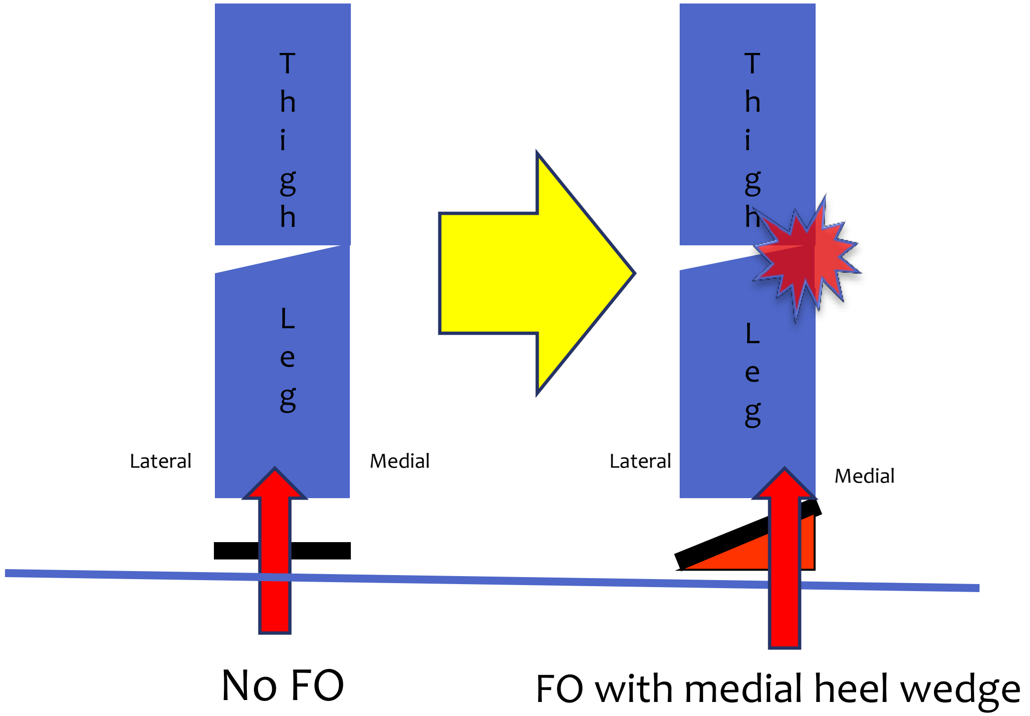
- Some situations warrant particular care in orthotic prescription. Examples include

1. Neuropathy and/or peripheral vascular disease and/or gross deformity

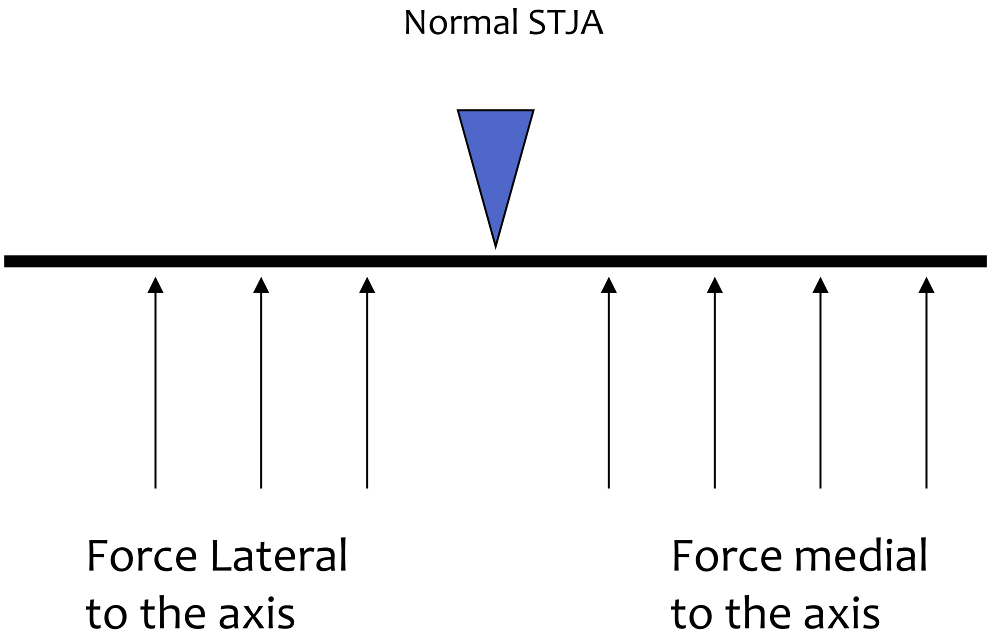
When should they be prescribed?

- Some situations warrant particular care in orthotic prescription. Examples include

2. Medial knee joint narrowing

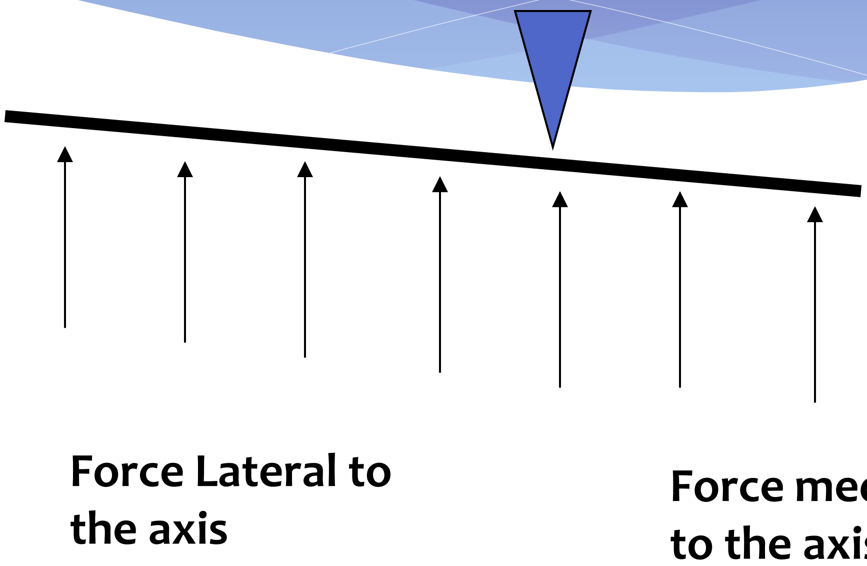


Orthoses and normalising foot function



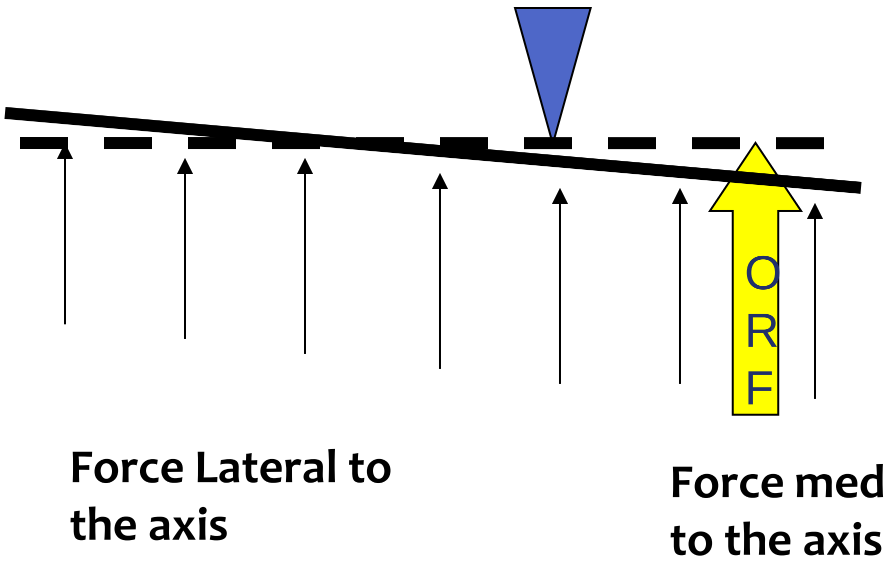
If the fulcrum, in this case a normal STJA, is in the middle of the see-saw and forces applied to the see-saw are equal and equidistant, **no motion will result**

Orthoses and normalising foot function



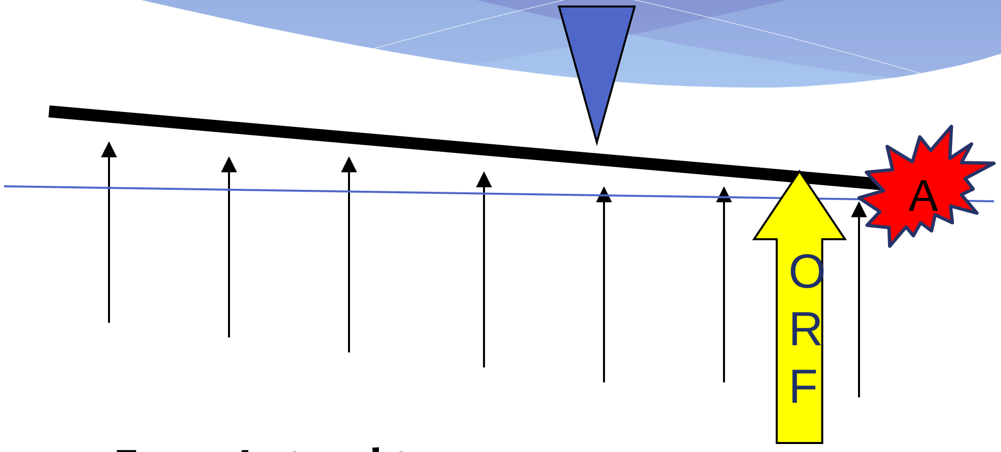
If the axis moves closer to one end of the lever, the lever will be longer on one aspect on the axis and the applied force increased. In this example**, a motion occurs around the axis (in this example, pronation).**

Orthoses and normalising foot function



The larger yellow arrow represents additional force from the orthosis, the 'orthosis reaction force'. In this case the moment applied to the axis via the orthoses reaction force is great enough to 'level the see-saw' (in this example, reduce the pronation).

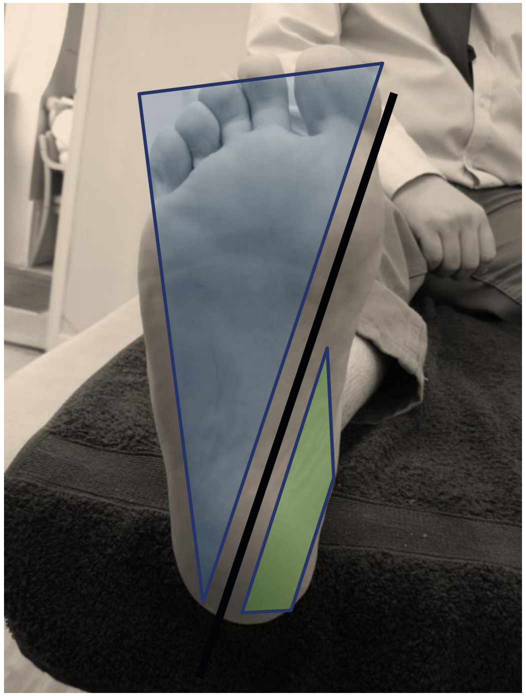
Orthoses and normalising foot function



The larger yellow arrow represents additional force from the orthosis, the ‘orthosis reaction force’. In this case the moment applied to the axis via the orthoses reaction force is not great enough to ‘level the see-saw’, However, pronatory moments would still have been decreased. This means the force applied at ‘**A**’ would still be decreased. Moment vrs Movement

Orthoses and normalising foot function

- By reducing pronatory moments via applying orthoses reaction force optimally



This is why podiatrists emphasise the importance of rearfoot 'posting' / wedging.

Rearfoot Posting

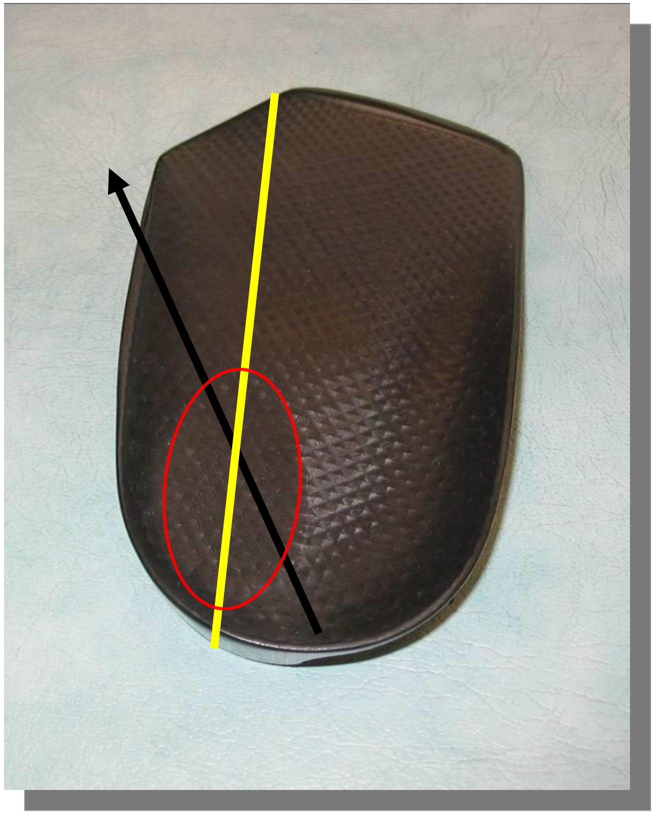
Rearfoot posting

Why at this angle?

Orthoses and normalising foot function

Applying Orthotic Reaction Force optimally

The Medial heel skive applies a force, that may be described as an ‘orthosis reaction force’, to the medial aspect of a medially deviated STJA. However, it does not apply this force perpendicular to it. A medially deviated STJA runs at an oblique angle from lateral posterior to anterior medial but the classic medial heel skive places a force onto the STJA at an angle approximately parallel to the edge of the shell

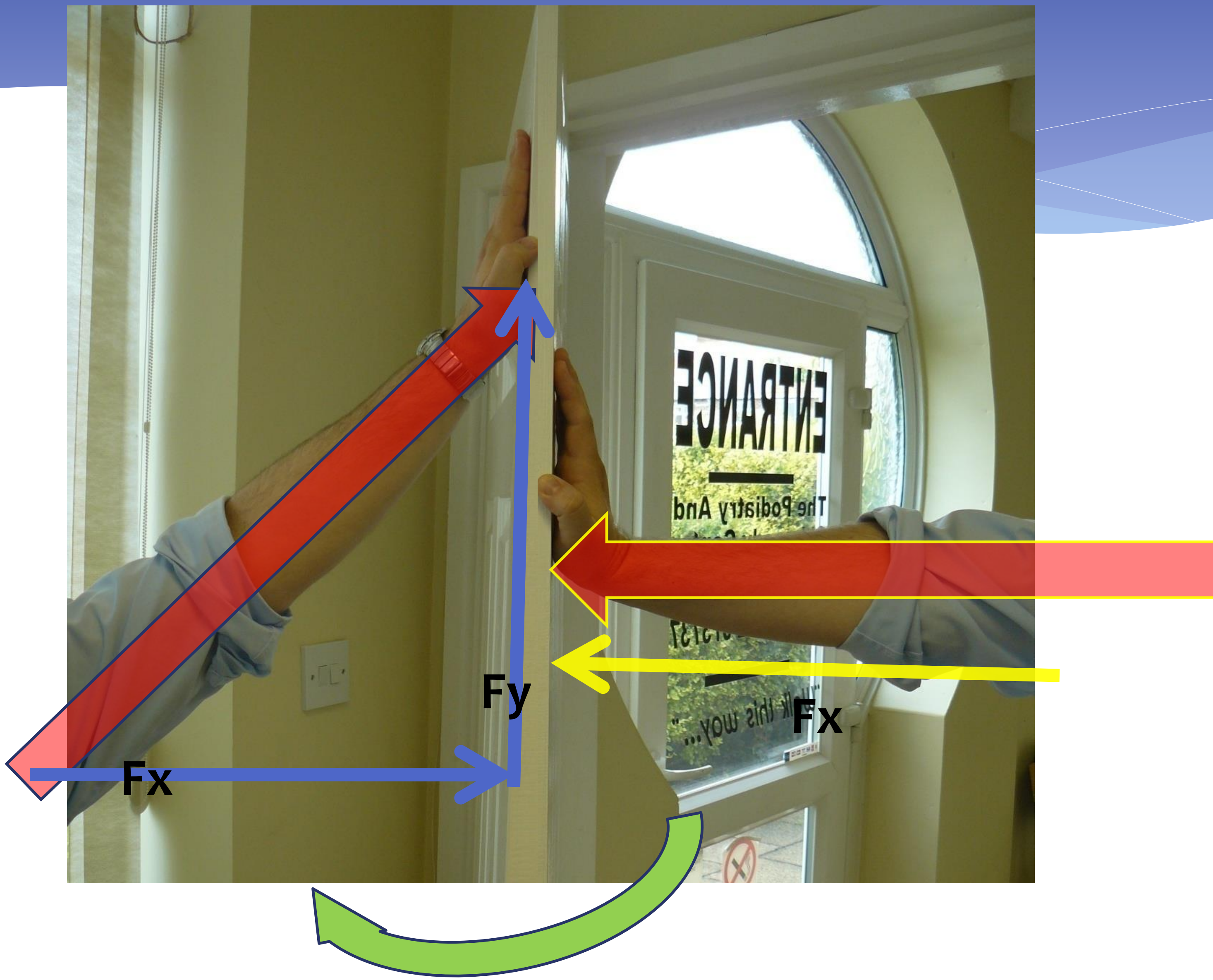


Applying Force optimally

This means that although the medial heel skive applies the moment in the desired place of the foot, the moment applied is reduced via the direction of its application

Forces and Axis

Forces and Axis



The MOSI – Applying ORF optimally

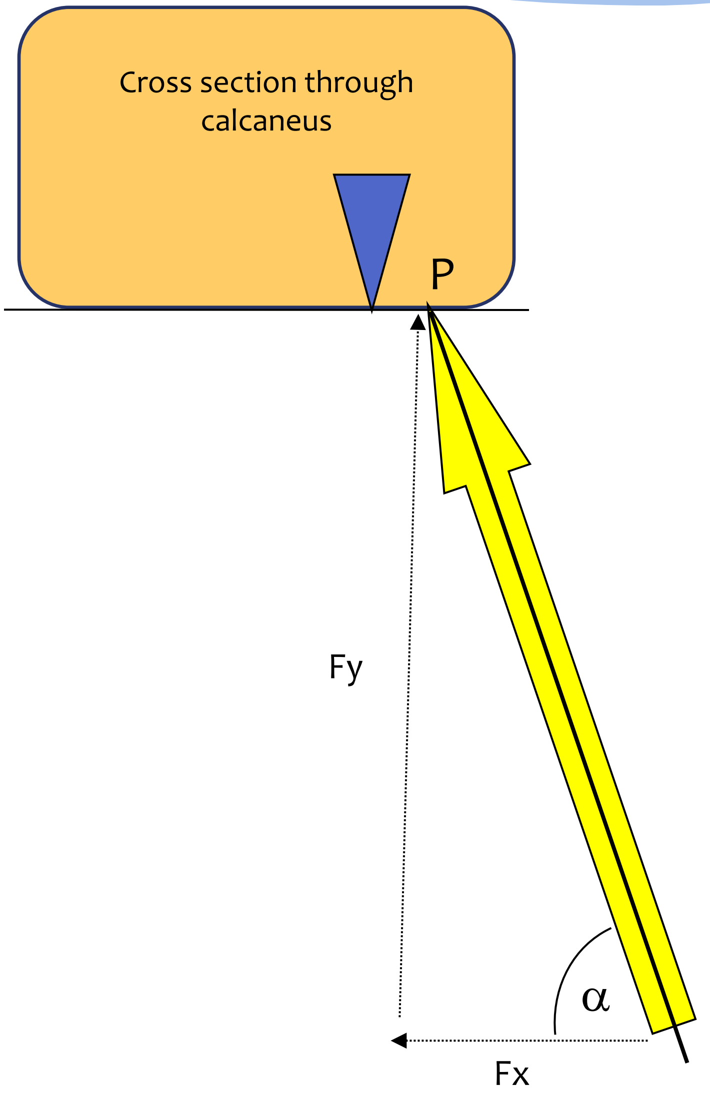
- Fx = P cos a
- Fy = P sin a

Where:

Fx = Horizontal force

Fy = Vertical force

P = Applied force



Example of vertical force lost

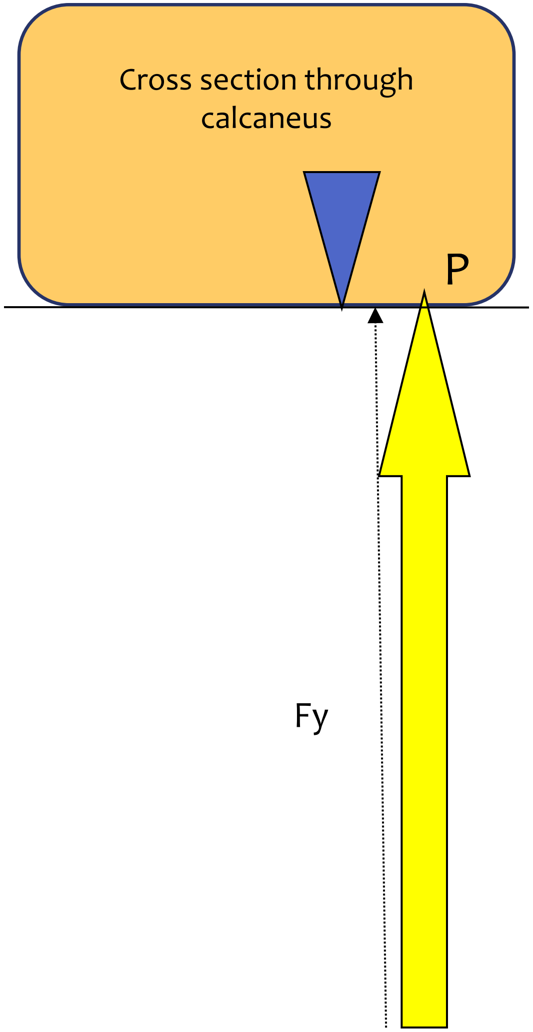
- Fy = P sin a
- Fy = 45N . Sin 60
- Fy = 38.97N

Force 'Lost' about 6N, or approximately 13%

Orthosis Reaction Force Applied by a Heel Post or Skive

- Some of the applied orthoses force to reduce the pronatory moment via the vertical force is lost to a horizontal force component in a foot with a medial axis
- This component in turn places a force to move the foot laterally on the shell
- This may limit our posting, as the patient feels they are "slipping off the orthotic"

The MOSI – Applying ORF optimally



- Fx = P cos a
- Fy = P sin a

Where

Fx = Horizontal force, not present

Fy = Vertical force

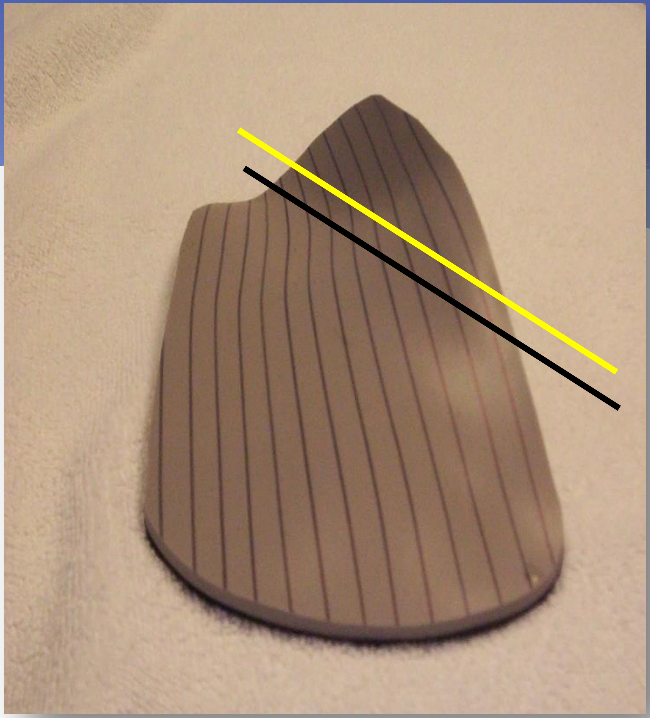
P = Applied force

Example of vertical force lost

- Fy = P sin a
- Fy = 45N . Sin 90
- Fy = 45N

Force Lost 0N, or 0%

The Medial Oblique Shell Inclination – Applying ORF optimally



* The MOSI (medial oblique shell inclination) was first published in 2008 by Harradine *et al* as a modification to aid in controlling the difficult pronator with a medial deviated subtalar joint axis.

It can therefore be seen that by aligning the orthoses reaction force more perpendicular to the STJ axis by running the shell inclination parallel to it, a greater supinatory force may be applied to STJ. This can be achieved through custom OR new prefab orthoses

What do we expect from an orthoses?

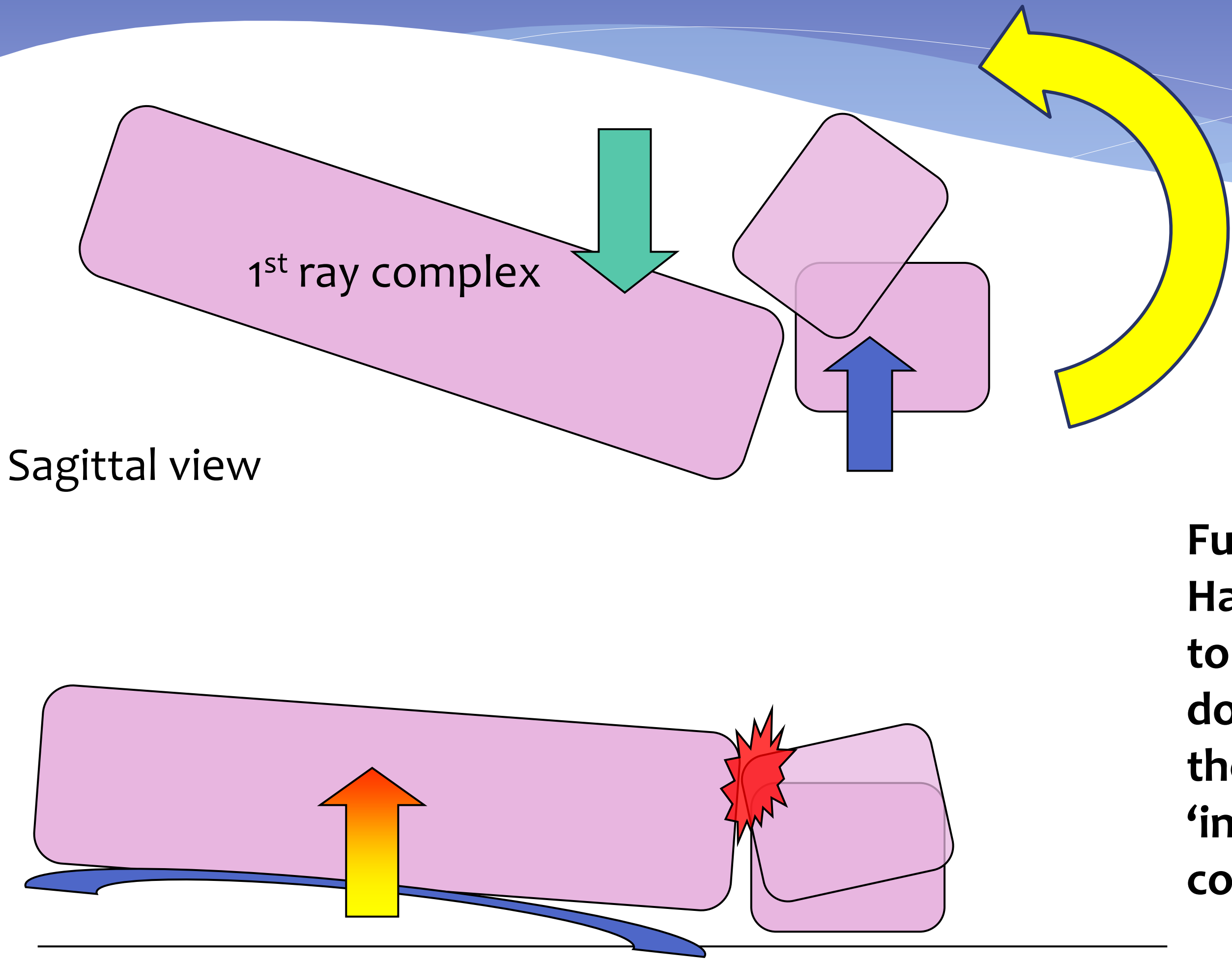
1. Not to make this worse and so have adverse effects elsewhere
2. Not to be uncomfortable
3. Not to wear down quickly or fall apart.
4. Not to need a different pair for every pair of shoes

Orthotics, from materials to prefabs, from courses to customs, are all driven by commercial interest......

‘The Superior man understands what is right, the inferior man understands what will sell’

Confucius

Poorly fitting orthoses (non-custom AND custom) can cause a functional hallux limitus….



Normal Hallux dorsiflexion with first ray plantarflexion

Functional Limitation of Hallux dorsiflexion due to an increase of dorsiflexory moments on the first ray from an 'incorrect' / high medial contour (arch) orthosis

HALLUX LIMITUS

Hallux Limitis / Rigidus

- **Grade I:** limited motion of the first MPJ, mild pain, no significant degenerative joint disease (DJD), minimal osteophyte
- **Grade II:** limited motion, pain, early DJD, osteophyte
- **Grade III:** limited motion, pain, DJD, osteophyte
- **Grade IV:** joint ankylosis, end stage DJD

Conservative Care

- In addition to anti-inflammatory medications, the non operative approaches to the treatment of hallux limitus include efforts to increase or restrict motion of the first MPJ.
- One may incorporate physical therapy to mobilize functional motion loss of the first MPJ.
- Indications for custom orthotics with accommodations to increase first MPJ range of motion include cases with a functional hallux limitus without much evidence of joint degeneration. These are typically the younger patients without a long history of joint pain.

A case-series study to explore the efficacy of foot orthoses in treating first metatarsophalangeal joint pain . Brian J Welsh, Anthony C Redmond, Nachiappan Chockalingam, Anne-Maree Keenan. *Journal of Foot and Ankle Research* 2010, 3:17 (27 August 2010)

Conservative Care

- Most patients with chronic joint pain will respond better to efforts to limit stress and motion through the first MTPJ. One can decrease stress by utilizing orthotics with a Morton's extension, stiff-soled shoes, a metatarsal bar and rocker-bottom shoes.

- Use intra-articular steroid injections sparingly. The goal of conservative treatment is to allow an active lifestyle with minimal to no pain in the first MPJ. If one cannot achieve this with the aforementioned options, consider surgery

HALLUX VALGUS

Juvenile Hallux Valgus (non-inflammatory Joint disease)

Andrew J, H Macfarlane, T E Kilmartin. Conservative treatment of juvenile Hallux Valgus - A seven-year prospective study. British Journal of Podiatry November 2004 ; 7 (4): 101-105

- This study has demonstrated that night splints can, over an average of 3 years treatment, prevent the deterioration of juvenile hallux valgus and subsequent development of associated deformities of the other digits. There is clear justification for deferral of surgical reconstruction until skeletal maturity when the outcomes of surgery are likely to be more predictable. Further, night splint therapy should be considered as a first line treatment for hallux valgus

Adult Hallux Valgus (non – inflammatory joint disease)

There is no research that conservative care has any benefit on deformity progression or pain

Adult Hallux Valgus (non – inflammatory joint disease)

J Foot Ankle Res. 2016 May 4;9:16. doi: 10.1186/s13047-016-0146-5. eCollection 2016.

Non-surgical treatment of hallux valgus: a current practice survey of Australian podiatrists.

Hurn SE[1], Vicenzino BT[2], Smith MD[2].

Author information

Abstract

BACKGROUND: Patients with hallux valgus (HV) frequently present to podiatrists for non-surgical management, with a wide range of concerns including pain, footwear difficulty and quality of life impacts. There is little research evidence guiding podiatrists' clinical decisions surrounding non-surgical management of HV. Thus practitioners rely largely upon clinical experience and expert opinion. This survey was conducted to determine whether a consensus exists among Australian podiatrists regarding non-surgical treatment of HV, and secondly to explore common presenting concerns and physical examination findings associated with HV.

METHODS: An online survey was distributed to Australian podiatrists in mid-2013 via the professional association in each state (approximately 1900 members). Podiatrists indicated common treatments recommended, presenting problems and physical examination findings associated with HV in juveniles, adults and older adults. Proportions were calculated to determine the most common responses, and Chi-squared tests were used to examine differences in treatment recommendations according to HV patient age group and podiatrist demographics.

RESULTS: Of 210 survey respondents, 65 % (136) were female and 80 % (168) were private practitioners. Complete survey responses were received from 159 podiatrists for juvenile HV, 146 for adults and 141 for older adults. Seven different non-surgical treatment options were commonly recommended (by >50 % podiatrists), although recommendations differed between adult, older adult and juvenile HV. Common treatments included footwear advice or modification, custom and prefabricated orthotic devices, addition of padding, and muscle strengthening/retraining exercises. Padding was more likely to be utilised in older adults, while exercises were more likely to be prescribed for juveniles. A diverse range of presenting problems and physical examination findings were reported to be associated with HV.

CONCLUSIONS: Despite the lack of empirical evidence in this area, there appears to be a consensus among Australian podiatrists regarding non-surgical management of HV, and these recommendations are largely aligned with available clinical consensus documents. Presenting concerns and physical examination findings associated with HV are diverse and have implications for treatment decisions. Management strategies differ across patient age groups, thus any updated clinical guidelines should differentiate between adult and juvenile HV. This study provides useful data to inform clinical practice, education, policy and future research.

Adult Hallux Valgus (non – inflammatory joint disease)

J Foot Ankle Surg. 2015 Sep-Oct;54(5):852-5. doi: 10.1053/j.jfas.2015.01.011. Epub 2015 Jun 6.

Biomechanical Evaluation of Custom Foot Orthoses for Hallux Valgus Deformity.

Doty JF[1], Alvarez RG[2], Ervin TB[3], Heard A[4], Gilbreath J[5], Richardson NS[6].

⊕ Author information

Abstract

The purpose of the present study was to compare the hallux valgus deformity pressure parameters seen in standard footwear (no orthosis) versus the pressure observed in the same footwear with the addition of 3 different length orthoses. The forefoot pressure at a hallux valgus deformity was recorded with pressure sensors placed on the plantar, medial, and dorsal surface of the first metatarsal head. The participants performed walking trials without an orthosis and with orthoses of 3 different lengths. The average pressure and maximum pressure of each area was recorded for each orthosis, and comparisons were made across the groups. The plantar pressures were decreased in the full length and 3/4 length orthoses, and the dorsal pressures were increased with the use of the full-length and sulcus-length orthoses. Significant changes in medial pressure were not seen with the addition of any orthosis compared with standard footwear alone. However, a trend toward increased medial pressures was seen with the full- and sulcus-length orthoses, and the 3/4-length orthoses exhibited a trend toward decreased medial pressures. We were unable to demonstrate that the use of a custom foot orthosis significantly decreases the medial pressures on the first metatarsal head in patients with hallux valgus deformity. The 3/4-length orthosis was less likely to negatively affect the dorsal or medial pressures, which were noted to increase with the sulcus- and full-length orthoses. Our data suggest that if a clinician uses this treatment option, a 3/4-length orthosis might be a better choice than a sulcus- or full-length orthosis.

METATARSALGIA

Metatarsalgia

* Metatarsalgia is a diagnostic term used to describe pain in the plantar forefoot. It can be due to:

1. **Interdigital neuritis**
2. **Capsulitis / synovitis**
3. **Arthritis**
4. **Freiberg's Infraction**
5. **Tumour**
6. **Stress Fractures**
7. **Predislocation Syndrome**
8. **HAV syndrome**
9. **Painful skin lessions, e.g Corns!**

Predislocation syndrome

- Gerard V. Yu, DPM, eloquently described and illustrated predislocation syndrome in 1995. What Dr. Yu described was a clinical syndrome characterized by focal pain under a lesser metatarsophalangeal plantar plate, most often affecting the second toe joint

Predislocation syndrome

- Subjective symptoms - a "grape-like" swelling under the affected toe joint, and a feeling as if there were a stone bruise on the ball of the foot

- Findings are pain upon palpation of the plantar plate, and subtle dorsal and/or transverse plane subluxation of the toe (exacerbated with loading of the foot) without frank hammertoe formation. Usually, there is no callus but one may see mild oedema in the region of the plantar plate.

- The clinician will also note that range of motion of the metatarsophalangeal joint is painful with end-range plantarflexion of the digit.

Predislocation syndrome or MTPJ synovitis / O/A?

- With metatarsalgia without predislocation syndrome, there is pain upon palpation of the metatarsal head, which is more proximal than the plantar plate. One would also usually see callus formation and note that range of motion of the metatarsophalangeal joint is not painful. In these cases, you may also note a lack of fat padding and a longstanding, non-reducible hammertoe deformity.

Predislocation syndrome

- In simplistic terms, the cause of predislocation syndrome is excessive plantar pressures to the MPJ. This may be a functional etiology from lesser metatarsal overload caused by hallux valgus or a functional / structural. There may be a structural cause such as a short first ray (relatively long second ray).

Predislocation syndrome

- Most clinicians will agree that treatment is difficult and can frustrate the patient when progress is slow. Often, predislocation syndrome will ultimately require surgical intervention. Unfortunately, surgical outcomes are sometimes unpredictable with recurrence of deformity and/or inability to completely resolve the deformity.

- Hopefully some day, we can build a better mousetrap for the elusive second toe!

Freiberg's Infraction

- First described by Freiberg in a review of six cases in 1914, infraction of the metatarsal head is most common in young females.
- The onset of the condition often occurs in the early to later stages of puberty.
- Although the etiology is not known for sure, the prevailing thinking is there is a vascular disruption at the epiphyseal plate that is likely secondary to trauma.

Freiberg's Infraction

- Repetitive stress can cause microfractures at the junction of the epiphysis and metaphysis. The disease process can be gradual over time as it responds to the repetitive trauma. The onset of this process of aseptic necrosis or osteochondrosis.

- It is not uncommon for a patient to be relatively asymptomatic through this process only to have the condition reveal itself later in life in response to poor shoegear, high heels, increased activity, etc.

- There is a strong female predilection in Freiberg’s disease with females five times more likely to have the condition than men.

Freiberg's Infraction

Treatment depends on severity and situation

1. Activity limitation
2. Immobilisation (relative or 'total')
3. Foot wear advice ('no' heels!)
4. Shoe modifications (stiff / rocker)
5. Steroid injections
6. Orthoses
7. Surgery

Interdigital Neuritis

- Morton's neuroma is an enlarged nerve that usually occurs in the third interspace, which is between the third and fourth toes

- The nerve lies in subcutaneous tissue, just above the fat pad of the foot, close to an artery and vein.

- Problems often develop in this area because part of the lateral plantar nerve combines with part of the medial plantar nerve here. When the two nerves combine, they are typically larger in diameter than those going to the other toes.

Interdigital Neuritis

- Above the plantar pedal interdigital nerve is a structure called the deep transverse metatarsal ligament. This ligament is very strong, holds the metatarsal bones together, and creates the ceiling of the nerve compartment.

- With each step, the ground pushes up on the enlarged nerve and the deep transverse metatarsal ligament pushes down. This causes **compression** in a confined space.

Interdigital Neuritis

Initial diagnosis is based upon subjective assessment and clinical tests:

1. Mulder's sign

2. Gauthier's test - This test consists of compression of the metatarsal heads while actively dorsiflexing and plantarflexing the digits for 30 seconds. A positive test results in pain to the patient or a sensory abnormality -

Interdigital Neuritis

Treatment (aimed to decrease compression / load)

1. Orthoses
2. Steroid
3. ECSWT
4. Surgery

Interdigital Neuritis - Steroid

J Bone Joint Surg Am. 2013 May 1;95(9):790-8, S1. doi: 10.2106/JBJS.I.01780.

Methylprednisolone injections for the treatment of Morton neuroma: a patient-blinded randomized trial.

Thomson CE[1], Beggs I, Martin DJ, McMillan D, Edwards RT, Russell D, Yeo ST, Russell IT, Gibson JN.

⊕ Author information

Abstract

BACKGROUND: Morton neuroma is a common cause of neuralgia affecting the web spaces of the toes. Corticosteroid injections are commonly administered as a first-line therapy, but the evidence for their effectiveness is weak. Our primary research aim was to determine whether corticosteroid injection is an effective treatment for Morton neuroma compared with an anesthetic injection as a placebo control.

METHODS: We performed a pragmatic, patient-blinded randomized trial set within hospital orthopaedic outpatient clinics in Edinburgh, United Kingdom. One hundred and thirty-one participants with Morton neuroma (mean age, fifty-three years; 111 [85%] female) were randomized to receive either corticosteroid and anesthetic (1 mL methylprednisolone [40 mg] and 1 mL 2% lignocaine) or anesthetic alone (2 mL 1% lignocaine). An ultrasonographic image was obtained before treatment, and injections were performed with the needle placed under ultrasonographic guidance. The primary outcome was the difference in patient global assessment of foot health between the two groups at three months after injection. This was measured with use of a 100-unit visual analog scale (VAS) anchored by "best imaginable health state" and "worst imaginable health state."

RESULTS: Compared with the control group, global assessment of foot health in the corticosteroid group was significantly better at three months (mean difference, 14.1 scale points [95% confidence interval, 5.5 to 22.8 points]; p = 0.002). The difference between the groups was also significant at one month. Significant and nonsignificant improvements associated with the corticosteroid injection were observed for measures of pain, function, and patient global assessment of general health at one and three months after injection. The size of the neuroma as determined by ultrasonography did not significantly influence the treatment effect.

CONCLUSIONS: Corticosteroid injections for Morton neuroma can be of symptomatic benefit for at least three months.

Interdigital Neuritis - ECSWT

J Am Podiatr Med Assoc. 2016 Mar;106(2):93-9. doi: 10.7547/14-131.

Extracorporeal Shockwave Therapy in Patients with Morton's Neuroma A Randomized, Placebo-Controlled Trial.

Seok H, Kim SH, Lee SY, Park SW.

Abstract

BACKGROUND: The aim of this study was to evaluate the efficacy of extracorporeal shockwave therapy (ESWT) for the treatment of Morton's neuroma by measuring changes in patient pain, function, and neuroma size.

METHODS: Patients with Morton's neuroma were randomly assigned to either the ESWT group or the sham stimulation group. Outcome measures, including visual analog scale (VAS) and American Orthopaedic Foot and Ankle Society lesser toes (AOFAS) scores, were assessed at baseline and 1 and 4 weeks after treatment. The Johnson satisfaction test was also performed 1 and 4 weeks after treatment. The neuroma diameter was measured using ultrasonography at baseline and 4 weeks after treatment.

RESULTS: Patients receiving ESWT exhibited significantly decreased VAS scores 1 and 4 weeks after treatment relative to baseline, and AOFAS scores were significantly improved 4 weeks after treatment relative to baseline. In the sham stimulation group, VAS and AOFAS scores showed no significant changes at any time after treatment. Neither group showed significant changes in Johnson satisfaction test results or neuroma diameter.

CONCLUSIONS: These results suggest that ESWT may reduce pain in patients with Morton's neuroma.

Interdigital Neuritis - Surgery

Adv Clin Exp Med. 2016 Mar-Apr;25(2):295-302. doi: 10.17219/acem/60249.

Long-Term Results of Neurectomy Through a Dorsal Approach in the Treatment of Morton's Neuroma.

Reichert P[1], Zimmer K[1], Witkowski J[1], Wnukiewicz W[1], Kuliński S[1], Gosk J[1].

⊕ **Author information**

Abstract

BACKGROUND: Morton's neuroma, a painful enlargement of the plantar digital nerve between the metatarsal heads, is a common cause of metatarsalgia. The etiology and treatment are still a controversial matter.

OBJECTIVES: The objective of this study was to evaluate the long-term follow-up results of neurectomy through a dorsal approach and to identify prognostic factors that can affect the final outcome.

MATERIAL AND METHODS: The study included 41 patients who were treated for Morton's neuroma. Their average age was 44 years (range: 25-69 years). The average follow-up time was 7.4 years (range: 5-12 years). Surgery was performed through a dorsal approach. The clinical evaluations, visual analog scale (VAS) scores and American Orthopedic Foot and Ankle Society (AOFAS) scores were assessed.

RESULTS: The mean preoperative AOFAS score was 39.4 ± 7.84 and the mean postoperative AOFAS score was 83.4 ± 12.1. The mean preoperative VAS scale was 7.04 ± 1.4 and the mean postoperative VAS scale was 1.4 ± 0.8. There were 31 patients (76%) with very good results in the subjective and objective patient assessments; six (15%) had good results; one (2%) had satisfactory results and three (7%) had poor results. Statistically significant differences in the results between single and multiple neuromas were found, depending on the size of the neuromas and the duration of the symptoms. There were no statistically significant differences depending on the time between surgery and assessment, on steroid injections before operation or on the duration of preoperative conservative treatment.

CONCLUSIONS: Despite the development of less invasive techniques and very good outcomes in a short period of time, long-term results have shown that neurectomy is still useful in the treatment of Morton's neuroma. The results of the study show that the outcome does not change during the postoperative follow-up period. The best results were achieved in the case of single neuromas larger than 3 mm that were resected within 12 months of the onset of symptoms.

LISFRANC JOINT INJURY

Lisfranc Joint Injury

The Lisfranc joint, or tarsometatarsal articulation of the foot, is named for Jacques Lisfranc (1790-1847), a field surgeon in Napoleon's army. Lisfranc described an amputation performed through this joint because of gangrene that developed after an injury incurred when a soldier fell off a horse with his foot caught in the stirrup

Lisfranc Joint Injury

- NOT seen in acute phases in UK podiatric clinics
- Seen as a chronic long term complication of previous injury, or in primary degenerative joint disease.
- Can be secondary to adult acquired flat foot

MIDTARSAL JOINT SYMPTOMS

MTJ syptomology

- Commonly presents in podiatry clinics as a degenerative joint issue
- Classic degenerative joint symptom pattern
- Can be secondary to adult acquired flat foot

PLANTAR FASCIITIS

Plantar Fasciitis

“why does sleep hurt my feet?”

Plantar Fasciitis

- More than two million people receive treatment for plantar fasciitis in the United States each year PFEFFER G et al, Foot Ankle Int 1999.**20:** 214,
- ‘Frequently’ seen in athletic Warren. Sports Med.1999. 5:338-345 and military Sadat-Ali. Mil Med. 1998. 1:56-57 populations
- 10% or ‘recreational runners’ report having plantar fasciitis Chandler and Kibler. Sports Med. 1993. 5:344-352, and 159 out of 267 running injury patients had plantar fasciitis. Taunton et al. 2002. Br J Sports Med. 2002. 36:99-101
- Regardless of activity levels, Plantar Fasciitis is classed as a ‘common’ condition Lee. Phys Ther Sport. 2008. 10: 12-18.

What is the Plantar Fascia

- The plantar fascia is the investing fascia of the sole of the foot and forms a strong mechanical linkage between the calcaneus and the toes. There may be medial, lateral and central bands.

- The medial band is frequently implicated (Kaya1996) when in fact it is thin and virtually non-existent at the proximal level (Sarrafian 1987)

What is the Plantar Fascia?

- The lateral band is also quite variable and in some in some it is fully developed and relatively thick, however, for 12% of the population, it is completely absent.

- The central aponeurotic band is cited as the major structural and functional component (Wearing 2006) and therefore the most likely to be implicated in plantar heel pain.

What is the Plantar Fascia?

- The histological anatomy of the plantar fascia is relatively unknown.
- It is a dense connective tissue, likened to both tendon and ligament (Boabighi et al 1993)
- But with biochemical and histological differences to ligaments of the foot (Davis et al 1996)

What is the Plantar Fascia?

It is *similar to tendon and ligament but comprised of elongated fibrocytes embedded in the extracellular matrix consisting primarily of crimped collagen fibres*

What is the Plantar Fascia?

- Fibrocytes produce collagen, and form a 3D communicating network (Benjamin and Ralphs 2000) and it is currently believed this arrangement may be capable of sensing and responding to changes in load. In this way, the plantar fascia may have a sensory capacity

What is the Plantar Fascia?

- So…. In addition to passively transmitting force, the plantar fascia may act as an active sensory structure capable of modulating its composition in response to external demands

Chronic Plantar Heel Pain

- Why / how does it get injured?

- Despite the historical nomenclature of plantar fasciitis, and the direct assumption therefore of inflammatory processes, the histopathology reveals the condition is not primarily inflammatory. For this reason, it may be more accurate to refer to the condition as chronic plantar heel pain or CPHP

What is the role of the plantar fascia?

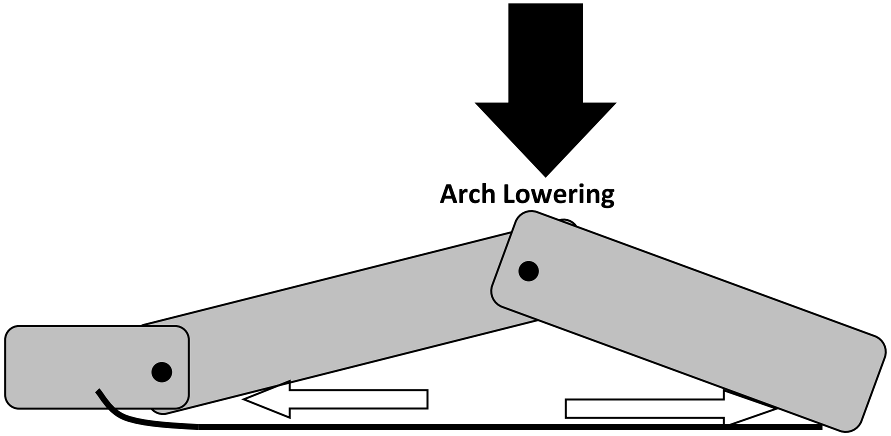
- The plantar fascia is a passive structure, essential to the normal function of the foot.
- Abnormal function of the foot is indicated as an aetiological factor in its injury
- Lets quickly recap this normal and abnormal function, specifically in relation to the role of the plantar fascia.

Basics of normal foot function….

1. The foot must coordinate the effect of lower extremity internal rotation with the impact at heel strike.
2. It must then reverse the direction of rotation by midstep and accommodate lower extremity external rotation
3. While simultaneously stabilizing itself to forces that can reach multiples of body weight prior to toe off
4. And permitting the entire body to pivot over it.

3. While simultaneously stabilising itself to forces that can reach multiples of body weight prior to toe off

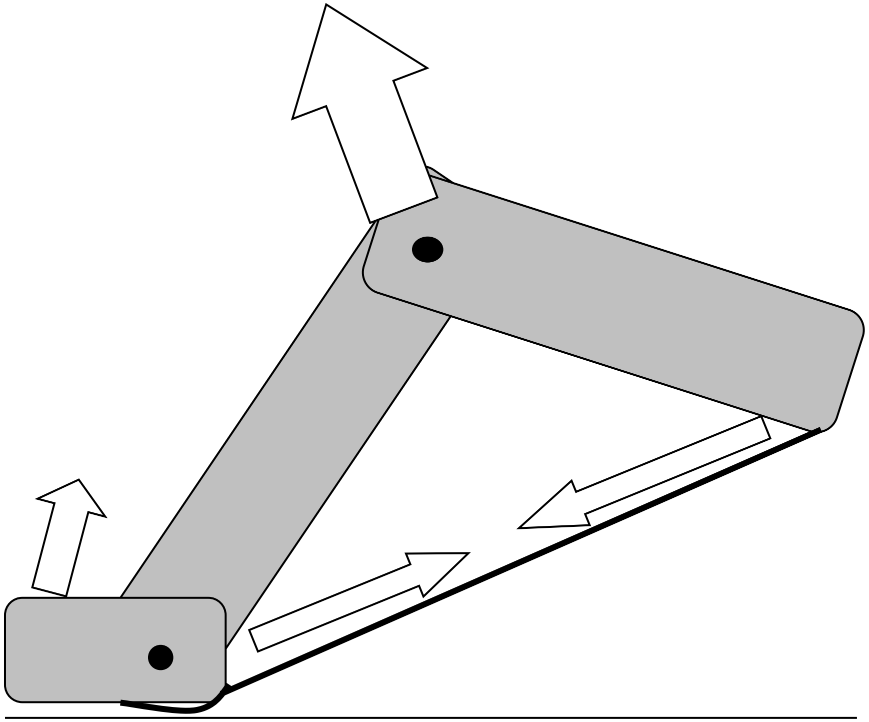
- **Stability at loading phase is accomplished via the *reverse* windlass mechanism**



• As the arch lowers it becomes longer and the plantar structures (in this example the plantar fascia, but also the plantar ligaments) become more taut. This in turn applies a compressive force longitudinally

3. While simultaneously stabilising itself to forces that can reach multiples of body weight prior to toe off

- **Stability at propulsive phase is accomplished via the windlass mechanism**



•As the foot supinates and the arch raises, tension is maintained in the plantar fascia via the ‘winding’ of the windlass around the 1st MTPJ.

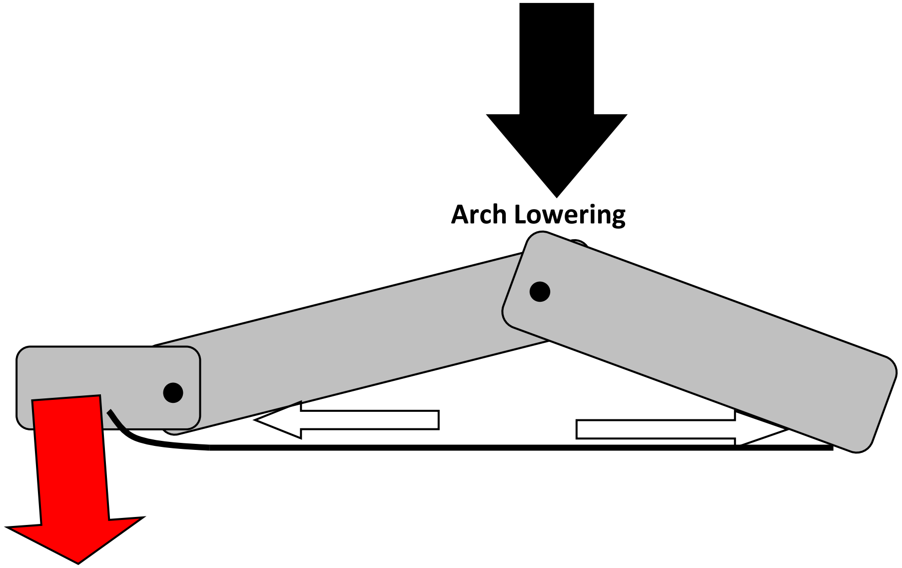
Plantar Fasciitis and Pronation

1. Pronating too hard, meaning the foot cannot resupinate.
2. Pronating too far, meaning there is lower limb functional malalignment.
3. Pronating too far, placing too much stress in the plantar fascia

↓

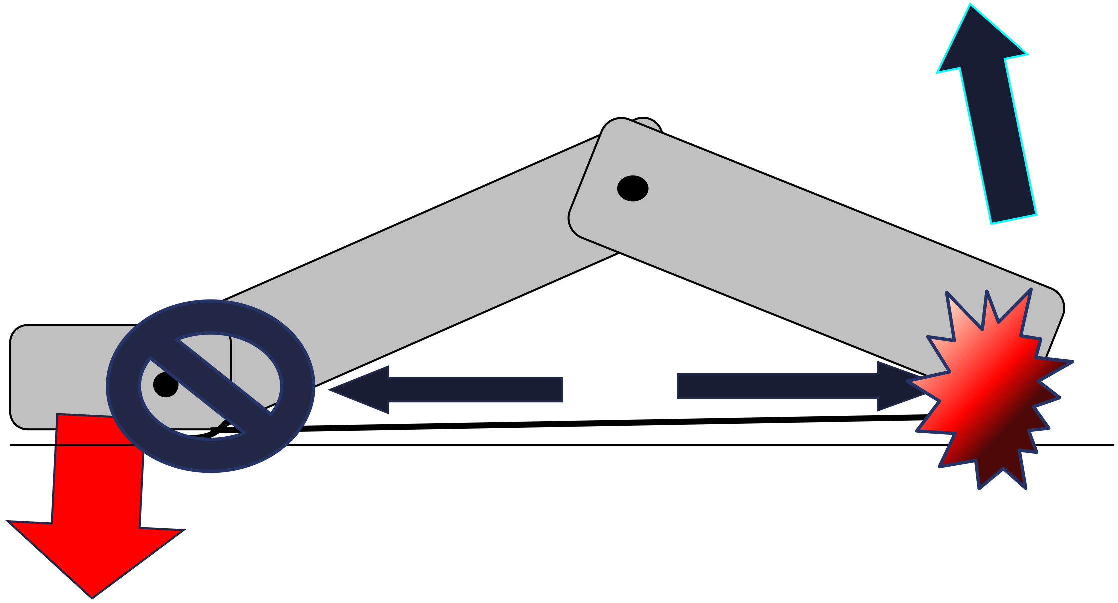
Reduced ability to pivot over the 1st MTPJ (functional hallux limitus)

3. Too much pronation limits hallux dorsiflexion via the reverse windlass



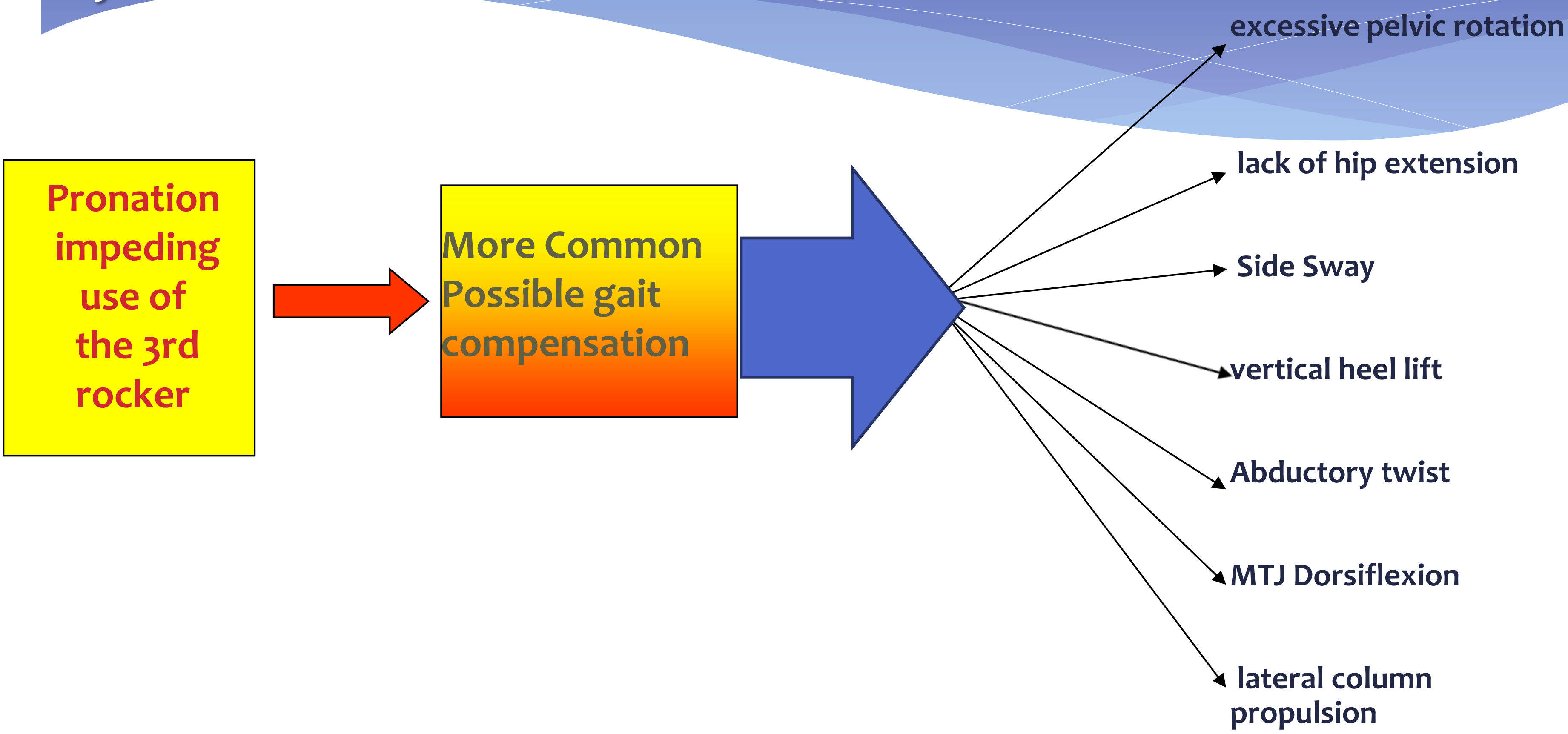
- **As the arch lowers it becomes longer and tensile strain in the plantar fascia increases, applying a plantarflexion moment on the digits. However, the greater the pronation, the greater the strain and the greater the plantarflexion moment**

3. Too much pronation limits hallux dorsiflexion via the reverse windlass, and as the heel tries to lift <u>tension in the plantar fascia increases</u>



- **As the heel tries to lift via hallux dorsiflexion, tensile stress will increase until dorsiflexion moments are greater than plantarflexion moments….or we compensate via gait dysfunction.**

As the heel tries to lift via hallux dorsiflexion, tensile stress will increase until dorsiflexion moments are greater than plantarflexion moments….or we compensate via gait dysfunction



Therefore, Anything that reduces pronation moments will reduce the strain in the plantar fascia

- And by doing so, decrease plantar fascia injury and reduce associated gait dysfunction

- **Therefore observing an improvement in gait dysfunction can be seen as a predictor to a successful outcome in treating plantar fasciitis**

CPHP– Evidence for Foot Orthoses prescription

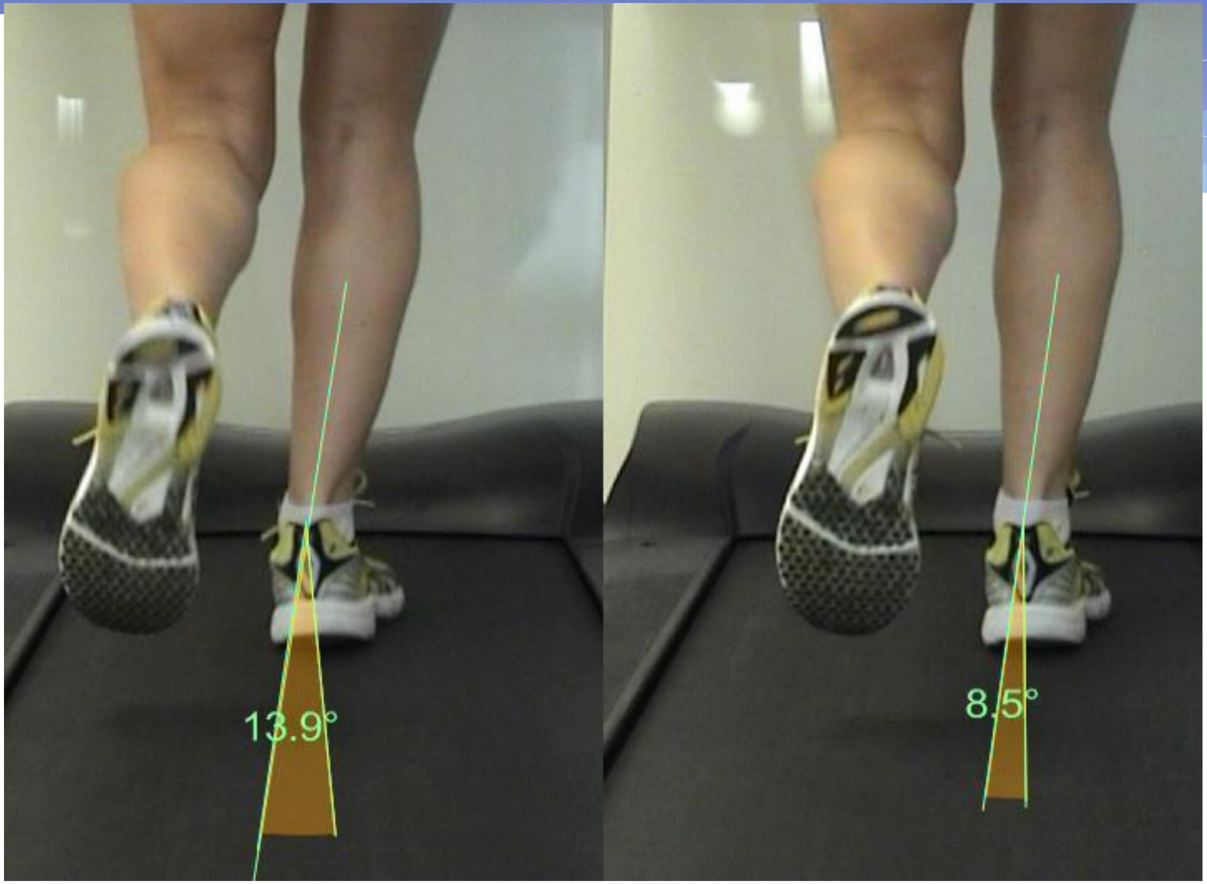
* Aims:

1. Decrease stress in plantar fascia by decreasing pronation moments

2. Not to impinge on first ray function

3. CUSHION!!!

DECREASE STRESS IN PLANTAR FASCIA BY DECREASING PRONATION MOMENTS



Only if prescribed correctly!!!

CPHP– Evidence for Foot Orthoses prescription

* Aims:

1. Decrease stress in plantar fascia by decreasing pronation moments

2. Not to impinge on first ray function

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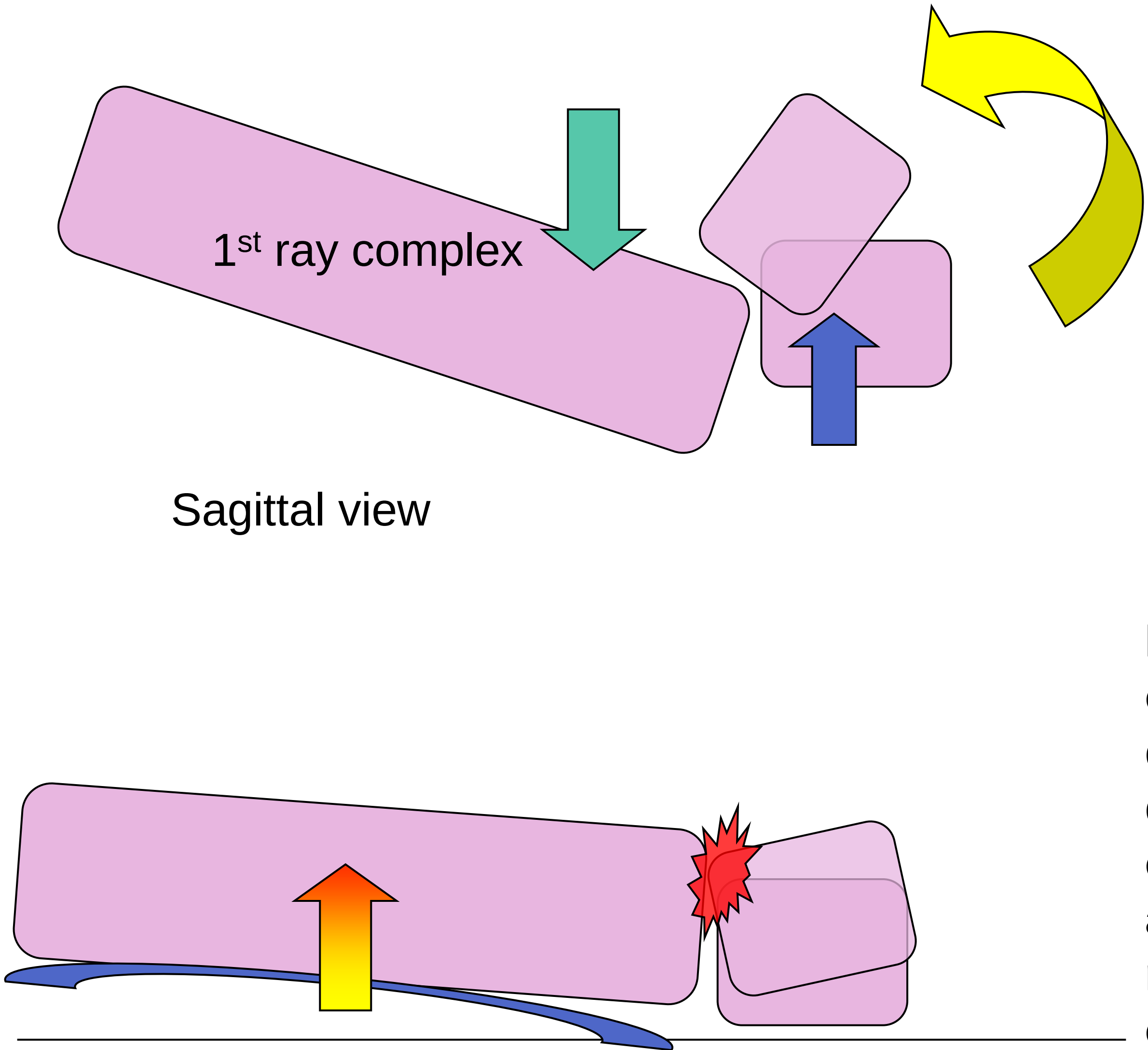
not to impinge on first ray function:



Normal Hallux dorsiflexion with first ray plantarflexion

Functional Limitation of Hallux dorsiflexion due to an increase of dorsiflexory moments on the first ray from an 'incorrect' / high medial contour (arch) orthosis

CPHP– Evidence for Foot Orthoses prescription

* Aims:

1. Decrease stress in plantar fascia by decreasing pronation moments

2. Not to impinge on first ray function

3. CUSHION!!!

Did he just Say ‘*cushion* ’ ?!

- CPHP may be related to degeneration, this being especially likely since the entheseal tissue in particular, is prone to degeneration

- The histopathological appearance of CPHP resembles the changes seen to articular cartilage during early stage OA with longitudinal fissuring of fibrocartilage, which then ossifies within the enthesis. Spur formation is likely to be a feature

Did he just Say ‘*cushion* ’ ?!

* According to McMillan at al (2009), “subcalcaneal spur formation is strongly associated with pain beneath the heel”

Did he just say '*heel spur*' ?!!!!

- A recent meta analysis undertaken by Jill Cook and Craig Purdham (2011) demonstrated that CPHP participants are over 8 times more likely to show evidence of spur than the control group. A recent study by Johal and Milnar (2012) demonstrated that 89% of a symptomatic CPHP cohort had associated calcaneal spur.

Did he just say ‘*heel spur* ’ ?!

* In all of this, vertical compressive loading has been identified as to be as important as traction classically linked to over-pronation (Menz et al 2008, Cook and Purdham 2011)

He did! He said ‘*heel spur* ’ !

- Yes I did!
- ‘Plantar fasciitis’ is not primarily inflammatory in nature and therefore should be regarded as fasciopathy with the nomenclature of CPHP (chronic plantar heel pain)
- The enthesis is brittle and therefore susceptible, especially with aging
- Bending, shear and compression are probably as important as tensile load
- The presence of a calcaneal spur is important and strongly linked to CPHP

Cushioning……

- Understanding this means we may obtain better results with orthotics and general treatment planning if we combine reduction in tensile plantar fascia stress WITH heel pad cushioning….

CPHP– Evidence for Foot Orthoses prescription

Aims:

1. Decrease stress in plantar fascia by decreasing pronation moments
2. Not to impinge on first ray function
3. CUSHION!!!

- Custom foot orthoses have been shown to be effective in both the short-term and long-term treatment of pain. Parallel improvements in function, foot-related quality of life, and a better compliance suggest that a foot orthosis is the best choice for initial treatment plantar fasciitis (*Roos et al 2006, Hume et al 2008, Lee et al 2009, Lewis et al, 2015*)

Other interesting Papers:

- Walther et al (2011). Effect of different orthotic concepts as first line treatment of plantar fasciitisFoot Ankle Surg. 2013 Jun;19(2):103-7.

Conclusion: After 3 weeks custom hard orthotics (with a soft top cover) are superior regarding pain reduction and pain free time when compared to Soft orthotics . Non-supportive orthotics (Cushioning) did not demonstrate a significant effect in the test setup used.

Other interesting Papers:

J Am Podiatr Med Assoc. 2015 Jul;105(4):281-94. doi: 10.7547/13-122.1. Epub 2015 May 5.

A randomized controlled trial of custom foot orthoses for the treatment of plantar heel pain.

Wrobel JS, Fleischer AE, Crews RT, Jarrett B, Najafi B.

Abstract

BACKGROUND: Up to 10% of people will experience heel pain. The purpose of this prospective, double-blind, randomized clinical trial was to compare custom foot orthoses (CFO), prefabricated foot orthoses (PFO), and sham insole treatment for plantar fasciitis.

METHODS: Seventy-seven patients with plantar fasciitis for less than 1 year were included. Outcome measures included first step and end of day pain, Revised Foot Function Index short form (FFI-R), 36-Item Short Form Health Survey (SF-36), activity monitoring, balance, and gait analysis.

RESULTS: The CFO group had significantly improved total FFI-R scores (77.4 versus 57.2; P = .03) without group differences for FFI-R pain, SF-36, and morning or evening pain. The PFO and CFO groups reported significantly lower morning and evening pain. For activity, the CFO group demonstrated significantly longer episodes of walking over the sham (P = .019) and PFO (P = .03) groups, with a 125% increase for CFOs, 22% PFOs, and 0.2% sham. Postural transition duration (P = .02) and balance (P = .05) improved for the CFO group. There were no gait differences. The CFO group reported significantly less stretching and ice use at 3 months.

CONCLUSIONS: The CFO group demonstrated 5.6-fold greater improvements in spontaneous physical activity versus the PFO and sham groups. All three groups improved in morning pain after treatment that included standardized athletic shoes, stretching, and ice. The CFO changes may have been moderated by decreased stretching and ice use after 3 months. These findings suggest that more objective measures, such as spontaneous physical activity improvement, may be more sensitive and specific for detecting improved weightbearing function than traditional clinical outcome measures, such as pain and disease-specific quality of life.

Trigger Point Dry Needling

A single randomised controlled trial by Cotchett et al (2011) provide evidence for the effectiveness of dry needling for the relief of CPHP.

Plantar Fascia “stretches”

Stretching the plantar fascia for CPHP has been shown to be superior to traditional weightbearing GSAT (gastrocnemius soleus Achilles tendon) stretching. Three randomised controlled trials have now shown the effectiveness of plantar fascial stretching (Rompe 2010, DiGiovanni 2006, DiGiovanni 2003).

Interesting Findings: DiGiovanni 2003. After 2 years, the sample that specifically stretched the plantar fascia had less pain than the group who did not....but both groups STILL HAD PAIN AFTER 2 YEARS!!!

Strength Training

Phys Ther Sport. 2017 Mar;24:44-52. doi: 10.1016/j.ptsp.2016.08.008. Epub 2016 Aug 18.

Strength training for plantar fasciitis and the intrinsic foot musculature: A systematic review.

Huffer D[1], Hing W[2], Newton R[3], Clair M[4].

Author information

Abstract

The aim was to critically evaluate the literature investigating strength training interventions in the treatment of plantar fasciitis and improving intrinsic foot musculature strength. A search of PubMed, CINHAL, Web of Science, SPORTSDiscus, EBSCO Academic Search Complete and PEDRO using the search terms plantar fasciitis, strength, strengthening, resistance training, intrinsic flexor foot, resistance training. Seven articles met the eligibility criteria. Methodological quality was assessed using the modified Downs and Black checklist. All articles showed moderate to high quality, however external validity was low. A comparison of the interventions highlights significant differences in strength training approaches to treating plantar fasciitis and improving intrinsic strength. It was not possible to identify the extent to which strengthening interventions for intrinsic musculature may benefit symptomatic or at risk populations to plantar fasciitis. There is limited external validity that foot exercises, toe flexion against resistance and minimalist running shoes may contribute to improved intrinsic foot musculature function. Despite no plantar fascia thickness changes being observed through high-load plantar fascia resistance training there are indications that it may aid in a reduction of pain and improvements in function. Further research should use standardised outcome measures to assess intrinsic foot musculature strength and plantar fasciitis symptoms.

ESWT

- The results of the ESWT studies are equivocal, with Crawford et al (2008) reporting that ESWT is more effective than placebo but only reports a mean difference of 6% (reduction in heel pain)

More recent papers….

- Erduran et al. A complication due to shock wave therapy resembling calcaneal stress fracture. Foot Ankle Int. 2013 Apr;34(4):599-602.

But then………….

- Agil et al, 2013. Extracorporeal shock wave therapy is effective in treating chronic plantar fasciitis: a meta-analysis of RCTs. Clin Orthop Relat Res. 2013 Nov;471(11):3645-52

"ESWT is a safe and effective treatment of chronic plantar fasciitis refractory to nonoperative treatments. Improved pain scores with the use of ESWT were evident 12 weeks after treatment. The evidence suggests this improvement is maintained for up to 12 months."

Taping

Calcaneal taping was shown to be a more effective tool for the relief of plantar heel pain than stretching, sham taping, or no treatment (Radford et al 2006, Hyland et al 2006)

Taping

J Phys Ther Sci. 2015 Aug;27(8):2491-3. doi: 10.1589/jpts.27.2491. Epub 2015 Aug 21.

Effects of the application of Low-Dye taping on the pain and stability of patients with plantar fasciitis.

Park C[1], Lee S[2], Lim DY[3], Yi CW[4], Kim JH[5], Jeon C[6].

Author information

Abstract

[Purpose] This study examined how the application of Low-Dye (LD) taping affected the pain and stability of patients with plantar fasciitis. [Subjects] The subjects were 30 patients with plantar fasciitis who were divided into two groups: a Low-Dye taping group (LTG, n=15) and a conservative treatment group (CTG, n=15). [Methods] The treatments were performed three times a week for six weeks in both groups. A visual analog scale (VAS) was used to evaluate the pain and stability of patients with plantar fasciitis, and the transfer area of the center of gravity (TAOCOG) was measured to evaluate stability using a BioRescue device. [Results] In the within-group comparison of the VAS, the LTG and CTG values significantly decreased. In the post-test between-group comparison, the VAS pain decreased more significantly in LTG than in CTG. In the within-group comparison of the TAOCOG, the LTG value significantly increased. In the post-test between-group comparison, the TAOCOG value increased more significantly than in LTG than in CTG. [Conclusion] Utilizing Low-Dye taping for patients with plantar fasciitis appears to be an effective intervention method for reducing pain and enhancing stability.

Steroid Injection

- The results from trials comparing steroid injections with placebo substances show

- No advantage in the active substance

- Only a short term improvement over placebo (Crawford and Thomson, 2008)

Other interesting Papers:

- Uden et al (2011). Plantar Fasciitis – to jab or to support? A systematic review of the current best evidence. J Multidiscip Healthcare.

Conclusion: Both functional foot orthotics and corticosteroid injections can lead to a reduction in pain associated with plantar fasciitis. While orthotics also increase functional outcomes, steroid injections may have side effects

Night Splints

- According to Bekler et al (2007), patients without previous treatments for plantar fasciitis obtain significant relief of heel pain in the short term with the use of a night splint, however, this application does not have a significant effect on prevention of recurrences after a two-year follow-up.

- However, Attard and Singh (2012) compared the effectiveness of a posterior AFO, which dorsiflexes the foot, with an anterior AFO, which maintains the foot in a plantigrade position, and came to the conclusion that "Plantar fasciitis night AFOs are poorly tolerated orthoses but their use can be justified in that the pain levels are reduced. **The anterior AFOs are more comfortable and more effective than posterior AFOs." !!!**

Surgery

Neufeld SK et al. Plantar fasciitis: evaluation and treatment. J Am Academy of Orth Surgeons. 2008 Jun;16(6):338-46

Findings: nonsurgical management of plantar fasciitis is successful in approximately 90% of patients. Surgical treatment is considered in only a small subset of patients with persistent, severe symptoms refractory to nonsurgical intervention for at least 6 to 12 months.

The general EBP approach to mechanical orientated plantar fasciitis is outlined below. This does not take into account specific situations or risk factors (e.g. tape allergy):

1. Orthoses (Reduce tensile stress and cushion), taping and specific plantar fasciitis stretches at initial assessment

2. ‘Non-evidence based treatments’ may also be used initially (as although there is a viable lack of research, there is not evidence to suggest these treatments do any harm.) For example, calf stretches, lateral rotator strengthening and footwear advice.

The general EBP approach to mechanical orientated plantar fasciitis is outlined below. This does not take into account specific situations or risk factors (e.g. tape allergy):

3. Combine the above with treatments based to irritate the area of Fasciosis to encourage healing. Examples include dry needling and extracorpeal shockwave therapy

4. If no benefit, prefabricated nightsplints are the next treatment option.

5. Steroid injections are an option if all conservative treatments fails, as is surgery.

Other interesting Papers:

Grieve R, Palmer S. Physiotherapy for plantar fasciitis: a UK-wide survey of current practice. Physiotherapy. 2016 Feb 12. [Epub ahead of print]

* 257 complete survey responses.
* Advice (92%), plantar fasciitis pathology education (81%) and general stretching exercises (74%) were most routinely used.
* Prefabricated orthotics, custom made orthotics and night splints were seldom always used.
* Commonly used outcome measures were pain assessment, functional tests and range of movement.

ACHILLES TENDONOPATHY

Achilles Tendinopathy

Tendinopathy – Tendon pain, swelling and impaired performance

- The patient rarely recalls a traumatic injury or sentinel event to induce the symptoms.
- While post-static dyskinesia is prevalent, pain is often exacerbated with increased exercise

Achilles Tendinopathy

- Surrounded by a clear areolar tissue that allows movement between the tendon and the surrounding tissue. This paratenon is capable of manifesting an inflammatory response and can become adherent in conditions such as peritendinitis and/or tendinosis

Achilles Tendinopathy

- Tendinosis, by definition, is a degenerative process of the Achilles, which manifests with the clinical hallmark of fusiform swelling
- Clinical signs are often the aforementioned fusiform swelling and intratendinous nodularity. On occasion, peritendinous swelling (peritendinitis) is visible concomitantly

Achilles Tendinopathy

- The fibers externally rotate beginning approximately 12 to 15 cm from the insertion and reaching a maximum of 2 to 5 cm proximal to it. This rotation may give insight as to why this area of the tendon is notoriously afflicted with pathology.

Achilles Tendinopathy

- One final but significant anatomic consideration is the popular contention of a hypovascular or so-called “watershed” region of the Achilles tendon. The oft-cited Lagergren and Lindholm study from the 1950s is the primary basis of this notion. However, more recent studies and technological advances have questioned this decades-old scientific dogma

- To this day, the debate about the vascular integrity of the Achilles tendon continues to evolve.

Achilles Tendinopathy

- Aetiological Factors, numerous in the literature
- Include: Training errors, over-pronation, equinus, footwear 'rub', trauma, Haglunds, Calc spurs, os-trigonum

Achilles Tendinopathy- Treatment Planning

* Good level of research on eccentric loading rehabilitation program and heel raises
* Decent orthoses research limited to ONE paper. Mayer F, Hirschmuller A, Muller S et al. Effects of short term treatment stratergies over 4 weeks in achilles tendonopathy. Br J sports Med. 41,e6: 2007
* Tx planning therefore should be Physio, footwear advice and heel raises PRIOR to referral. Even then, patients should demonstrate marked abnormal foot function / foot related gait dysfunction.

Achilles Tendinopathy- Treatment Planning

Br J Sports Med. 2015 Aug;49(15):989-94. doi: 10.1136/bjsports-2014-093845. Epub 2014 Sep 22.

Effectiveness of customised foot orthoses for Achilles tendinopathy: a randomised controlled trial.

Munteanu SE[1], Scott LA[1], Bonanno DR[1], Landorf KB[1], Pizzari T[2], Cook JL[3], Menz HB[1].

⊕ **Author information**

Abstract

AIM: To evaluate the effectiveness of customised foot orthoses in chronic mid-portion Achilles tendinopathy.

METHODS: This was a participant-blinded, parallel-group randomised controlled trial at a single centre (La Trobe University, Melbourne, Australia). One hundred and forty participants aged 18-55 years with mid-portion Achilles tendinopathy were randomised to receive eccentric calf muscle exercises with either customised foot orthoses (intervention group) or sham foot orthoses (control group). Allocation to intervention was concealed. The Victorian Institute of Sports Assessment-Achilles (VISA-A) questionnaire was completed at baseline, then at 1, 3, 6 and 12 months, with 3 months being the primary end point. Differences between groups were analysed using intention to treat with analysis of covariance.

RESULTS: After randomisation into the customised foot orthoses group (n=67) or sham foot orthoses group (n=73), there was 70.7% follow-up of participants at 3 months. There were no significant differences between groups at any time point. At 3 months, the mean (SD) VISA-A score was 82.1 (16.3) and 79.2 (20.0) points for the customised and sham foot orthosis groups, respectively (adjusted mean difference (95% CI)=2.6 (-2.9 to 8.0), p=0.353). There were no clinically meaningful differences between groups in any of the secondary outcome measures.

CONCLUSIONS: Customised foot orthoses, prescribed according to the protocol in this study, are no more effective than sham foot orthoses for reducing symptoms and improving function in people with mid-portion Achilles tendinopathy undergoing an eccentric calf muscle exercise programme.

Mechanical benefit paper

Sinclair et al. Effects of foot orthoses on Achilles tendon load in recreational runners. Clin Biomech (Bristol, Avon). 2014 Sep;29(8):956-8.

Achilles tendon pathology is a frequently occurring musculoskeletal disorder in runners. Foot orthoses have been shown to reduce the symptoms of pain in runners but their mechanical effects are still not well understood.

FINDINGS:

The results indicate that running with foot orthotics was associated with significant reductions in Achilles tendon load compared to without orthotics.

INTERPRETATION:

In addition to providing insight into the mechanical effects of orthotics in runners, the current investigation suggests that via reductions in Achilles tendon load, foot orthoses may serve to reduce the incidence of chronic Achilles tendon pathologies in runners.

SINUS TARSI SYNDROME

(LATERAL IMPINGEMENT SYNDROME)

Sinus Tarsi Syndrome

- Sinus tarsi syndrome was first described by O'Connor in 1949. He summarised the condition as an unremitting pain in the lateral ankle area and instability of the rearfoot, usually following an inversion sprain .

Chronic Sinus Tarsi Syndrome

Clin Anat. 2017 May 17. doi: 10.1002/ca.22908. [Epub ahead of print]

The dimensions of the tarsal sinus and canal in different foot positions and its clinical implications.

Kleipool RP[1], Blankevoort L[2], Ruijter JM[1], Kerkhoffs GMMJ[2,3,4], Oostra RJ[1].

Author information

Abstract

INTRODUCTION: This study presents a reference for the dimensions of the tarsal sinus and canal in healthy adults in different foot positions to facilitate understanding of the kinematics of the subtalar joint, the effect of an implant, and other clinical issues.

MATERIALS AND METHODS: In a 3D CT stress test on 20 subjects, the right foot was forced into a neutral and eight different extreme foot positions while CT scans were obtained. The bones were segmented in the neutral foot position. The kinematics of the bones in the extreme positions were determined relative to the neutral position. The dimensions of the tarsal sinus and canal were calculated by determining the radii of the maximal inscribed spheres at 20 equidistant locations along an axis in 3D surface models of the tali and calcanei in each foot position.

RESULTS: The radii were small on the medial side and increased laterally. Medial from the middle, the radii were small and not significantly different among the various foot positions. At the lateral side, the dimensions were affected mainly by eversion or inversion and less by dorsiflexion or plantarflexion. The pattern was reproducible among subjects, but there were between-subject differences.

CONCLUSIONS: The dimensions are mostly determined by rotation in the frontal plane. A pivot point was found medial from the middle. These data serve as a reference and model for predicting the effect of sinus implants and understanding such clinical problems as sinus tarsi syndrome. Between-subjects differences have to be taken into account.

Chronic Sinus Tarsi Syndrome (Lateral impingement Syndrome)

Four clinical signs evident in sinus tarsi syndrome:

1. Pain over the lateral sinus tarsi opening which decreases with rest
2. Increased pain over uneven surfaces
3. Complete relief of pain with injection into the sinus tarsi
4. Clinical and radiological studies are insignificant.

Sinus Tarsi Syndrome - Aetiology

- Due to a compression force of the synovial membrane lining the sinus

1. Increased compression due to inflammation following ankle sprain
2. Maximum pronation
3. Both of the above

Sinus Tarsi Syndrome - Treatment

- No conclusive literature on any outcomes!
- If maximally pronated initially try non-custom orthoses and monitor (unless contra-indicated)
- Custom orthoses if assessment indicates their use

POSTERIOR TIBIAL TENDON DYSFUNCTION

Posterior Tibial Tendon Dysfunction


Posterior tibial tendon dysfunction
(adult acquired flat foot)

Posterior Tibial Tendon Dysfunction - Classification

As described by the Richie modification of the Johnson and Strom classification

- **Stage I.**, Stage I demonstrates little or no structural changes weightbearing or non-weightbearing. The presenting symptom is tendinitis associated with either symmetrical occurring or unilateral flatfoot. Usually, the patient can still raise the heel on the symptomatic side but with more difficulty. Symptoms of Stage I usually resolve with orthotics and physiotherapy, and this response is diagnostic of Stage I. The rearfoot remains flexible

Posterior Tibial Tendon Dysfunction - Classification

As described by the Richie modification of the Johnson and Strom classification

Stage II . This is characterized by a change in the weightbearing morphology of the foot, particularly the lowering of the longitudinal arch and abduction of the forefoot distal to the midtarsal joint, producing the signature sign of too many toes. These changes are due to an actual tendinosis, not simply a tendinitis of the tendon. The patient can rarely perform a simple heel raise. These signs are usually a result of the attenuation or rupture of the tibialis posterior tendon. The rearfoot remains flexible.

Posterior Tibial Tendon Dysfunction - Classification As described by the Richie modification of the Johnson and Strom classification

- **Stage III.** Characterized and easily differentiated from I and II by rigidity of the rearfoot. Forced weightbearing manipulation of the rearfoot into a more neutral position is not possible. Radiographs usually demonstrate moderate to severe arthritic changes at the posterior facet of the subtalar joint and degeneration of subchondral bone at the talonavicular joint. The simple heel raise fails

Posterior Tibial Tendon Dysfunction - Classification

As described by the Richie modification of the Johnson and Strom classification

Stage IV . This stage is classified as the most dramatic deformity and is resistant to any treatment options other than surgical fusions. The hallmark of this deformity is the severe valgus deformity of the talocrural joint, degenerative joint disease of the rearfoot joints and, in dramatic cases, fractures of the fibular malleolus secondary to the huge lever of the lateral deforming forces.

Other grading scales:

Stage	Description
I	No deformity (preexisting relative flatfoot often present)
IIa	Moderate flexible deformity (minimal abduction through talonavicular joint, <30 % talonavicular uncoverage)
IIb	Severe flexible deformity with either abduction deformity through talonavicular joint (ie, >30 %–40 % talonavicular uncoverage) or subtalar impingement
III	Fixed deformity (involving the triple-joint complex)
IVa	Hindfoot valgus and flexible ankle valgus without significant ankle arthritis
IVb	Hindfoot valgus with rigid ankle valgus or flexible deformity with significant ankle arthritis

Vulcano et al, 2013

Posterior Tibial Tendon Dysfunction – Aetiological Factors

Direct trauma Laceration **Iatrogenic** Steroid injection **Structural / Anatomical** Os navicularis Rigid flat foot Flexible flat foot Osteophytic proliferation in malleolar groove Zone of tendon “hypovascularity” Shallow malleolar groove	**Inflammatory process causing tenosynovits** Rheumatoid arthritis Seronegative disease **Indirect trauma** Ankle fracture Eversion ankle sprain Acute avulsion off navicular TP dislocation **Other** Primary/ metastatic bone tumour

Posterior Tibial Tendon Dysfunction – Aetiological Factors

Foot posture influences the electromyographic activity of selected lower limb muscles during gait. Murley G et al**. Journal of Foot and Ankle Research.** 2009, **2:**35

During midstance/propulsion, the flat-arched group **exhibited increased activity of tibialis posterior** (peak amplitude; 86 versus 60% of maximum voluntary isometric contraction)
Effect sizes for these significant findings ranged from 0.48 to 1.3, representing moderate to large differences in muscle activity between normal-arched and flat-arched feet.

Treatment planning

Curr Rev Musculoskelet Med. 2013 Dec;6(4):294-303. doi: 10.1007/s12178-013-9173-z.

Approach and treatment of the adult acquired flatfoot deformity.

Vulcano E[1], Deland JT, Ellis SJ.

Author information

Abstract

Adult acquired flatfoot deformity (AAFD), embraces a wide spectrum of deformities. AAFD is a complex pathology consisting both of posterior tibial tendon insufficiency and failure of the capsular and ligamentous structures of the foot. Each patient presents with characteristic deformities across the involved joints, requiring individualized treatment. Early stages may respond well to aggressive conservative management, yet more severe AAFD necessitates prompt surgical therapy to halt the progression of the disease to stages requiring more complex procedures. We present the most current diagnostic and therapeutic approaches to AAFD, based on the most pertinent literature and our own experience and investigations.

Posterior Tibial Dysfunction – Orthoses as Treatment

- Treatment depends upon stage of the condition
- Theoretically to apply enough supinatory moments via orthoses / splinting / footwear to reduce tissue strain and malalignment.
- What's the 'evidence'?

1) Kulig K, et al.Nonsurgical management of posterior tibial tendon dysfunction with orthoses and resistive exercise: a randomized controlled trial. Phys Ther. 2009 Jan;89(1):26-37.

As already stated there is relatively little research, but orthoses are universally recommened at all stages of Posterior Tibial Tendon Dysfunction.

1) Julie Kohls-Gatzoulis et al. Tibialis posterior dysfunction: a common and treatable cause of adult acquired flatfoot. *BMJ 2004;329:1328–33*

Suggests 'off the peg', 'custom made', 'UCBL', 'AFOs' depending on need and stage

2) Trnka HJ. Dysfunction of the tendon of tibialis posterior. J Bone Joint Surg Br. 2004 Sep;86(7):939-46.

Suggests 'Custom made' (with examples of materials) 'UCBL', 'AFOs' depending on need and stage. Mentions may need 'plantar dells' to allow for plantar exostosis (Commonly under the navicular)

What do we expect from orthoses?

1. Not to make this worse and so have adverse effects elsewhere
2. Not to be uncomfortable
3. Not to wear down quickly or fall apart.
4. Not to need a different pair for every pair of shoes

These are more difficult for PTTD, and become more so the more progressive the condition

1. Not to make this worse and so have adverse effects elsewhere
2. Not to be uncomfortable
3. Not to wear down quickly or fall apart.
4. Not to need a different pair for every pair of shoes

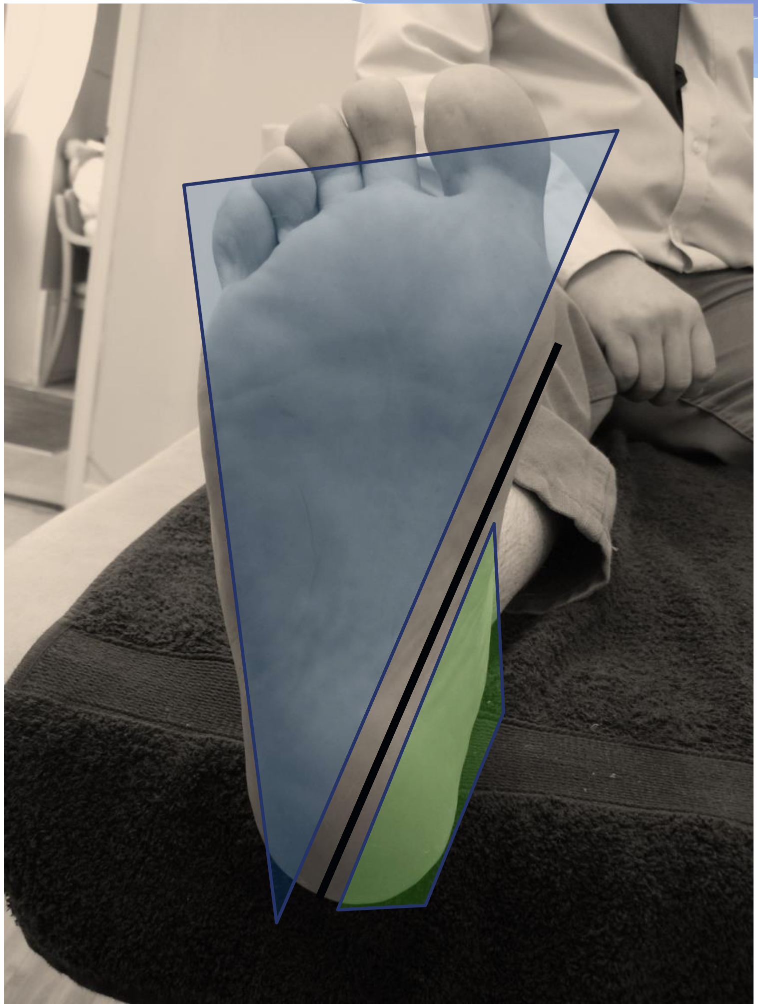
So, how should orthoses be prescribed?

* Theoretically to apply enough supinatory moments to reduce tissue strain and malalignment.

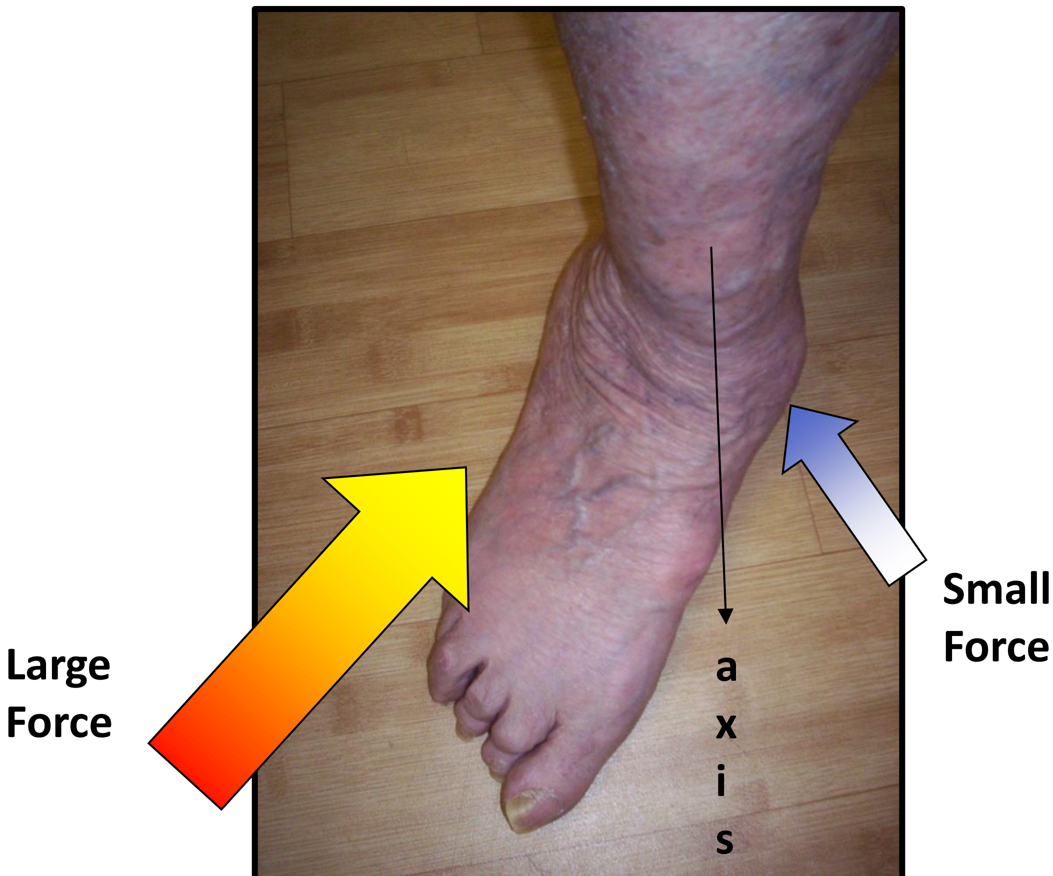
1. Harradine P D et al. A new method of increasing supinatory moments to a medially deviated subtalar joint axis - The Medial Oblique Shell Inclination. *Podiatry Now*. 2008 .11(3).
2. Harradine P D et al: The Medial Oblique Shell Inclination Technique. A Method to Increase Subtalar Supination Moments in Foot Orthoses. *J of the American Podiatric Med Assoc.* 2011. 101;6. 523-530

Suggests using specific custom shell inclines to optimise the applied orthotic reaction force to the axis of the Subtalar Joint. ***<u>But how do they actually work???</u>***

STJA most often medial in PTTD



STJA and PTTD



The MOSI – Applying ORF optimally

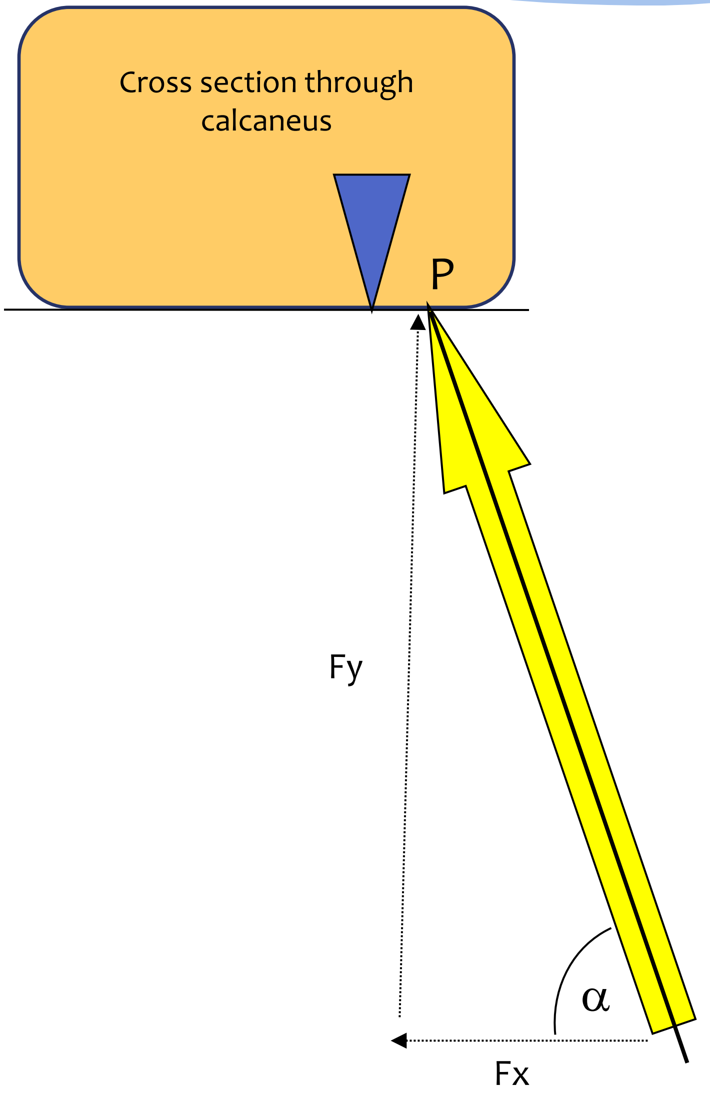
- Fx = P cos a
- Fy = P sin a

Where:

Fx = Horizontal force

Fy = Vertical force

P = Applied force



Example of vertical force lost

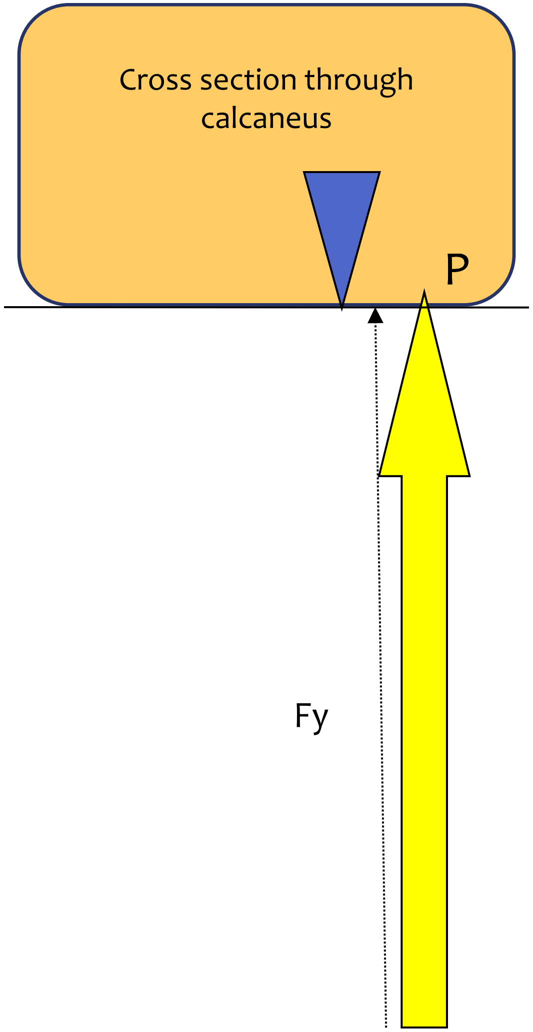
- Fy = P sin a
- Fy = 45N . Sin 60
- Fy = 38.97N

Force 'Lost' about 6N, or approximately 13%

Orthosis Reaction Force Applied by a Heel Post or Skive

- Some of the applied orthoses force to reduce the pronatory moment via the vertical force is lost to a horizontal force component in a foot with a medial axis
- This component in turn places a force to move the foot laterally on the shell
- This may limit our posting, as the patient feels they are "slipping off the orthotic"

The MOSI – Applying ORF optimally



- Fx = P cos a
- Fy = P sin a

Where

Fx = Horizontal force, not present

Fy = Vertical force

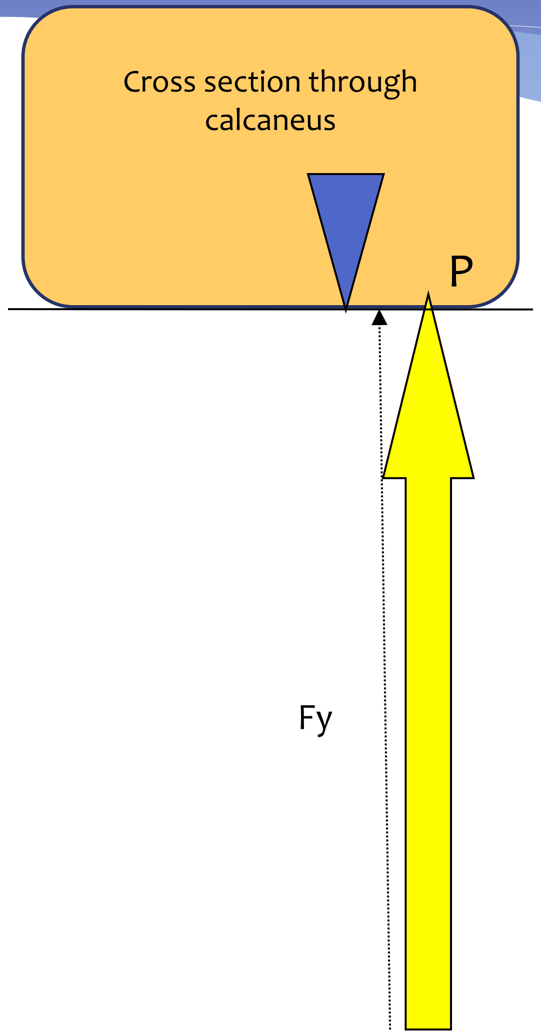
P = Applied force

Example of vertical force lost

- Fy = P sin a
- Fy = 45N . Sin 90
- Fy = 45N

Force Lost 0N, or 0%

The MOSI – Applying ORF optimally



* Fx = P cos a
* Fy = P sin a
* Where

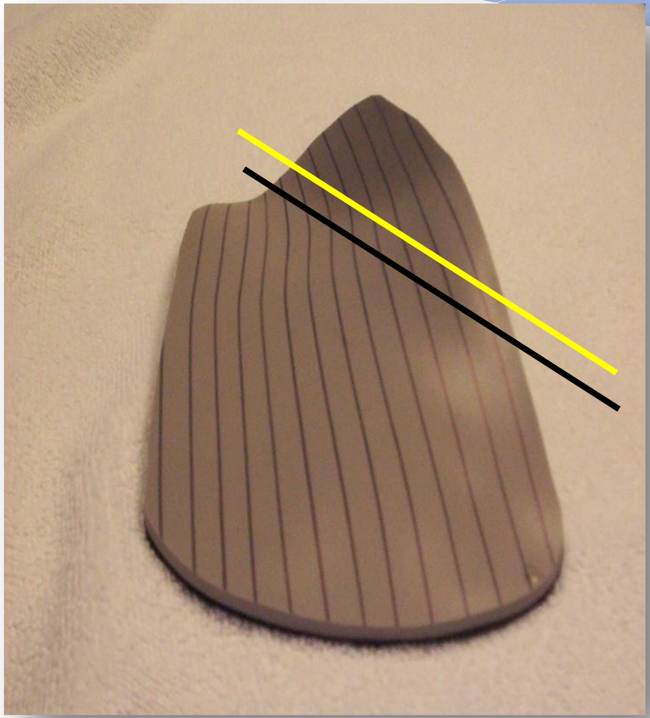
Fx = Horizontal force, not present

Fy = Vertical force

P = Applied force

* Example of vertical force lost
* Fy = P sin a
* Fy = 45N . Sin 90
* <u>Fy = 45N</u>
* **<u>Force Lost 0N, or 0%</u>**

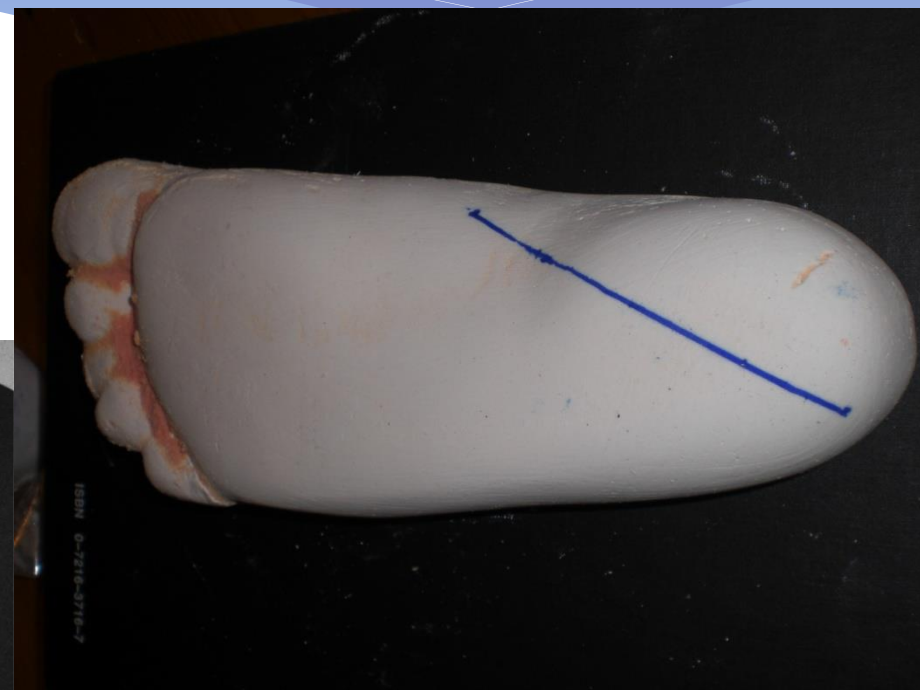
The MOSI modification



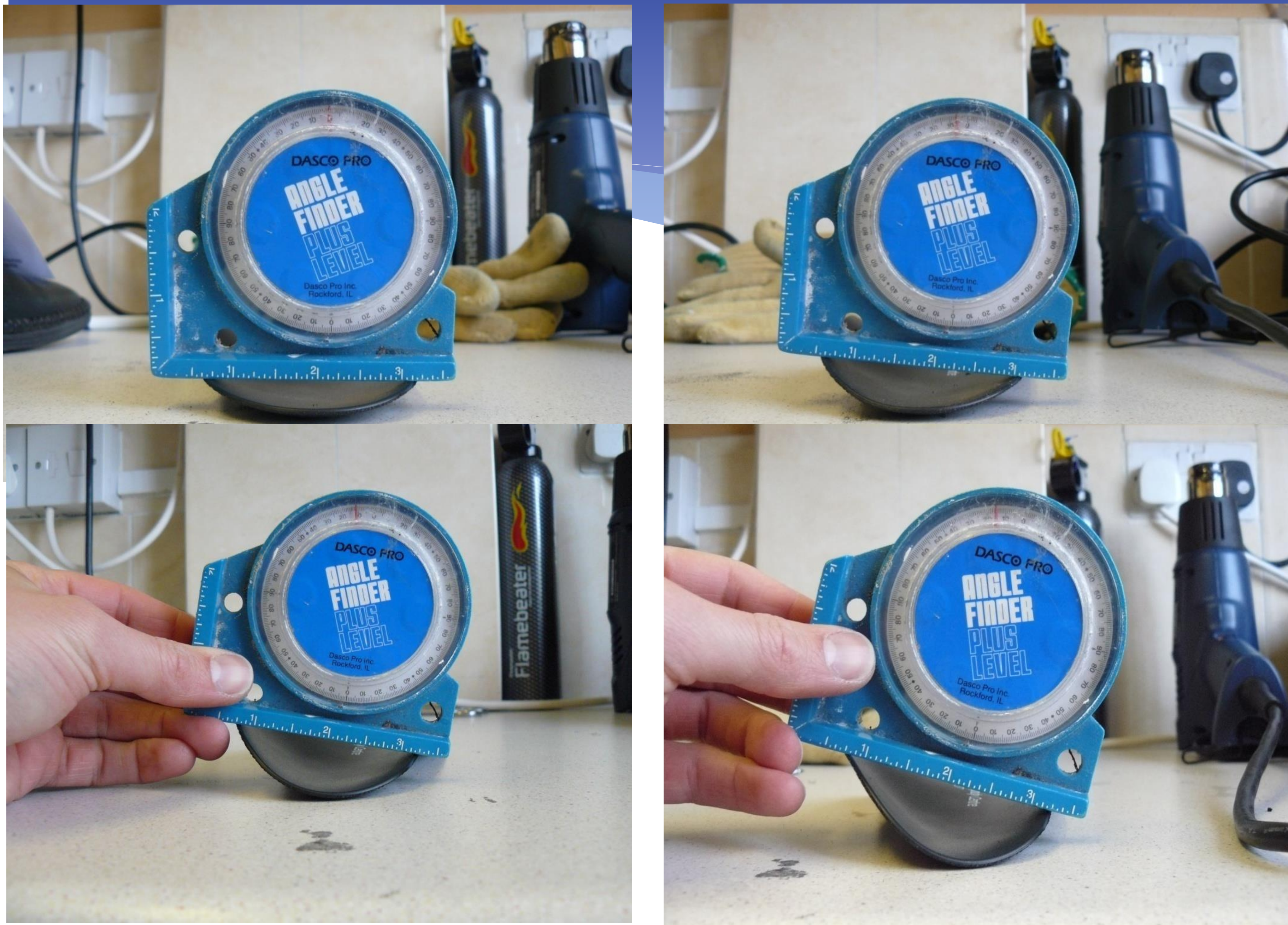
MOSI Prescription written to an orthotics laboratory

- Casts / impressions are taken as normal
- When asking for a MOSI, the lab need to know 2 additional details so the cast can be modified
- Rearfoot extrinsic posting can me as normal (e.g. Full or Hemi) or specifically a MOSI post can be added

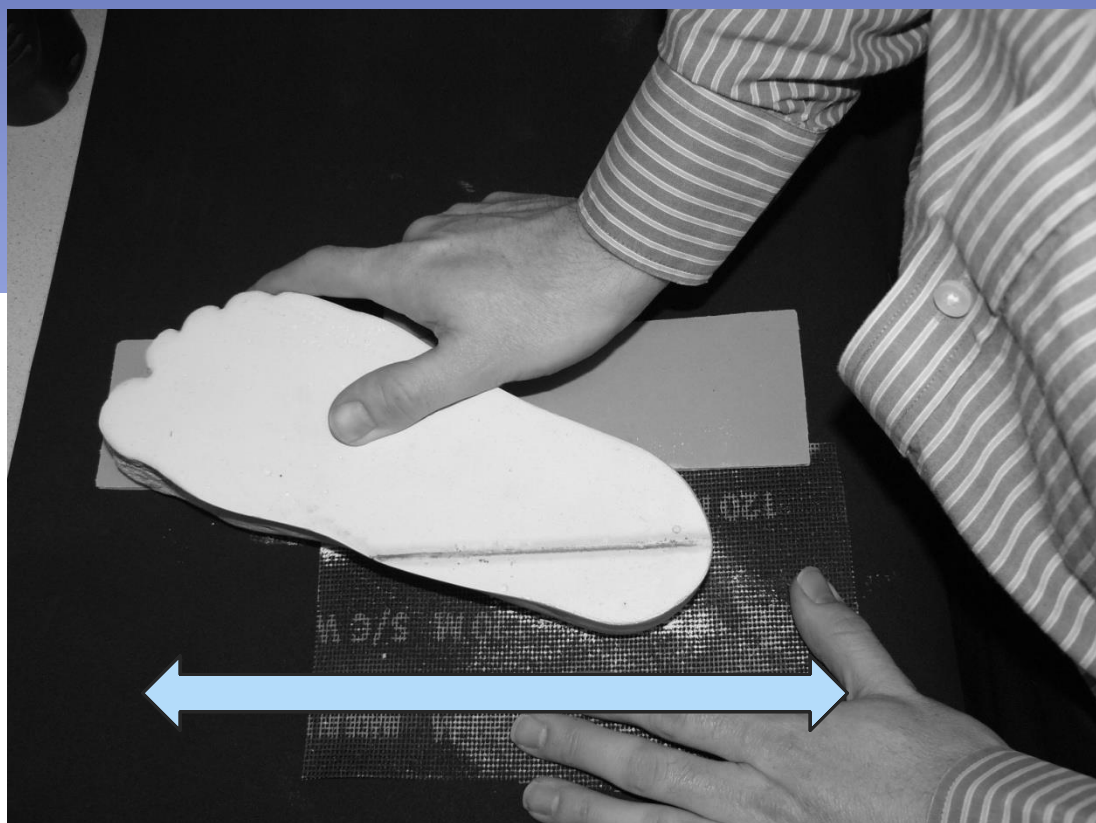
1) The Tranverse plane angulation, the approximation of the STJA you want the MOSI to follow



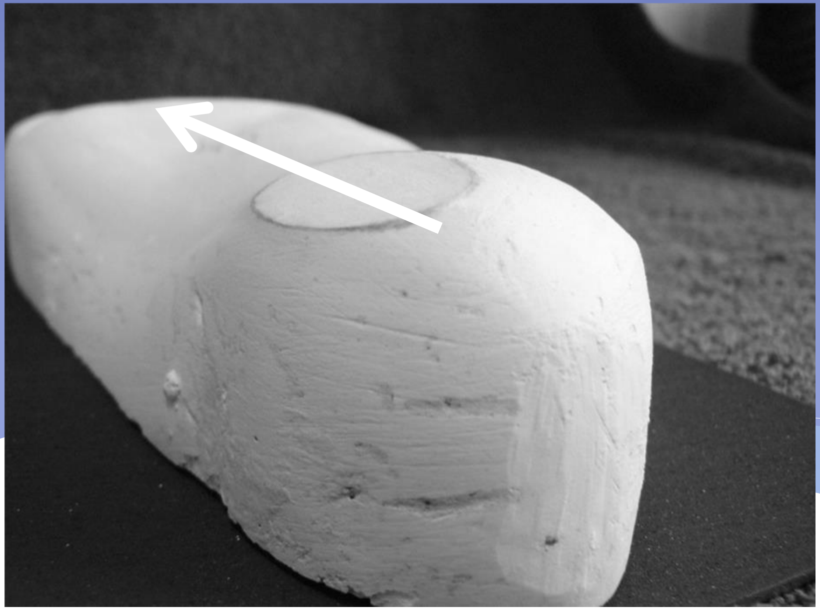
2) The amount of frontal plane modification you require

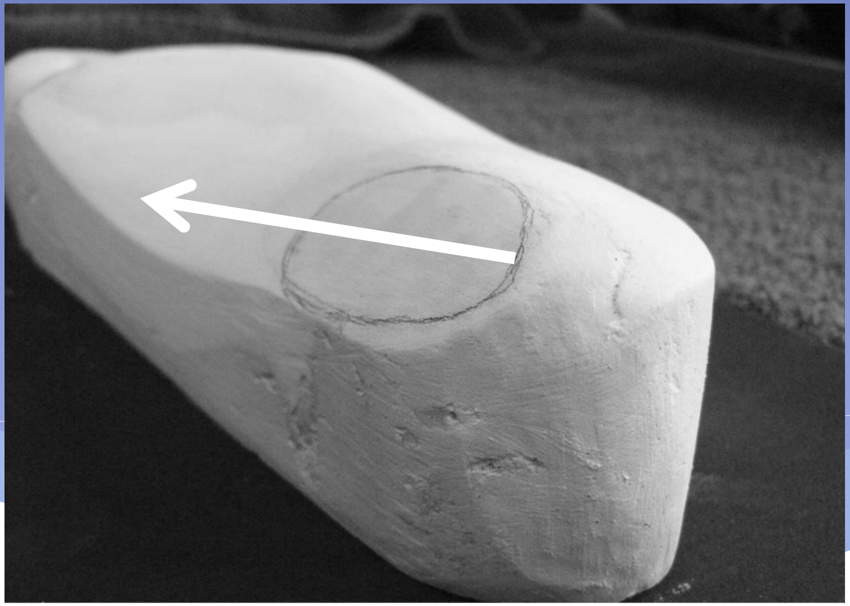


The cast is positioned with the transverse plane line pointing perpendicular to the manufacturer. The required frontal plane angulation is placed on the lateral aspect to the forefoot. The cast can then be moved back and forth in this position until approximately 2/3 of the medial heel has been removed.

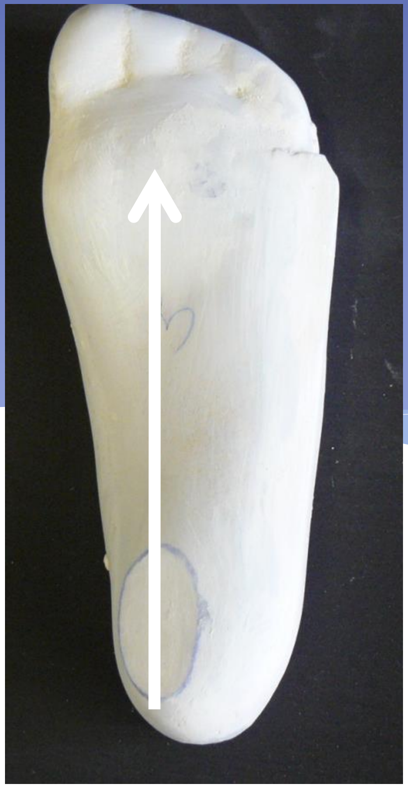


Posterior view of positive casts with the A) medial heel skive modification and B) MOSI modification. The white arrows demonstrate the different angle of application of the incline between the two cast modifications.

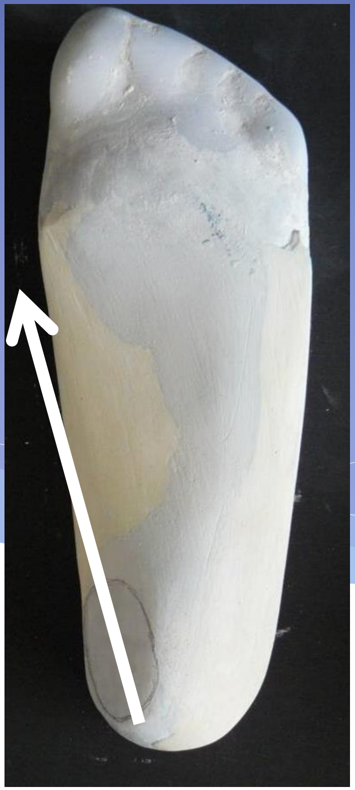




Plantar view of positive casts with the A) medial heel skive modification and B) MOSI modification. The white arrows demonstrate the different angle of application of the incline between the two cast modifications.

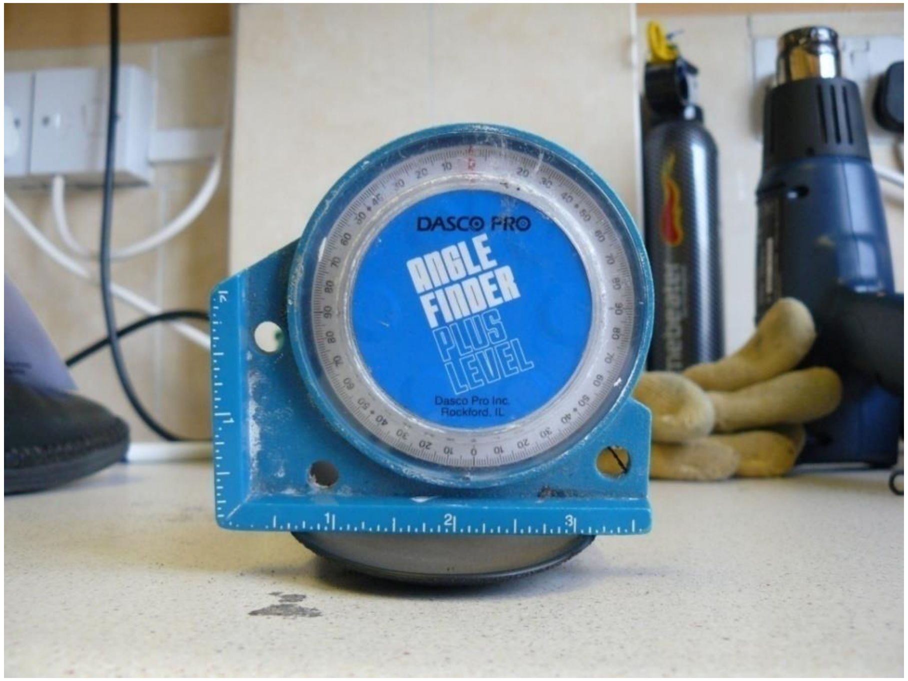


A – Medial heel skive



B - MOSI

Manufacture of the MOSI



Manufacture of the MOSI

MOSI Post Addition

MOSI Post Addition

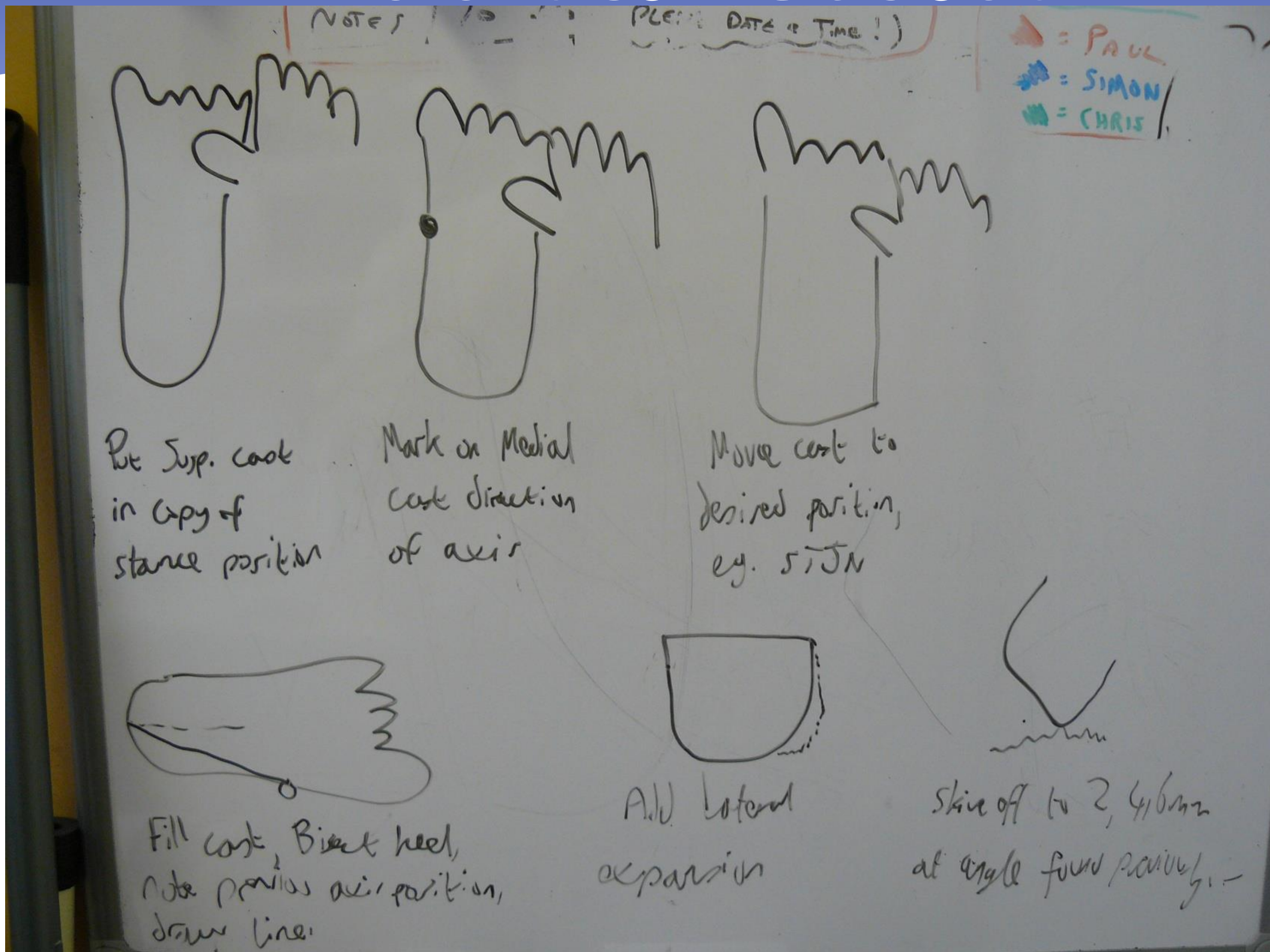
MOSI


Podiatry and Chiropody Centre
02392 373737


The Podiatry and Chiropody Centre
02392 373737

MOSI and PTTD

How to make from a cast…how did it come about?



Restricted budget and the MOSI…if you have less ability to apply a large supinatory moment, then try not to waste any.

PTTD

- A poor budget does not have to mean poor outcomes, a poor clinician might though!

Possible Contraindications

- As with all orthoses prescription, care should be taken to do no harm.
- By increasing the supinatory moment placed upon the STJA, it may be possible to 'over supinate' a foot and cause adverse effects.
- In addition the orthoses reaction force being applied is also more perpendicular to the talocrural joint axis. Theoretically this can also increase the moment plantarflexing the foot at the ankle. This modification therefore may not be suitable for patients exhibiting weak anterior tibial components, anterior compartment syndrome and patients at risk of such injuries due to chosen activities, e.g., hill running.

Posterior Tibial Dysfunction - Treatment

* Physiotherapy and Splinting

Posterior Tibial Dysfunction - Treatment

- Orthopaedic Team Referral

PATELLOFEMORAL PAIN STNDROME

Patellofemoral Pain – Is there a place for a foot up approach?

Is there a place for a foot up approach?

* Does everybody with PFPS need orthotics?
* Does nobody with PFPS need orthotics?
* If anybody with PFPS does needs foot orthotics… then who?

What's the idea behind the foot up approach?

- There is growing evidence for the efficacy of foot orthoses prescription when treating individuals with PFPS.

Eng JJ & Pierrynowski MR. 1993 & 1994; Amell TK, Et al, 2000; Johnston LB & Gross MT. 2004 ;Pitman D, & Jack D. 2000 ; Sutlive TG et al 2004 ; Collins N, et al, 2008 ; Barton CJ et al 2011)

- Traditionally, foot orthoses have been advocated for PFPS based on the premise that they are needed to reduce excessive foot pronation.

What's the bigfoot idea?

- Tiberio (1987) proposed that excessive or prolonged foot pronation (rearfoot eversion) during the stance phase of gait would result in greater tibial internal rotation.

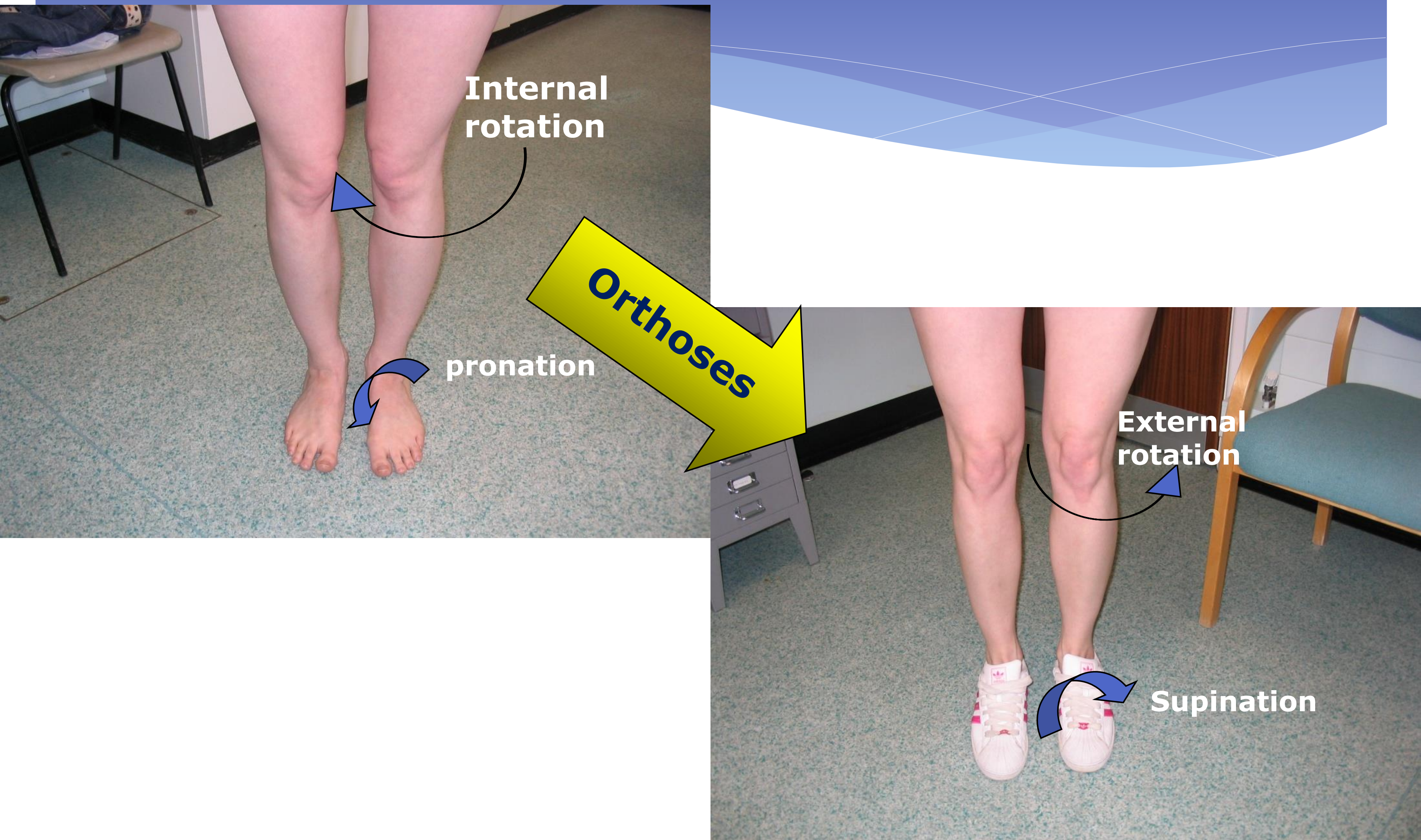
- This would in turn delay or reduce the tibial external rotation relative to the femur required to allow knee extension through midstance.

- To compensate, the hip (femur) would need to rotate internally to a greater degree, thereby also increasing hip adduction and dynamic Q angle.

What's the bigfoot idea?

- These tibial and femoral kinematic variations are thought to be detrimental to the PFJ owing to the associated reduced contact area and increased lateral PFJ compression (Wilson T, 2007)

What's the bigfoot idea?



Does research show there's a link?

- Barton et al (2011) found fair association between pronated foot posture (as indicated by the FPI) and a stronger association with dynamic maximum rearfoot eversion (pronation).

- However, prospective studies are required to determine whether this relationship is causal.

	FACTOR	PLANE	SCORE 1 Date__________ Comment__________		SCORE 2 Date__________ Comment__________		SCORE 3 Date__________ Comment__________	
			Left (-2 to +2)	**Right** (-2 to +2)	**Left** (-2 to +2)	**Right** (-2 to +2)	**Left** (-2 to +2)	**Right** (-2 to +2)
Rearfoot	Talar head palpation	*Transverse*						
	Curves above and below lateral malleoli.	*Frontal/ trans*						
	Inversion/eversion of the calcaneus	*Frontal*						
Forefoot	Bulge in the region of the TNJ	*Transverse*						
	Congruence of the medial longitudinal arch	*Sagittal*						
	Abd/adduction of forefoot on rearfoot (too-many-toes).	*Transverse*						
	TOTAL							

Reference values
Normal = 0 to +5
Pronated = +6 to +9, Highly pronated 10+
Supinated = -1 to –4, Highly supinated –5 to -12

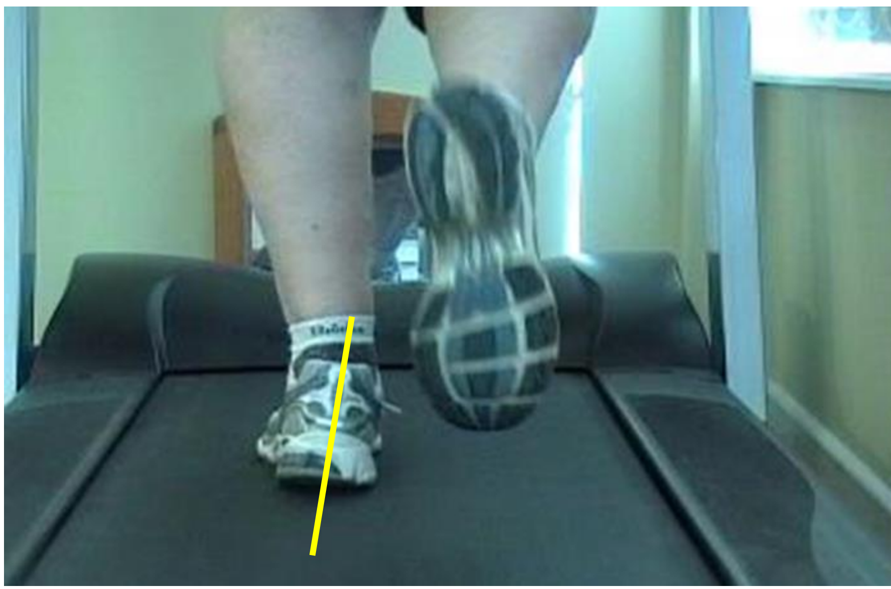
Should orthotics to reduce pronation only be supplied to patients with over pronation?!

- Greater peak rearfoot eversion predicts foot orthoses efficacy in individuals with patellofemoral pain syndrome.
- Barton CJ, et al, 2011.

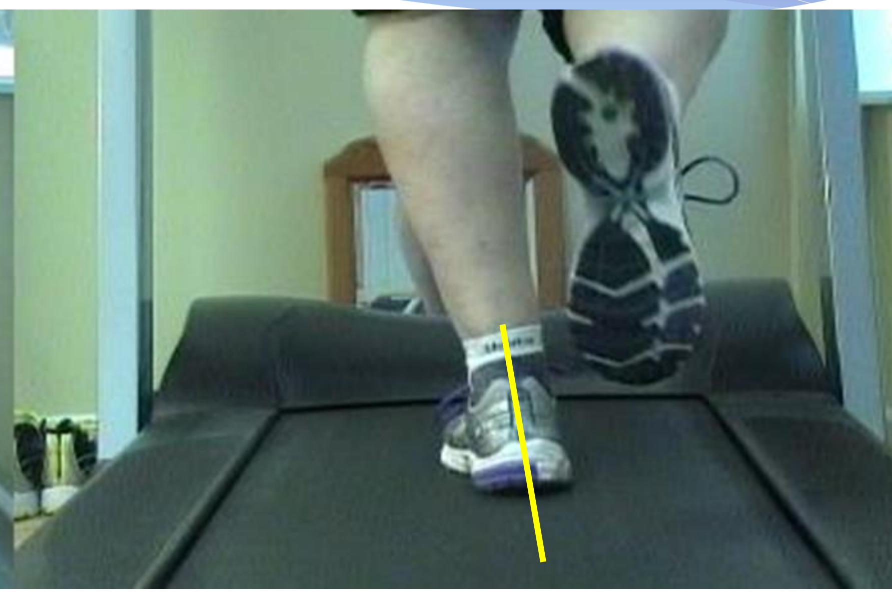
- "The best way to cure sea sickness is to sit under a tree"
- The late, Great, Spike Milligan

Orthoses outcome examples

1) Assess for over-pronation
2) Check its improved with treatment!



No orthotics



Orthotics

Could it be that straight forward?

Rodrigues p et al. Medially posted insoles consistently influence foot pronation in runners with and without anterior knee pain. Gait Posture. 2013 Apr;37(4):526-31

“medially posted insoles significantly reduced rearfoot eversion and eversion velocity in runners with and without PFP.”

Could it be that straight forward?

- **Insoles, however, had only a small influence on tibial and knee kinematics. Assuming a biomechanical aetiology for PFP, these data suggest that insoles may bring about their symptomatic relief at the knee not only by altering its transverse plane kinematics, but perhaps by influencing other variables.**

- Other such variables include effects of foot orthotics in the sagittal plane (MacLean et al, 2006) and muscle recruitment patterns (Nawoczenski and Ludewig, 1999)

Could it be that straight forward?

Sportverletz Sportschaden. 2015 Jun;29(2):107-17. doi: 10.1055/s-0034-1399002. Epub 2015 Feb 12.

[The Influence of Foot Orthoses on Patellofemoral Pain Syndrome: A Systematic Analysis of the Literature].

[Article in German]

Ahlhelm A[1], Alfuth M[1].

Author information

Abstract

BACKGROUND: The patellofemoral pain syndrome (PFPS) is one of the most commonly encountered disorders involving the knee. The symptoms often lead to a reduction of physical activities resulting in sport- and job-related disabilities and the potential occurrence of severe disorders. Different theories for the development of the syndrome exist which result in different therapy modalities. A change in foot posture and its effect on lower limb kinematics seem to be one potential risk factor for the development of the syndrome. This leads to the assumption that foot orthoses might be a potential therapy device.

OBJECTIVES: The aims of this study were to outline the state of evidence for the treatment of PFPS with foot orthoses and to identify the effect of foot orthoses on PFPS.

STUDY DESIGN: A systematic review of clinical (CT) and randomized controlled trials (RCT) was undertaken.

METHODS: A systematic search for studies (CT, RCT) was conducted using the databases of Medline (PubMed), Cochrane library, and PEDro. The relevance for further analysis of studies was reviewed on the basis of title and abstract. An additional search was undertaken using the reference lists of the included studies and additional literature as well as the PubMed function "related articles".

RESULTS: 11 studies were included in this analysis. The effect of different types of foot orthoses on pain, function and kinematics of the lower limb and muscle activation of selected lower limb muscles was analysed. Significant effects on pain and function were determined. A slight effect on kinematics of the lower limb and muscle activation of selected lower limb muscles was identified.

CONCLUSION: Foot orthoses seem to be an effective treatment device in the therapy for PFPS. An immediate and long-term reduction in pain and an improvement of function occurred following the intervention. There was just a slight change in lower limb kinematics and muscle activation of selected lower limb muscles. The relationship between biomechanical effects of orthoses and pain still seems to be unclear.

Is there a place for a foot up approach?

* Does <u>everybody</u> with PFPS need orthotics?

…… No

* Does <u>nobody</u> with PFPS need orthotics?

…..No

* If <u>anybody</u> with PFPS needs foot orthotics… <u>then who</u>?

…….People who dynamically over-pronate, but we aren't sure why, and we haven't even began to discuss defining 'over-pronation'….

Iliotibial band syndrome

- Most common cause of lateral knee pain
- ITB originates from G.Maximus and Tensor fascia lata, crosses lateral tight + knee and inserts on Gerdy's tubercle
- Pain occurs over the lateral knee where ITB crosses femoral epicondyle – can occur on tibia or thigh/lateral hip

Aetiology

- May have side sway
- May have 'squinting patella'
- May have weak Gluteals
- May have leg length discrepancy
- Results in chronic irritation to the ITB/Bursa/Periosteum over the epicondyle

Aderem J, Louw Q. **Biomechanical risk factors associated with iliotibial band syndrome in runners: a systematic review.** BMC Musculoskelet Disord. 2015; 16: 356

- Shod runners who went onto develop ITBS present with increased peak hip adduction and increased peak knee internal rotation during stance phase
- Meta-analyses of cross-sectional studies show female shod runners with ITBS may present with increased peak knee internal rotation and trunk lateral ipsilateral flexion during the stance phase of running.
- Meta-analyses of three cross-sectional studies showed no difference in peak hip adduction, peak hip abductor moment and peak contralateral pelvic drop between female shod runners with ITBS and healthy runners
- A trend of increased rearfoot eversion was found in ITBS
- However, unless the methodological rigour of ITBS research is enhanced, conclusive clinical recommendations are not possible.

Treatment

- Icing therapy
- “ITB stretching”
- Gluteal strengthening
- Foot Orthoses
- Core stability assessment and treatment
- Electrotherapy
- NSAIDS

LOWER BACK PAIN

And the foot

Back to the foot: Foot Based Gait Dysfunction and Lower Back Pain?

Move on to the research

Sahar T, El al: Insoles for prevention and treatment of back pain: a systematic review within the framework of the Cochrane Collaboration Back ReviewGroup. **Spine 2009, 34(9):924–933**.

* Up to October 2008, There is strong evidence that insoles are not effective for the prevention of back pain. The current evidence on insoles as treatment for existing low back pain does not allow any conclusions.

Since October 2008……

Cambron JA, et al. Shoe orthotics for the treatment of chronic low back pain: a randomized controlled pilot study. **J Manipulative Physiol Ther. 2011 May;34(4):254-60.**

- This study showed improvement in back pain and disability with the use of shoe orthotics for 6 weeks compared with a wait-list control group. It appears that improvement was maintained through the 12-week visit, but the subjects did not continue to improve further during this time.

Since October 2008….

Williams et al.: Foot orthoses for the management of low back pain: a qualitative approach capturing the patient's perspective. **Journal of Foot and Ankle Research 2013 6:17.**

* Interviews revealed that foot orthoses did improve back pain. This result is supported with the results of the Roland-Morris Disability Questionnaire which was completed as a standard 'clinical' outcome measure

Since October 2008….

Castro-Méndez A, et al: The short-term effect of custom-made foot orthoses in subjects with excessive foot pronation and lower back pain: a randomized, double-blinded, clinical trial. **Prosthet Orthot Int** 2013: [Epub ahead of print].

* In the sample studied, the use of custom-made foot orthoses to control foot pronation led to a reduction of perceived low back pain within the time scale of their study ("short term").

Since October 2008....

Arch Phys Med Rehabil. 2017 Apr 29. pii: S0003-9993(17)30262-9. doi: 10.1016/j.apmr.2017.03.028. [Epub ahead of print]

Shoe Orthotics for the Treatment of Chronic Low Back Pain: A Randomized Controlled Trial.

Cambron JA[1], Dexheimer JM[2], Duarte M[3], Freels S[4].

Author information

Abstract

OBJECTIVES: To investigate the efficacy of shoe orthotics with and without chiropractic treatment for chronic low back pain as compared to no treatment.

DESIGN: Randomized Controlled Trial SETTING: An integrative medicine teaching clinic at a Midwestern university.

PARTICIPANTS: Two hundred and twenty-five adult subjects with symptomatic low back pain of 3 months or longer were recruited from a volunteer sample.

INTERVENTIONS: Subjects were randomized into one of three treatment groups (Orthotics, Plus, and Wait-list Groups). The Orthotics Group received custom-made shoe orthotics The Plus Group received custom-made orthotics plus chiropractic manipulation, hot or cold packs, and manual soft tissue massage. The Wait-list Group received no care.

MAIN OUTCOME MEASURES: The primary outcome measures were change in perceived back pain (Numeric Pain Rating Scale) and functional health status (Oswestry) after 6 weeks of study participation. Outcomes were also assessed after 12 weeks and then after an additional 3, 6, and 12 months.

RESULTS: After six weeks, all three groups demonstrated significant within-group improvement in average back pain, but only the Orthotics and Plus Groups had significant within-group improvement in function. When compared to the Wait-list Group, the Orthotics Group demonstrated significantly greater improvements in pain ($p<0.0001$) and function ($p=0.0068$). The addition of chiropractic to orthotics treatment demonstrated significantly greater improvements in function ($p=0.0278$) when compared to orthotics alone, but no significant difference in pain ($p=0.3431$). Group differences at 12 weeks and later were not significant.

CONCLUSIONS: Six weeks of prescription shoe orthotics significantly improved back pain and dysfunction compared to no treatment. The addition of chiropractic care led to higher improvements in function.

And then get clinical……. .

So, pronation may lead to gait dysfunction. But does that link to lower back pain

- Lower back pain

➢ **Facilitating an erect torso**

Lumbar flexion creates disc compression as well as muscular overuse

➢ **Positioning the limb to initiate swing phase**

Iliopsoas overuse and shear at inter-vertabral discs (Kapandjii, 1974)

➢ **Reduction of angle between leg and ischial tuberocity**

Lack of nutation. Tight hamstrings due to flexed trunk. Golgi tendon response.

➢ **Lateral Trunk Bending**

Bending from the ipsilateral restricted side to the contrlateral side at ipsolateral toe-off. Caused by two groups, Quadratus Lumborum and contralateral glut max / ITB complex. Drags trailing limb. Can lead to: Pain in QL between 12th rib and iliac crest, greater troch bursitis, lateral knee pain, and (owing to QL's partial insertion into the iliolumbar ligament) disc compression pain related to rotation of the 5th lumber vertebra

So from a podiatry perspective, how would we reduce these abnormal gait patterns?

1. Reduce dorsiflexion moments on the first ray

2. Reduce pronation moments across the subtalar joint axis (STJA)

Conclusion

* The current research shows positive trends on the use of orthotics for Lower Back Pain
* The need and method of orthotic prescription needs to be based upon clinical reasoning and observation of outcomes

LBP and orthotics?!

* Custom orthotics are often required due to asymmetrical foot function and avoidance of first ray impingement.
* Podiatrists are not back pain specialists. Referral for orthotics / assessment of validity of orthoses use should come from a profession such as physiotherapy.
* Podiatrists need to be SPECIFIC in the patients they treat, checking for gait improvement outcomes and correlation to outcomes

National Institute for Health and Care Excellence

Final version

Low back pain and sciatica in over 16s: assessment and management

Assessment and non-invasive treatments

NICE guideline NG59

Methods, evidence and reco

November 2016

But NIHCE do not agree….

Foot orthotics

The GDG noted that there was some evidence of benefit from the use of customised insoles compared to placebo in improving pain and function for people with low back pain and sciatica. However, it was noted that this evidence was from a small single study. There was evidence to suggest the use of foot orthotics may have a clinically important benefit on pain severity when compared to usual care in patients with low back pain and sciatica, however the evidence was of low quality and from a single study and no clinically important difference in function was observed.

When rocker sole shoes were compared with flat sole shoes no benefit was observed favouring rocker sole shoes for any of the reported outcomes in either the short or long term follow-up. It was noted that health-related quality of life was in fact, worse in the rocker sole group at both the short and longer term time points.

The GDG therefore agreed that there was no good evidence that foot orthotics or rocker soles were of benefit to people with low back pain with or without sciatica, and recommended against their use.

ACL INJURY

ACL injury?

- One function of the ACL is to limit internal rotation of the tibia
- A Study (Jenkins, 2001) suggest a contributing factor to ACL injury is excessive tibial rotation with abnormal pronation
- Recent research shows orthotics may reduce the incidence of ACL injury in female collegiate basketball players

Symptoms and Specific Patient Groups

If not discussed already

- Specific Client Groups

1. Rheumatoid Arthritis
2. Diabetes
3. Paediatric Flexible Pes Planus

THE RHEUMATOID FOOT

The Rheumatoid Foot

Catch it while you can……

The Rheumatoid Foot

The Rheumatoid Foot

- At diagnosis, 16% of rheumatoid arthritis patients have foot joint involvement. MacSween A et al, 1999)

- This increases to 90% as disease duration increases. (Chalmers A et al. 2000)

- The recognised progression of joint instability and deformity results in walking difficulties, limitation in functional ability and restriction of daily living. (Clark H et al. 2006).

Recent systematic review

Disabil Rehabil. 2015;37(14):1209-13. doi: 10.3109/09638288.2014.961654. Epub 2014 Sep 23.

Systematic review and meta-analysis of effects of foot orthoses on pain and disability in rheumatoid arthritis patients.

Conceição CS[1], Gomes Neto M, Mendes SM, Sá KN, Baptista AF.

Author information

Abstract

PURPOSE: This meta-analysis examined the effects of foot orthoses (FO) on pain and disability in rheumatoid arthritis (RA) patients.

METHODS: MEDLINE, Cochrane Controlled Trials Register, EMBASE, SPORT Scielo, and CINAHL were searched through July 2014 for randomized controlled trials (RCTs) examining the effects of orthoses on pain and disability in RA patients. Two reviewers selected studies independently. Weighted mean differences (WMDs) and 95% confidence intervals (CIs) were calculated, and heterogeneity was assessed using the I(2) test.

RESULTS: Three studies, involving 110 patients who received FO and 108 control patients, met the study criteria. Relative to controls, FO had a positive impact on pain (WMD 0.40; 95% CI 0.04-0.57). Between group differences in disability were not statistically significant.

CONCLUSIONS: FO may improve pain in RA patients, but their impact on disability remains undetermined. Additional large RCTs are needed to investigate the effects of these devices in RA patients. Implications for Rehabilitation The use of foot orthoses (FO) often part of the conservative treatment of patients with rheumatoid arthritis (RA). However, the indication of these devices is usually empiric. Thus, the results of this meta-analysis can provide guidance to rehabilitation professionals to undertake these devices to therapeutic programs. There is no consensus among rehabilitation professionals regarding the efficacy of FO improved pain and disability in patients with RA. The results of this meta-analysis suggest that the use of the FO improves pain but has no impact on disability. Thus, rehabilitation professionals, from reading this article will make clear to their patients that benefit of the FO is exclusively in pain improvement. Healthcare professionals and organizations should take into account the costs of production of FO during the definition of the therapeutic program. In case of low cost, the effect on improvement of pain in the feet can justify the indication of these devices to a patient with RA.

The National Collaborating Centre for Chronic Conditions

Funded to produce guidelines for the NHS by NICE

RHEUMATOID ARTHRITIS

National clinical guideline for management and treatment in adults

Published by

Royal College of Physicians

Setting higher medical standards

6.4.6 From evidence to recommendations

There is evidence that insoles and footwear have a positive impact on symptoms, function and quality of life for people with RA. There is a hierarchy of strength of evidence affect, with the most robust evidence being for custom-built shoes, tailored to the patient's own feet, and the least evidence for soft insoles.

The GDG felt that it was necessary for all patients to have access to a podiatrist. Basic assessments and interventions can be conducted by all HPC registered podiatrists, and an assessment of foot health needs followed by appropriate intervention or referral appears warranted in all cases. The GDG also agreed that access to more skilled 'specialist' podiatrists may be required for more complex assessments and interventions.

Simple interventions such as mass-produced insoles are not well evidenced, whereas for more complex interventions, such as provision of customised insoles and therapeutic footwear, the evidence was stronger. The GDG felt that simple insoles were suitable for general use because of their low cost, while provision of more complex insoles and footwear may require specialist podiatric involvement.

RECOMMENDATIONS

R14 All people with RA and foot problems should have access to a podiatrist for assessment and periodic review of their foot health needs (see recommendations 36 and 37).

R15 Functional insoles and therapeutic footwear should be available for all people with RA if indicated.

RA and the forefoot

- The capsular and ligamentous structures of the MTPJ are weakened and become incapable of stabilising the joints
- Supporting structures are weakened and destroyed
- Weight bearing causes deformity and loss of function

RA and the forefoot

- Forces of gait cause lesser MTJP to dorsal subluxation and dislocation
- The metatarsal heads may herniate through the plantar capsule dislocating the proximal phalanges
- The fat pad pulled distally with the dislocation

RA and the Forefoot

- The forefoot begins with destructive synovitis

RA and the rearfoot

- The foot and ankle joints are involved in greater dysfunction and pain than the upper extremities
- The ‘Rearfoot’ includes the STJ and the MTJ, although not structures distal to this
- The Talonavicular joint is often reported to be the most affected

Posterior tibial tendon dysfunction and the rheumatoid foot

- When the posterior tibial tendon is affected by chronic tenosynovitis, tendon dysfunction is common
- Rearfoot deformity may subsequently be caused by clinically evident dysfunction of the posterior tibial muscle and complex interplay of rearfoot joint disruption caused by the inflammatory process

When and what to prescribe?

- FO may reduce foot pain and improve functional ability (Clark H et al, 2006)
- Both “hard” and “soft” FO decreased forefoot pain, while “hard” FO decreased rearfoot pain and decreased levels of foot deformity (Budiman-mak 1995, Woodburn 2002)
- Powell M et al (2005) found similar benefits to pain and functional status in children with juvenile idiopathic arthritis using custom “hard” FO.
- General consensus is to prescribe EARLY.....

When and what to prescribe?

- Conflicting recent finding on orthotic type and rearfoot pain… both soft and hard help!

Foot (Edinb). 2016 Jun;27:27-31. doi: 10.1016/j.foot.2016.03.004. Epub 2016 Mar 22.

Foot orthoses in the management of chronic subtalar and talo crural joint pain in rheumatoid arthritis.

Gatt A[1], Formosa C[2], Otter S[3].

⊕ **Author information**

Abstract

BACKGROUND: This pilot study investigated whether semi-rigid and soft orthoses had an effect on pain, disability and functional limitation in participants with chronic rheumatoid hindfoot involvement.

METHODS: Participants with chronic hindfoot pain were randomly assigned to 2 groups, commencing either with semi-rigid Subortholene orthoses or soft EVA orthoses. The Foot Function Index and the Ritchie Articular Index were administered pre- and post-intervention, which lasted for 3 months. Following a 2 week washout period, each group was switched over to the other type of orthoses.

RESULTS: Nine female participants (mean age 52.2years (SD 9.1); mean weight 71kg (SD 12.64); mean height 160cm (SD 5.18)) with a mean RA duration of 11.7years (SD 7.83), and a mean ankle/subtalar joint pain duration of 5.7years (SD 2.62), completed the programme. Mean improvement in FFI score for both orthoses resulted in the same statistical significance (p=0.001). Statistically significant reduction in pain, disability and functional limitation was observed for both interventions, together with improvement in the Ritchie Articular Index score.

CONCLUSION: Both Subortholene and EVA orthoses significantly reduced pain, disability and functional limitations in participants with chronic ankle/subtalar joint pain in rheumatoid arthritis.

Flexible Paediatric Pes Planus

Flexible Paediatric Pes Planus

- A common concern in podiatric and paediatric settings
- No universally accepted definition of paediatric flatfoot (Evans M, 2008)
- Consistent inclusions are that of a “valgus heel” and “flattened medial longitudinal arch” (Staheli L, 1987)
- Prevalence estimates have a broad range, which is not surprising with the lack and variation in specific definitions.
- Also, it is possible to to have a low arch and not be maximally pronated OR to have a high arch and be maximally pronated……

Flexible Paediatric Pes Planus

- This means if we worked solely on a “high arch is good, low arch is bad” assessment criteria we may be treating what does not need to be treated, and not treating what does.....

- Normal ethnic deviations in arch height…..

Flexible Paediatric Pes Planus

* Bearing this in mind the most current treatment pathway for flexible paediatric flat foot is as follows:

- TREAT
  Symptomatic typical paediatric flexible flat foot

- MONITOR and TREAT depending on clinical judgement
  Asymptomatic Non-developmental typical paediatric flexible flat foot

- LEAVE ALONE
  Normal developmental typical paediatric flexible flat foot.

(Evans M, 2009)

Flexible Paediatric Pes Planus

* However, this treatment guideline has not be accepted without some controversy. (Bresnahan, 2009)

- ‘The greater risk to the pediatric patient is to "do nothing" while the child is young and allow the abnormally pronated foot to follow a life-long course that will often lead to any of several "developmental" conditions in adulthood, such as a painful flatfoot, bunions, hammertoes, and possibly knee and hip arthritis. The effects of a lifetime of weightbearing on an eccentrically loaded foot will almost certainly lead to secondary sequelae as a result of the body’s compensatory mechanisms.’

Flexible Paediatric Pes Planus

- In reply, Evans M (2009) stated "Finally, let me be very clear. In the absence of symptoms, the clinician prescribing customized foot orthoses for a child with flat feet is on very thin ice"

Flexible Paediatric Pes Planus

* Another issue may be the definition of 'symptoms'.

- Kirby (1992) and Lin et al (2001) have both cited flexible paediatric pes planus as a possible aetiological factor in children with gross motor skill development delay

- Symptoms may therefore link to other aspects of childhood than "just pain".

Cochrane Library Conclusion

.
Evans AM, Rome K. A Cochrane review of the evidence for non-surgical interventions for flexible pediatric flat feet. Eur J Phys Rehabil Med. 2011 Mar;47(1):69-89.

- The available prevalence estimates are all limited by variable sampling, assessment measures and age groups and hence result in disparate findings (0.6-77.9%).
- Consistently, flat foot has been found to normally reduce with age. The normal findings of flat foot versus children's age estimates that approximately 45% of preschool children, and 15% of older children (average age 10 years) have flat feet.
- There is no standardized framework from which to evaluate the pediatric flat foot.
- Customised foot orthoses should be reserved for children with foot pain and arthritis, for unusual morphology, or unresponsive cases.

American academy of orthopaedics journal

Pediatrics. 2016 Mar;137(3):e20151230. doi: 10.1542/peds.2015-1230. Epub 2016 Feb 17.

Pediatric Pes Planus: A State-of-the-Art Review.

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Author information

Abstract

Flatfoot (pes planus) is common in infants and children and often resolves by adolescence. Thus, flatfoot is described as physiologic because it is usually flexible, painless, and of no functional consequence. In rare instances, flatfoot can become painful or rigid, which may be a sign of underlying foot pathology, including arthritis or tarsal coalition. Despite its prevalence, there is no standard definition for pediatric flatfoot. Furthermore, there are no large, prospective studies that compare the natural history of idiopathic, flexible flat feet throughout development in response to various treatments. The available literature does not elucidate which patients are at risk for developing pain and disability as young adults. Current evidence suggests that it is safe and appropriate to simply observe an asymptomatic child with flat feet. Painful flexible flatfoot may benefit from orthopedic intervention, such as physical therapy, bracing, or even a surgical procedure. Orthotics, although generally unproven to alter the course of flexible flatfoot, may provide relief of pain when present. Surgical procedures include Achilles tendon lengthening, bone-cutting procedures that rearrange the alignment of the foot (osteotomies), fusion of joints (arthrodesis), or insertion of a silicone or metal cap into the sinus tarsi to establish a medial foot arch (arthroereisis). It is important for a general pediatrician to know when a referral to an orthopedic specialist is indicated and which treatments may be offered to the patient. Updated awareness of the current evidence regarding pediatric flatfoot helps the provider confidently and appropriately counsel patients and families.

What to prescribe.....

- Reduce pronatory moments adequately WHILE NOT causing secondary issues such as impinging on first ray function
- As always, do no harm

What to prescribe.....

- Use appropriate FO modification to reduce pronatory moments (rearfoot posts, shell inclines, firm materials etc)
- Consider childs choice of footwear, activity levels and growth
- If private practice, recurrent cost needs to be explained to parents / guardians.

DIABETES, another thing to think about!

A introduction to the effect of diabetes on the foot in relation to gait

Range of motion at the Ankle and 1st MTPJ is essential for normal gait

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Reduced ankle ROM in diabetes linked to both plantar fascia AND achilles tendon:

- Increased thickness in subjects suffering from type I and type II diabetes mellitus (Akturk et al, 2007; Giacomozzi et al, 2005)
- More frequent in diabetic patients with neuropathy and previous foot ulcers. (Abate et al, 2012; Papanas et al, 2009; Batista et al, 2008)
- Thickness may be also increased in type II diabetic patients free from complications. (Abate et al, 2013)
- Thickness correlates positively with BMI. (Kabbabe et al, 2010)
- Involvement of Achilles tendon and plantar fascia is associated to reduced ankle joint ROM. (Abate et al, 2013)

Range of motion at the Ankle and 1st MTPJ is therefore essential for normal gait

<u>Reduced 1st MTPJ ROM in diabetes:</u>

- Reduction in ROM reported to range from 25 degrees to 45 degrees (Giacomozzi et al, 2005; Zimmy et al, 2004)
- Turner et al (2007) found most significant difference in ulcer group compared to reference group

The effect of a decreased range of motion at the Ankle and 1st MTPJ on gait

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Increased pronation, decreased hip and knee extension………

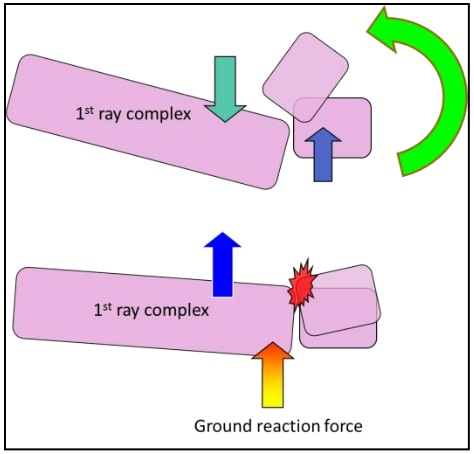
Diabetes and Ankle Equinus

Pronation and Diabetes

García-Álvarez et al, 2013

The confluence of risk factors such as neuropathy, body mass index, duration of diabetes and limited joint mobility in patients with diabetes mellitus and pronated foot may be a high-risk anthropometric pattern for developing associated complications such as Charcot foot and plantar ulceration. A prospective analysis of these patients is required to define the risk for developing such complications

Pronation and Hallux Dorsiflexion



- Harradine PD, Bevan LS. The effect of rearfoot eversion on maximal hallux dorsiflexion. A preliminary study. J Am Podiatr Med Assoc. 2000 Sep;90(8):390-3.
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- Durrant B, Chockalingam N. Functional hallux limitus: a review. J Am Podiatr Med Assoc. 2009 May-Jun;99(3):236-43
- Gatt A, et al. Severity of pronation and classification of first metatarsophalangeal joint dorsiflexion increases the validity of the Hubscher Manoeuvre for the diagnosis of functional hallux limitus. The Foot. 2014 Jun;24(2):62-5.

Gait adaptions linked to and ability to use the 2nd and 3rd Rocker in gait

- Limited ankle ROM may restrain the forward progression of the tibia on the fixed foot during the stance phase of walking. This, in turn, results in prolonged and excessive weight bearing stress under the metatarsal heads during the foot-floor interaction, which is thought to contribute to the development of foot ulcers in individuals with diabetes mellitus

Examples include:

- Achilles Lengthening…bilaterally
- Slightly higher heeled footwear
- Manipulations / Mobilisations (ankle and / or 1st MTPJ)
- Exercise therapy
- Forefoot rocker footwear
- Orthotics

How would orthotics help?

1. **Reduce dorsiflexory moments on the first ray**

2. **Reduce pronatory moments across the STJA**

Link with CMT and plantar fascia atrophy?

Chuter V, Payne C: Limited Joint Mobility and Plantar Fascia Function in Charcot's Neuroarthropathy. *Diabetic Medicine*, March 2001.

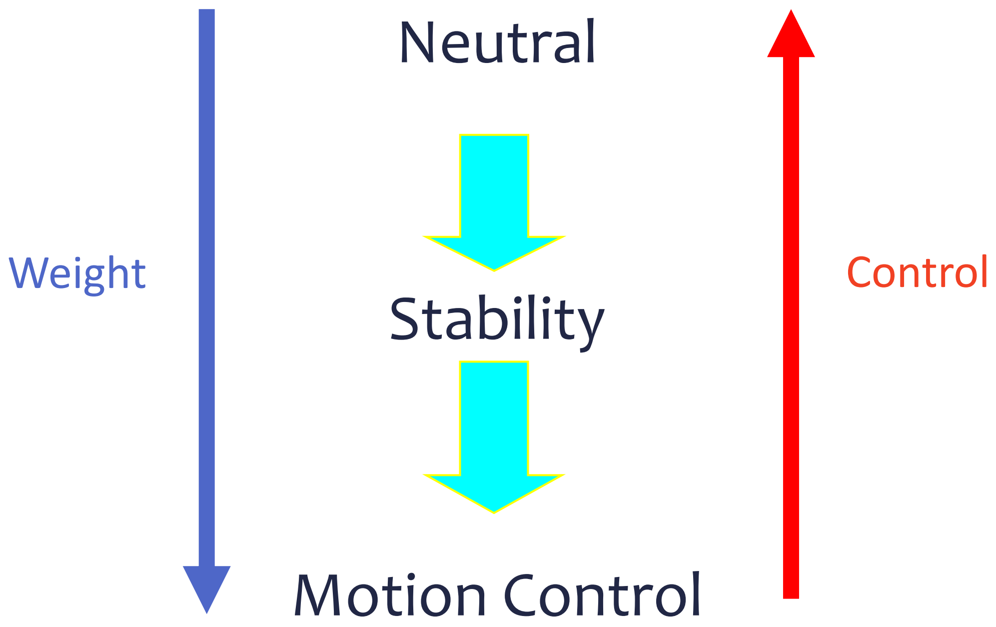
TRAINERS

An introduction

All about trainers…..

* Many varieties
* Many ‘sub varieties’!!!
* …and they don’t all do what they say on the box.

How does the classification work?



Running shoes

Medial Sole Support

Running shoes

‘Upper’ Support

Running shoes

Good Flexion Stability

BAD flexion stability

Running shoes – in no order!

- **Neutral**
  - Brooks Glycerin
  - Asics Cumulus and Nimbus
  - New Balance 1080
  - Mizuno Waverider
  - Nike Pegasus
  - Saucony Triumph or Ride

Running Shoes

Stabilty

- Brooks GTS Adrenalin
- Asics 1000, 2000, Kayano
- Mizuno Wave inspire
- Saucony Omni
- Adidas Sequence
- New Balance 860

Running Shoes

Motion Control

- Brooks Beast
- Mizuno Paradox
- NewBalance 940
- Saucony Redeemer

But.....

- For the last 50 years, no marathon has been won barefoot
- No world records have been set while barefoot for at least the last 25 years. All current track and field, cross country and road race records have been set with shoes on, not barefoot
- Barefoot runners represent about 1/1000 runners at most large running events

Why are we talking about barefoot running…again???

* *"Barefoot running is a fad, which repeats itself every 25 years"* *Prof J Hammill 2012, Dr Nigg, 2011.*

1960s (Abebe Bikila)

1960 Rome.
Time: 2:15:16

1964 Tokyo.
Time: 2:12:11

1984 (Zola Budd)

2009 (Born to Run)

Author speculates that modern cushioned running shoe creates injuries and barefoot and "minimalist shoes" prevent injuries

Next occurrence → 2034?

The new thing... ‘*minimalist*’

* These are NOT a new thing, we called them “running flats”….

1972, Nike Marathoner

1974, Onitsuka tiger Jayhawk

Shoes have evolved over the last 30 years…

There was no significant difference in the incidence of running injuries reported in this time, so what about the site of injury….?

Injury Site	Clement et al, 1981	McIntyre et al, 1991	Taunton et al, 2002
Knee	43%	47%	47%
Lower Leg	27%	20%	22%
Foot	17%	16%	15%
Hip	5%	6%	10%
Lower Back	4%	5%	3%
Upper leg	4%	5%	6%

But shoes with less heel make us midfoot strike…right?

WRONG!

* Hamill et al 2011. 41 Habitual RF strikers..

- shoe 1 – 4 mm heel thickness, only outsole in forefoot
- shoe 2 – 12 mm heel thickness, 8 mm in forefoot
- shoe 3 – 20 mm heel thickness, 16 mm forefoot
- barefoot

* In all running shoes (even with no midsole), natural rearfoot strikers still ran with a rearfoot footfall pattern
* these same runners altered their footfall pattern to a midfoot or forefoot pattern when running barefoot
* This suggested that the change in footfall pattern was not due to shoe conditions alone

Why do we have different foot fall patterns?

- Task specificity in running...
- for economical running – rearfoot
- for fast but less economical running – midfoot
- for sprinting - forefoot

Miller and Hamill, 2012

So its a “virtual Craze”…

* Everybody is talking about doing it, but hardly anybody actually is!

Barefoot running…

- Theoretically links to reported clinic occurrence of achilles injury, plantar fasciitis, tibial stress response forefoot stress fractures.
- It does not link to improved performance.
- There is no evidence that footwear weakens foot muscles, or barefoot running strengthens them!
- There is no research that switching

  type of footwear reduces injury
- There is no reason I can find to do i

If barefoot isn't good, how about learning to midfoot strike

* Heel Strike is more efficient. Computer simulation study investigated if heel-striking or midfoot-striking was the most efficient method to run at 4.0 m/sec (6:42 min/mile) Results showed that most energy efficient running form was heelstriking (15.9 W/kg) compared to midfoot striking (16.9 W/kg), a 6.3% difference in efficiency. Miller RH, Russell EM, Gruber AH, Hamill J. Foot-strike pattern selection to minimize muscle energy expenditure during running: a computer simulation study. Proc ASB. State College, PA, 2009.

It seems its the weight of the shoe, not the reported changes in barefoot running tecnique, is detrimental!

* **Barefoot vs Shod VO2 Differences: Shoe or Mass Effect?**
* 12 subjects ran at 3.61 m/sec (7:26 min/mile) while barefoot, in diving socks unloaded, loaded with 150 g and 350 g and in 150 g and 350 g shoes.
* VO2 increased same amount with masses added to socks as when running in same mass shoes

"Higher metabolic cost was only due to the extra mass induced by the shoe itself and not due to other mechanical properties of the shoe"

Divert C, Mornieux G et al: Barefoot-shod running differences: shoe or mass effect. Int J Sports Med, 29:512-518, 2008.

Is this why elite runners don’t run barefoot?

- Nearly all elite runners race while in shoes in track, cross country and road races
- Increased metabolic efficiency of running barefoot doesn’t seem to equate to faster barefoot racing speeds
- Why aren’t more elite runners racing barefoot?

Is this why elite runners don't run barefoot?

- Faster Top Running Speeds Caused by Increased GRF. Barefoot may stop this from occuring.
- 33 track athletes of varying ability tested to determine whether faster runners moved legs faster during forward recovery or increased GRF Speed ranged from 6.2 to 11.1 m/sec (4:29 min/mile - 2:25 min/mile) Force was 1.26 times greater for faster runner than for slower runner while speed of swinging limb forward did not change

Weyand PG, Sternlight DB et al: Faster top running speeds are achieved with greater ground forces not more rapid leg movements. J Appl Physiol, 89:1991-1999, 2000.

Why aren't Elite runners BF?

- Increased magnitudes of plantar reaction forces experienced with race speeds increase discomfort and risk of plantar foot injury?
- Shorter stride lengths caused by barefoot running limits running velocity by decreasing ability to heel contact and lengthen stride?
- Since shoe companies are biggest sponsors of elite runners, are elites wearing shoes only to make money?...*how important is winning to elite athletes?*

To Conclude

* Prof Jo Hammill, PhD, retired runner but current Biomechanist. Author of more than 400 peer review articles. 2012 Biomechanics Summer School, Manchester: *Is Barefoot Running Good For You Health*.

"in one word, No"

We are dammed if we do…

- By recommending barefoot running or "running foot strike coaching" I am not complying with best practice and possible increasing forefoot and rearfoot injury, which would make my clinic more busy and therefore increase my income

And damned if we don't...!

- By not recommending barefoot running or “running foot strike coaching” I am complying with current best practice but will be accused by numerous “running Gurus” (most often with no actual qualifications) that I am saying this just to protect my income!!!!!

Conclusion

Excepting that:

‘Our present satisfaction with our state of understanding may reflect the paucity of the data rather than the excellence of the theory.’

Martin Rees, *National Geographic*, ‘unveiling the universe’, Oct.1999.

Questions………………

There has already been a major paradigm shift in the understanding of podiatric biomechanics in the life time of most podiatrists, why is it so unrealistic that it wont happen again?

Payne 1997

Questions

* Success is not final, failure is not fatal: it is the courage to continue that counts.

Winston Churchill