An introduction to the clinical assessment and treatment of foot related lower limb injury

Day 1

Paul Harradine

Podiatrist MSc FRCPodM FFPM RCPS (Glasg) CertEd
Doctoral Student, University of Southampton

THE PODIATRY CENTRE

Now it's all about you, The days general plan

1. Functional foot/ankle anatomy – Clear and clinical
2. Understanding normal and abnormal foot function
3. Treatment options to address foot related lower limb symptomology in standing and walking
4. Objective is to make the day as clinically relevant as possible, using common symptoms and case presentations.

Todays Chronological Plan

1. Basic functional anatomy
2. Theories of foot function
3. The unified theory of foot function
4. Normal foot function in stance
5. Abnormal foot function in stance
6. Normal walking gait
7. Foot related gait dysfunction with commonly linked symptoms
8. Foot orthotics and other foot related treatment options

The suggestions from previous courses and resultant changes to today

1) To have questions and recaps (if required) after each session break
2) To have longer practical sessions and to “move around” to more feet
3) Less information, I was trying to fit too much into Day 1 (“information overload” – “I would book onto day 2”)
4) Videos as well as practicals to demonstrate gait dysfunction and static tests
5) Speak slower!!!

Assessment of the Foot in Relation to Gait Dysfunction and Injury

For years, we’ve called it ‘Podiatric Biomechanics’

For years, we've called it Podiatric Biomechanics

- However, there is NO professional ownership in this area (unlike for example, dentistry) with many professions having equal and valid input to the foot and ankle

- But, the definition does have worth in focussing the specific approach the foot and ankle needs as the contact medium of the leg to the floor

For years, we've called it Podiatric Biomechanics

- What is Podiatry?
- What is Biomechanics?
- What is Podiatric Biomechanics?

Podiatry

- Podiatry is the examination, diagnosis, treatment and prevention of diseases and malfunctions of the foot and its related structures.
- *Ref: The BMA's complete family health encyclopedia. Dorlans Kindersley, 1st Ed, 1993.*

Biomechanics

- The application of mechanical laws to living structures, specifically to the Locomotor system.
- *Ref: Dorlan's Illustrated Medical Dictionary, 25th Ed.*

Podiatric biomechanics?

‘The application of mechanical laws to the foot and its related structures’

Basic functional anatomy

- PRONATION - A single motion comprising of Abduction, Eversion and Dorsiflexion

- SUPINATION - A single motion comprising of Adduction, Inversion and Plantarflexion

- FOREFOOT - Structures distal to the Midtarsal joint

Anatomy Revision

Functional and Clinical

- ✓ Ankle Joint
- ✓ Subtalar Joint
- ✓ Midtarsal Joint
- ✓ 1^{st} Ray
- ✓ 1^{st} MTPJ

Ankle Joint (Talocrural Joint)

- Clinically, we model this as sagittal plane “hinge” type joint
- This is a useful ‘clinical fiction’!

The Subtalar Joint - *a 'true' triplanar joint*

	Frontal plane	Transverse Plane	Sagittal Plane
Pronation (arch lowering)	Eversion	Abduction	Dorsiflexion
Supination (arch raising)	Inversion	Adduction	Plantarflexion

Subtalar Joint

Measured in the frontal plane, average ROM of 30 degrees with a 2:1 ration of inversion to eversion

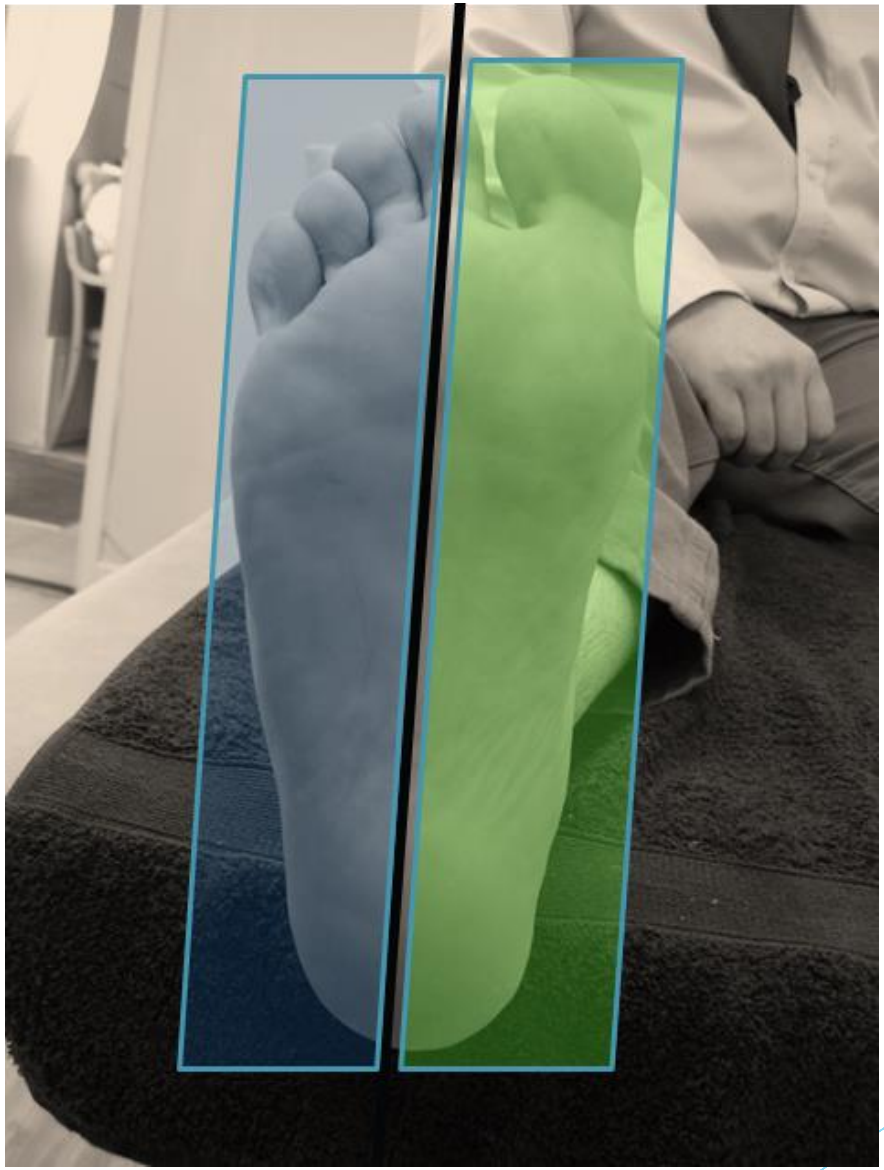
Eversion

(ROM average 10 degrees)

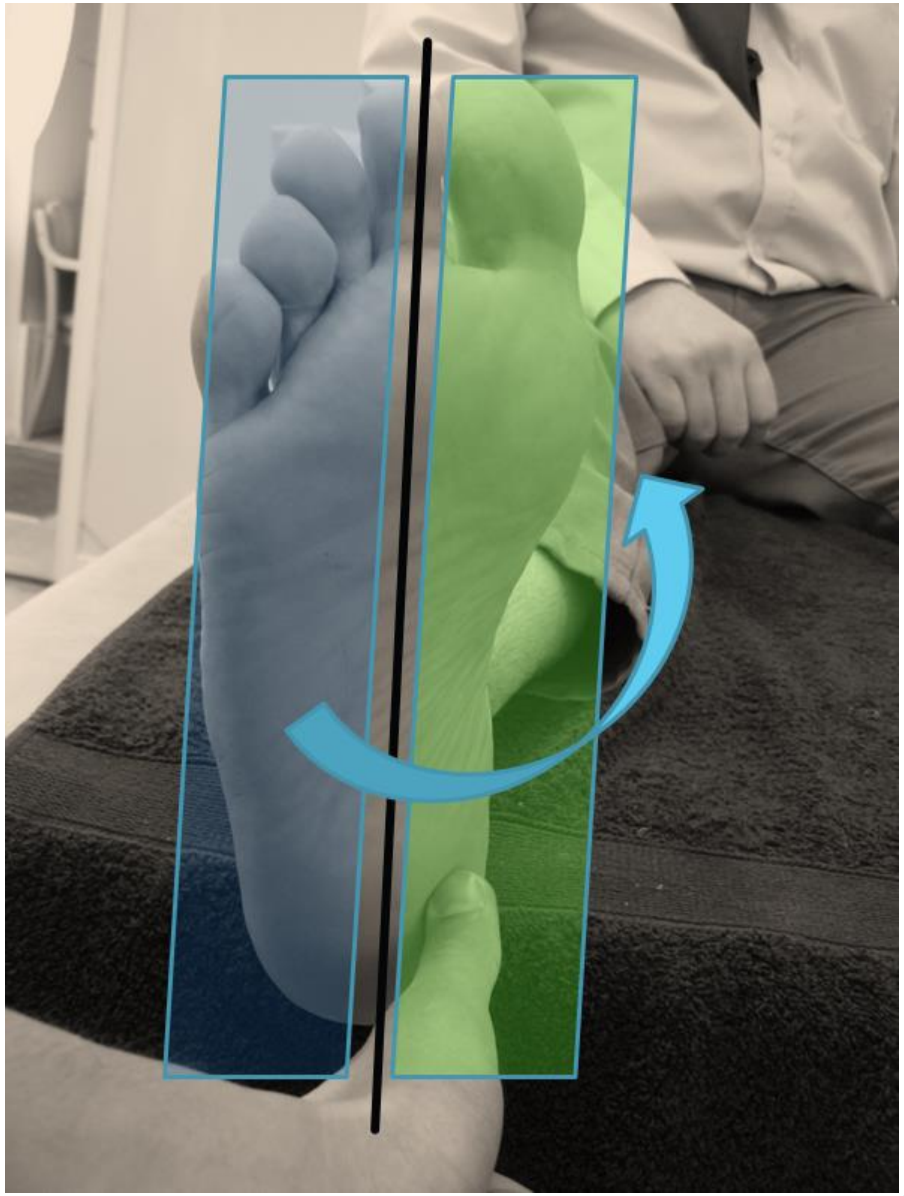
Inversion

(ROM average 20 degrees)

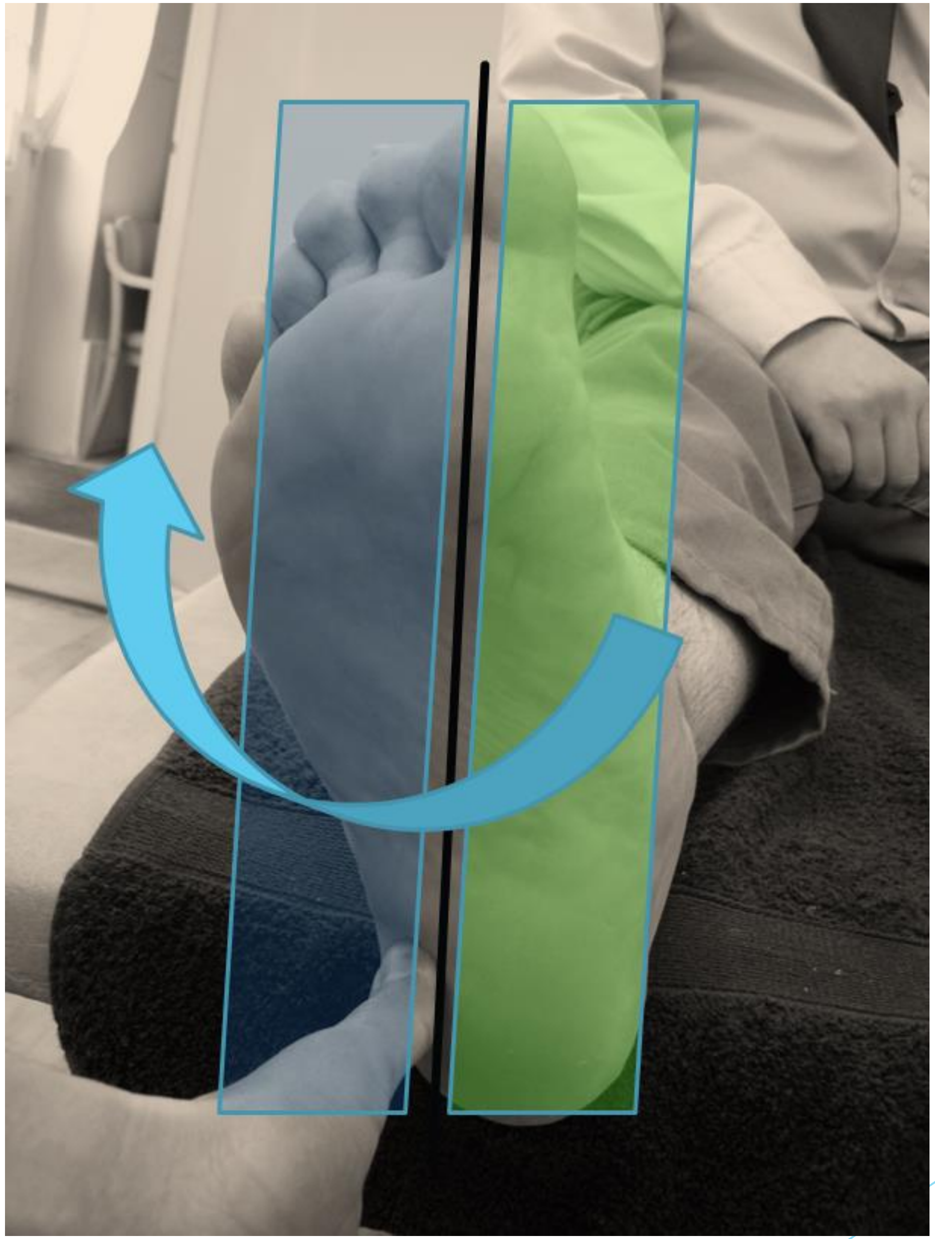
Normal STJ and Foot Function



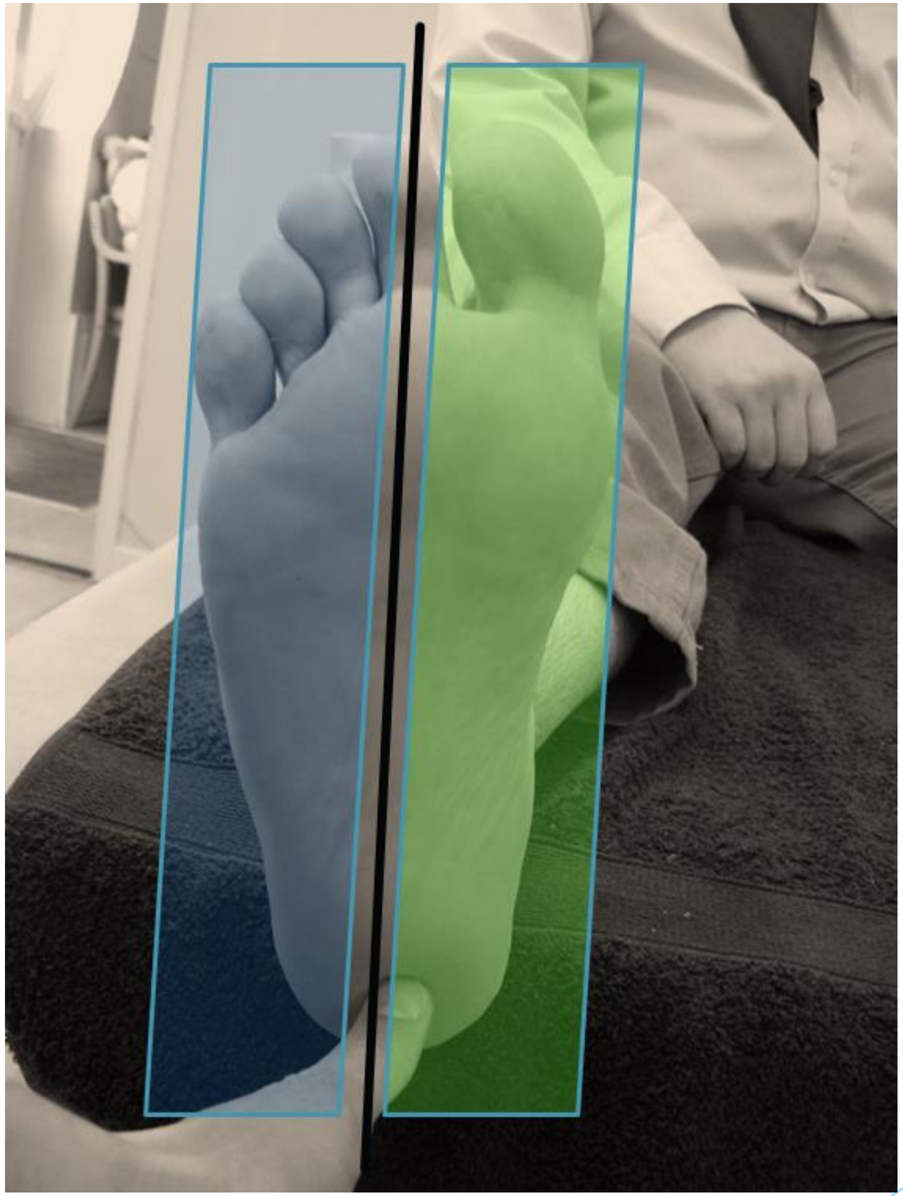
Normal STJ and Foot Function



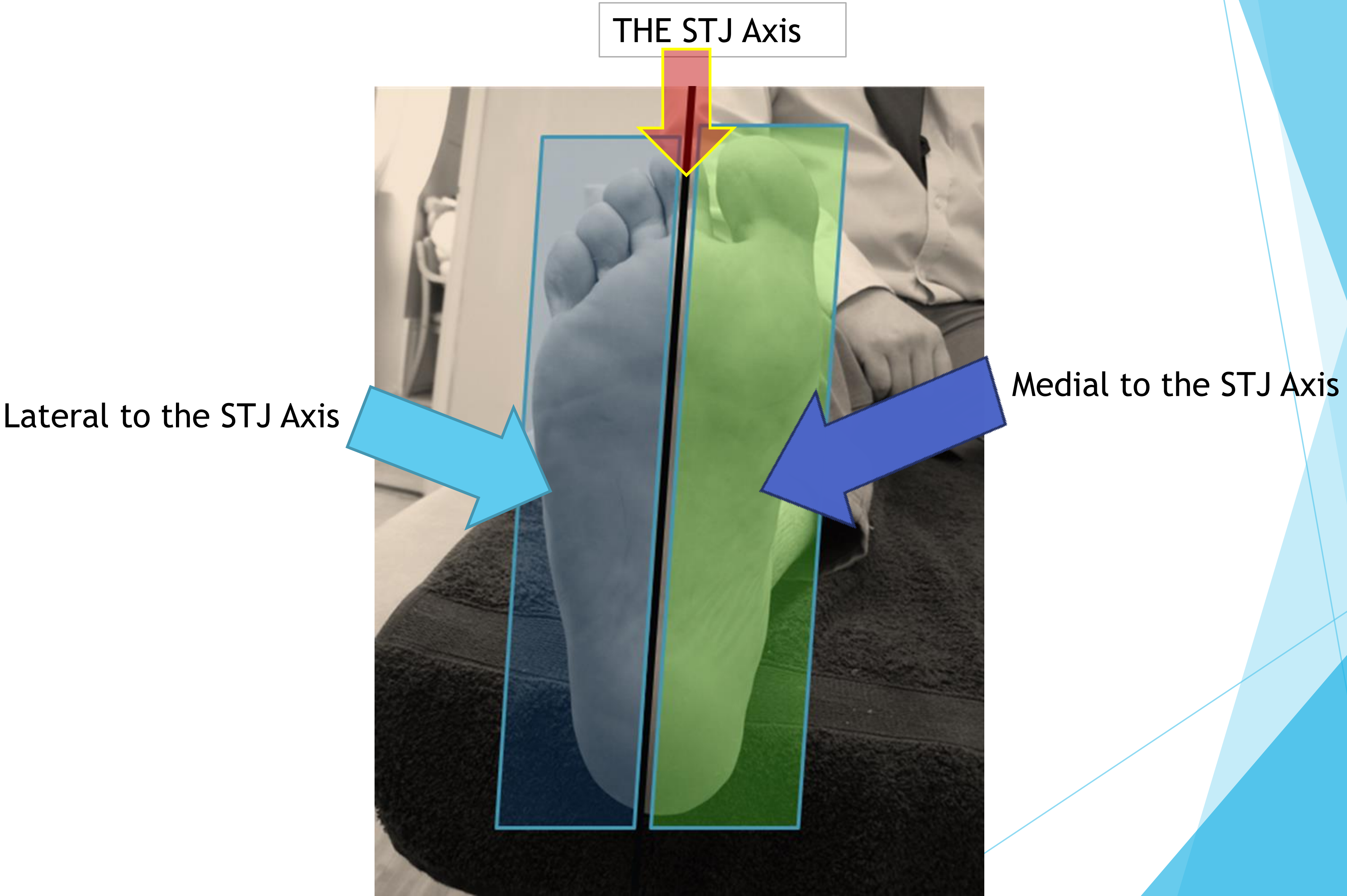
Normal STJ and Foot Function



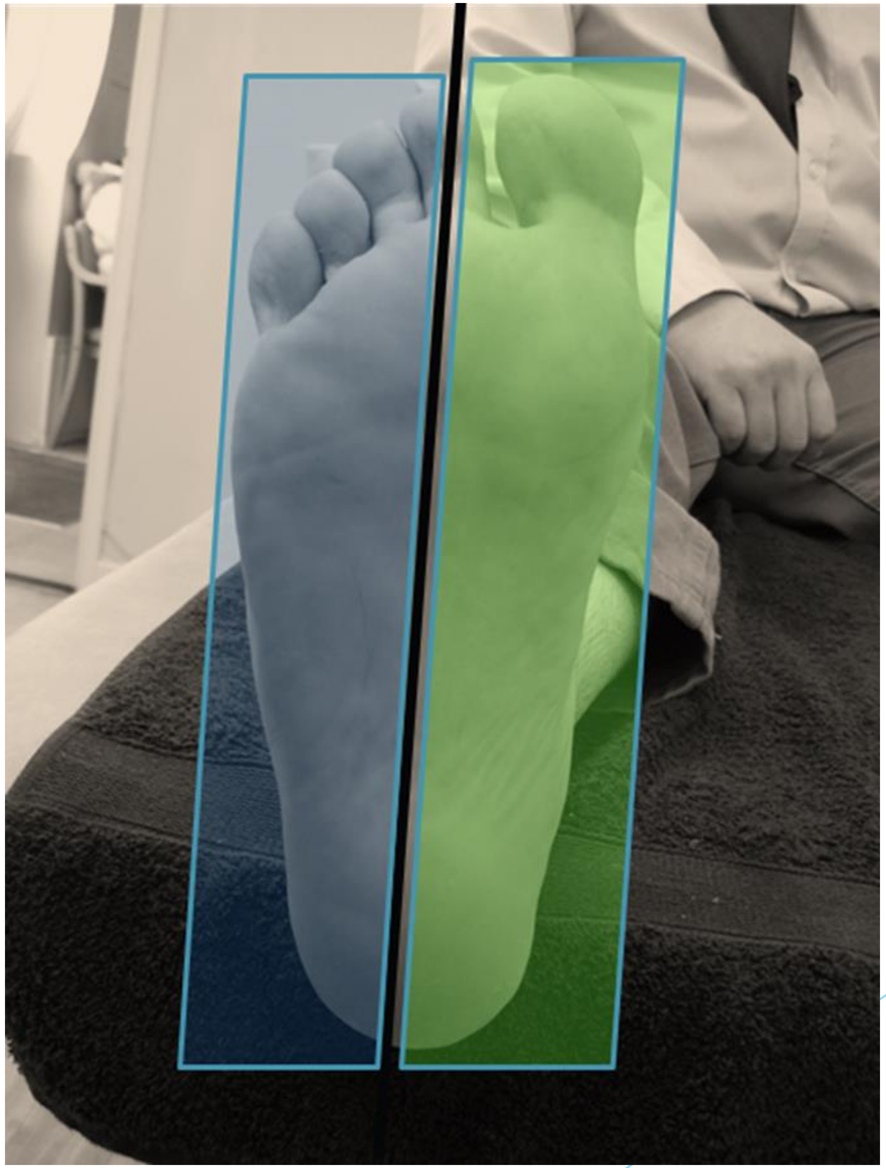
Normal STJ and Foot Function



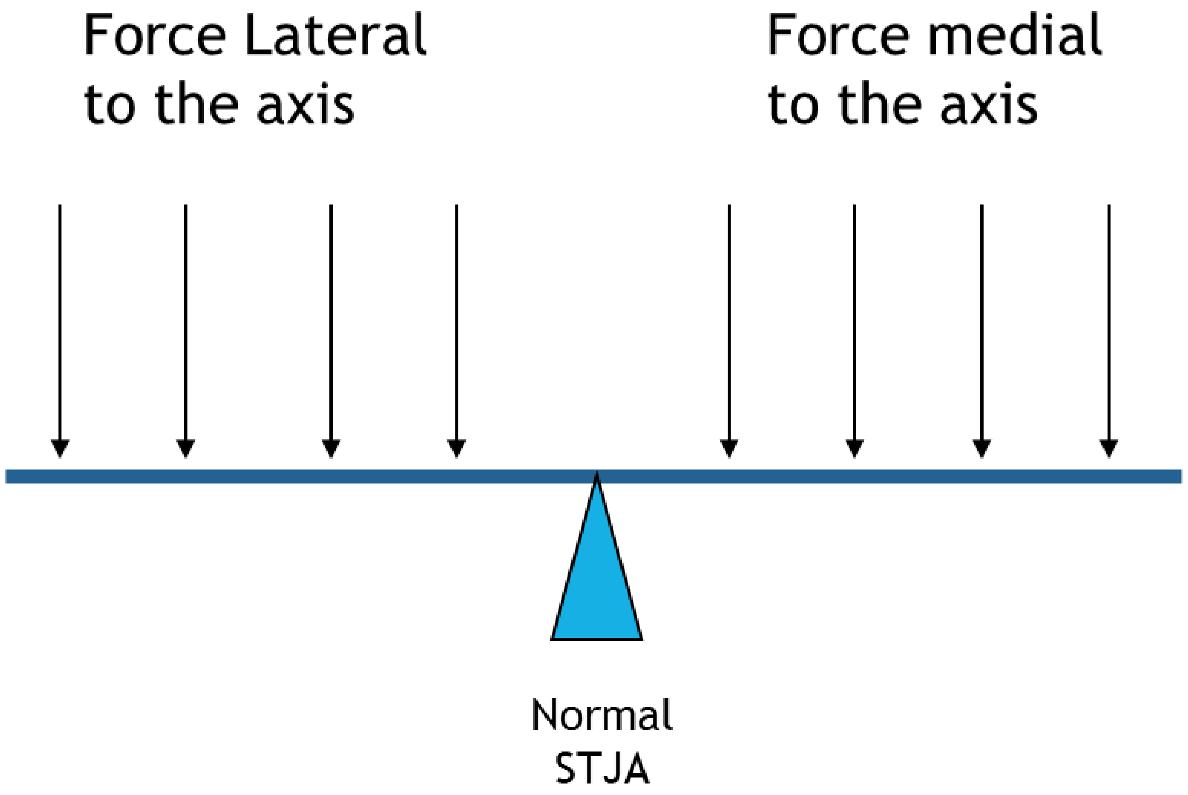
Normal STJ and Foot Function



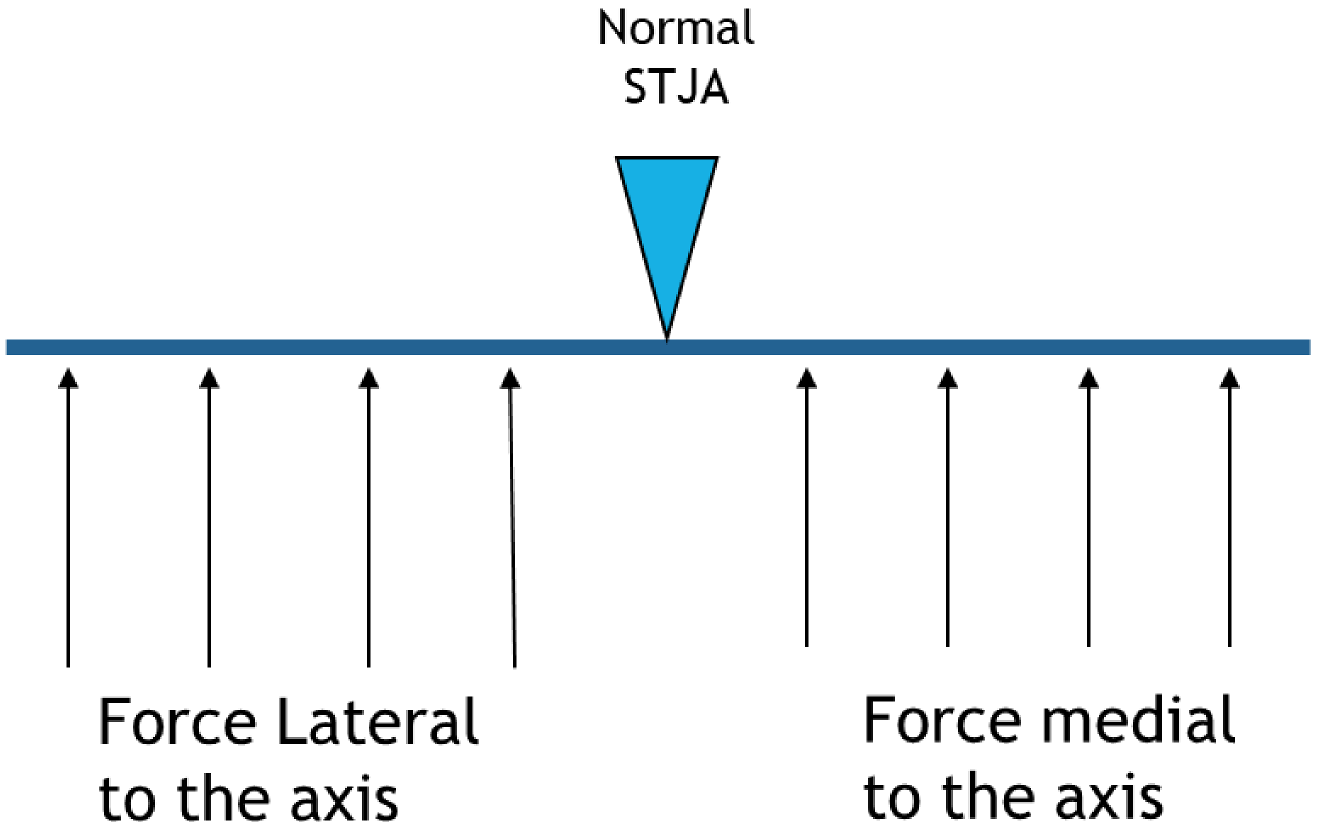
Motion around the STJ is a type 1 lever

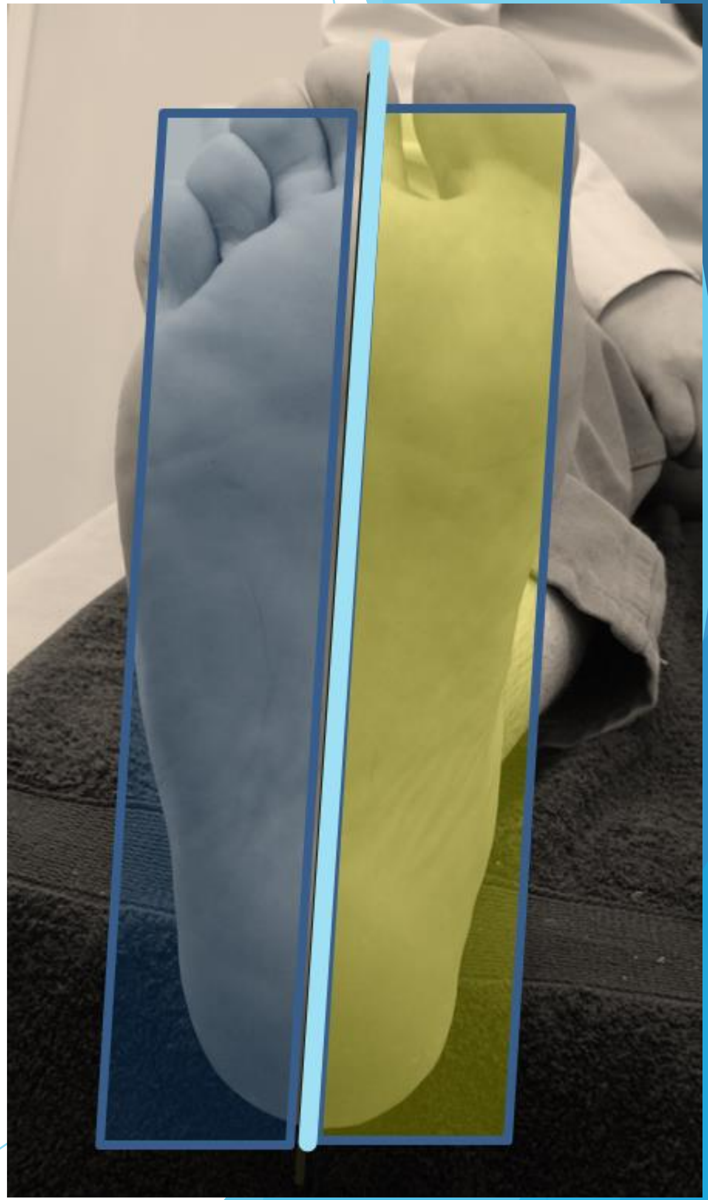


The see-saw STJ axis analogy



The INVERTED see-saw STJ axis analogy





STJ Force coupling and the STJA

- STJ PRONATION causes the leg to internally rotate.

- STJ SUPINATION causes the leg to externally rotate.

➢ The ratio of this force coupling is variable

Souza TR, Pinto RZ, Trede RG, Kirkwood RN, Fonseca ST. Temporal couplings between rearfoot-shank complex and hip joint during walking. Clin Biomech (Bristol, Avon). 2010 Aug;25(7):745-8. Epub 2010 Jun 8.

Midtarsal Joint

- Made up of the talo-navicular and calcaneo-cuboid joints
- Has an envelope of motion
- Is Mono-Axial Nester CJ, et al. Scientific approach to the axis of rotation at the midtarsal joint. JAPMA. 2001 Feb;91(2):68-73.
- Confusion possibly due to anatomy and function

The First Ray

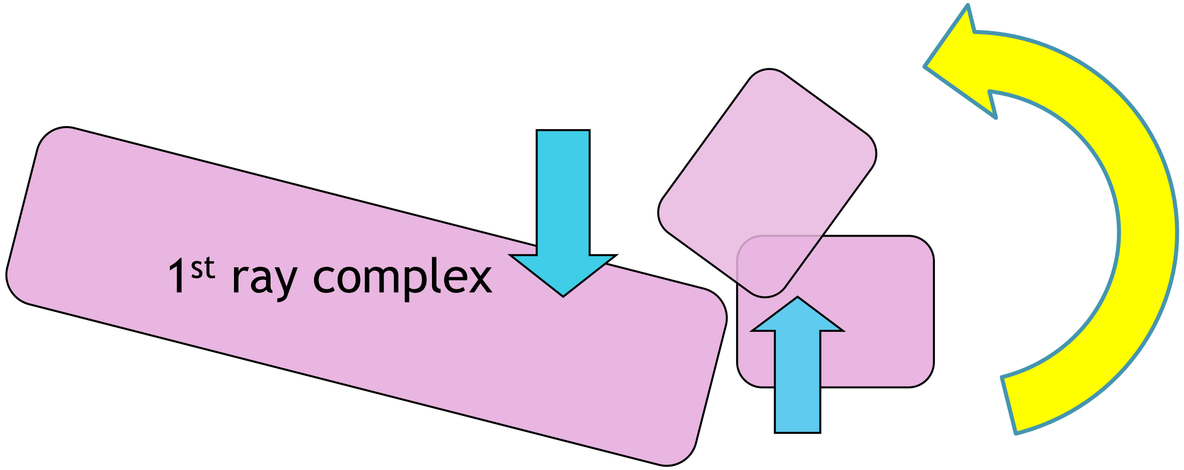
- The medial column of the foot, distal to the MTJ
- Made up of the 1st metatarsal, medial cuneiform and navicular
- Triplanar, but majority of ‘relevant’ motion is in the sagittal plane

Dorsiflexion at the 1st MTPJ

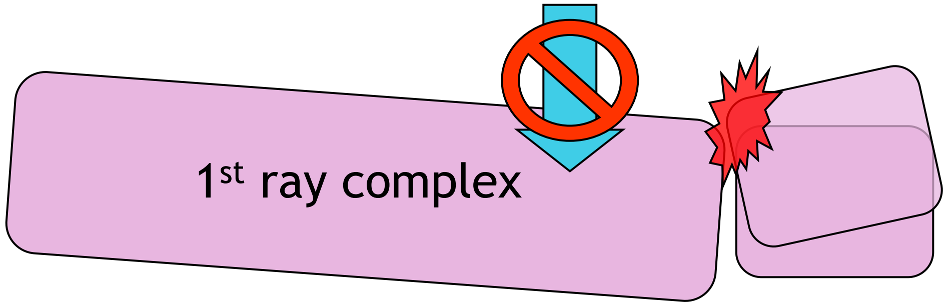
- The Range of dorsiflexion at the 1st MTPJ is dependant on the position of the first ray
- Group practical 2

1st MTPJ ROM appears dependant on 1st ray position

Medial view

a) 

Normal Hallux dorsiflexion with first ray plantarflexion

b) 

Functional Limitation of Hallux dorsiflexion with lack of first ray plantarflexion

Webinar plan - An introduction to:

1. Basic functional anatomy
2. Theories of foot function
3. The unified theory of foot function
4. Normal foot function in stance
5. Abnormal foot function in stance
6. Normal walking gait
7. Foot related gait dysfunction with commonly linked symptoms
8. Foot orthotics and other foot related treatment options

Historical theories of 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

Theories of foot function

Because there are some! But more than 3…so this is an area of confusion

- Harradine P, Gates L, Bowen C. If It Doesn't Work, Why Do We Still Do It? The Continuing Use of Subtalar Joint Neutral Theory in the Face of Overpowering Critical Research. J Orthop Sports Phys Ther. 2018. Mar;48(3):130-13
- Harradine P, Bevan L. A review of the theoretical unified approach to podiatric biomechanics in relation to foot orthoses therapy. J Am Podiatr Med Assoc. 2009. Jul-Aug;99(4):317-25
- Why are they avoided?

Historical theories on foot function in gait and foot orthoses…

And a good example of why this may be confusing and avoided

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

1) **Reduce the first ray dorsiflexion moment**
2) **Reduce the Pronation moment**

Harradine and Bevan, JAPMA, 2009.

The Unified Theory of Foot Function (Harradine and Bevan , 2009)

The Unified Theory principle is that the three common podiatric theories may have different historical perspectives, but similar orthotic prescription outcomes.

These outcomes / aims appear to be to:

1) **Reduce the first ray dorsiflexion moment**

2) **Reduce the Pronation moment**

Historical theories on foot function in gait and foot orthoses

Theoretical Perspective	Foot Morphology Theory	Sagittal Plane Facilitation Theory	Tissue Stress Theory	Unified Theory (Harradine and Bevan; 2003, 2006, 2009)
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	Dynamically the foot functions within the parameters of the dynamic walking theory, acting as a rocker while allowing normal timing of internal and external leg rotation. In stance the foot rests in equilibrium without causing abnormal tissue stress or 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	Casting is not essential but may aid in comfort and fit. Modifications can be made at casting to aid in applying the correct forces to the foot. Whether via a cast or prefab, emphasis is placed upon comfort and avoiding a high arch appliance, which could increase a first ray dorsiflexion moment
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	To reduce an abnormal pronation or supination moment while offloading injured structures and facilitating first ray function in gait.

Historical theories on foot function in gait and foot orthoses

We won't spend time going through the details now, as this will make up the underpinning theory and be explained in the rest of this evening

Unified Theory (Harradine and Bevan; 2003, 2006, 2009)
Dynamically the foot functions within the parameters of the dynamic walking theory, acting as a rocker while allowing normal timing of internal and external leg rotation. In stance the foot rests in equilibrium without causing abnormal tissue stress or injury
Casting is not essential but may aid in comfort and fit. Modifications can be made at casting to aid in applying the correct forces to the foot. Whether via a cast or prefab, emphasis is placed upon comfort and avoiding a high arch appliance, which could increase a first ray dorsiflexion moment
To reduce an abnormal pronation or supination moment while offloading injured structures and facilitating first ray function in gait.

The Unified Theory of Foot Function (Harradine and Bevan , 2009)

"Remember that all models are wrong; the practical question is how wrong do they have to be not to be useful"

Or

"**Essentially, all models are wrong, but some are useful**"

(Box G,1987)

Is the most popular model (The foot morphology / STJN theory) still the most useful?

- Harradine P, Gates L, Bowen C. If It Doesn't Work, Why Do We Still Do It? The Continuing Use of Subtalar Joint Neutral Theory in the Face of Overpowering Critical Research. *J Orthop Sports Phys Ther*. 2018 Mar;48(3):130-132

- Jarvis H, Nester C, Bowden P, et al. Challenging the foundations of the clinical model of foot function: further evidence that the root model assessments fail to appropriately classify foot function. *J Foot Ankle Res*. 2017; 10:7

This is a discussion for another day…but it is important!

"However, it is important to recognise Dr Root's STJN theory as being a clinical fiction, as the acceptance of the fiction as fact results in practitioner resistance to change and an inability to look outside of established theory. Such a situation can lead to stagnation and slow development of alternative ideas"

Harradine et al, 2018.

Is your practice based upon STJN? Remember, all models are wrong, but is this one still useful?

Is the most popular model (The foot morphology / STJN theory) still the most useful?

- Harradine P, Gates L, Bowen C. If It Doesn't Work, Why Do We Still Do It? The Continuing Use of Subtalar Joint Neutral Theory in the Face of Overpowering Critical Research. *J Orthop Sports Phys Ther*. 2018 Mar;48(3):130-132

- Jarvis H, Nester C, Bowden P, et al. Challenging the foundations of the clinical model of foot function: further evidence that the root model assessments fail to appropriately classify foot function. *J Foot Ankle Res*. 2017; 10:7

This is a discussion for another day…but it is important!

"However, it is important to recognise Dr Root's STJN theory as being a clinical fiction, as the acceptance of the fiction as fact results in practitioner resistance to change and an inability to look outside of established theory. Such a situation can lead to stagnation and slow development of alternative ideas"

Harradine et al, 2018.

Is your practice based upon STJN?

Most current practice appears NOT based on STJN theory, with no relation to STJN in either gait or static posture

Todays Plan

1. Basic functional anatomy
2. Theories of foot function
3. The unified theory of foot function
4. Normal foot function in stance
5. Abnormal foot function in stance
6. Normal walking gait
7. Foot related gait dysfunction with commonly linked symptoms
8. Foot orthotics and other foot related treatment options

Normal and abnormal foot function in stance

If you only treat patients whose injury relates 100% to running, then this bit may bore you.

But, if like most of us you treat a variety of patients with a variety of occupations and activities, this is a section too often neglected

So, before we get into Gait, what do we stand on?

Much of our normal day (as well as our work and sport for some) involves standing

Standing and foot pain

Similar to "counting steps", standing more is being advocated for our health

Adults aged 19 to 64 are advised to try to sit down less throughout the day, including at work, when travelling and at home. Recommendations include:

1) stand on the train or bus

2) place a laptop on a box or similar to work standing

3) stand while on the phone

https://www.nhs.uk/live-well/exercise/why-sitting-too-much-is-bad-for-us/ *Accessed 10/1/21*

Standing and foot pain

However, prolonged standing has been shown to be associated with a number of potentially serious health outcomes, such as lower back pain, **lower limb pain**, cardiovascular problems, fatigue, discomfort, and pregnancy related health outcomes (Waters & Dick, 2015)

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

Abnormal Foot Function in Standing

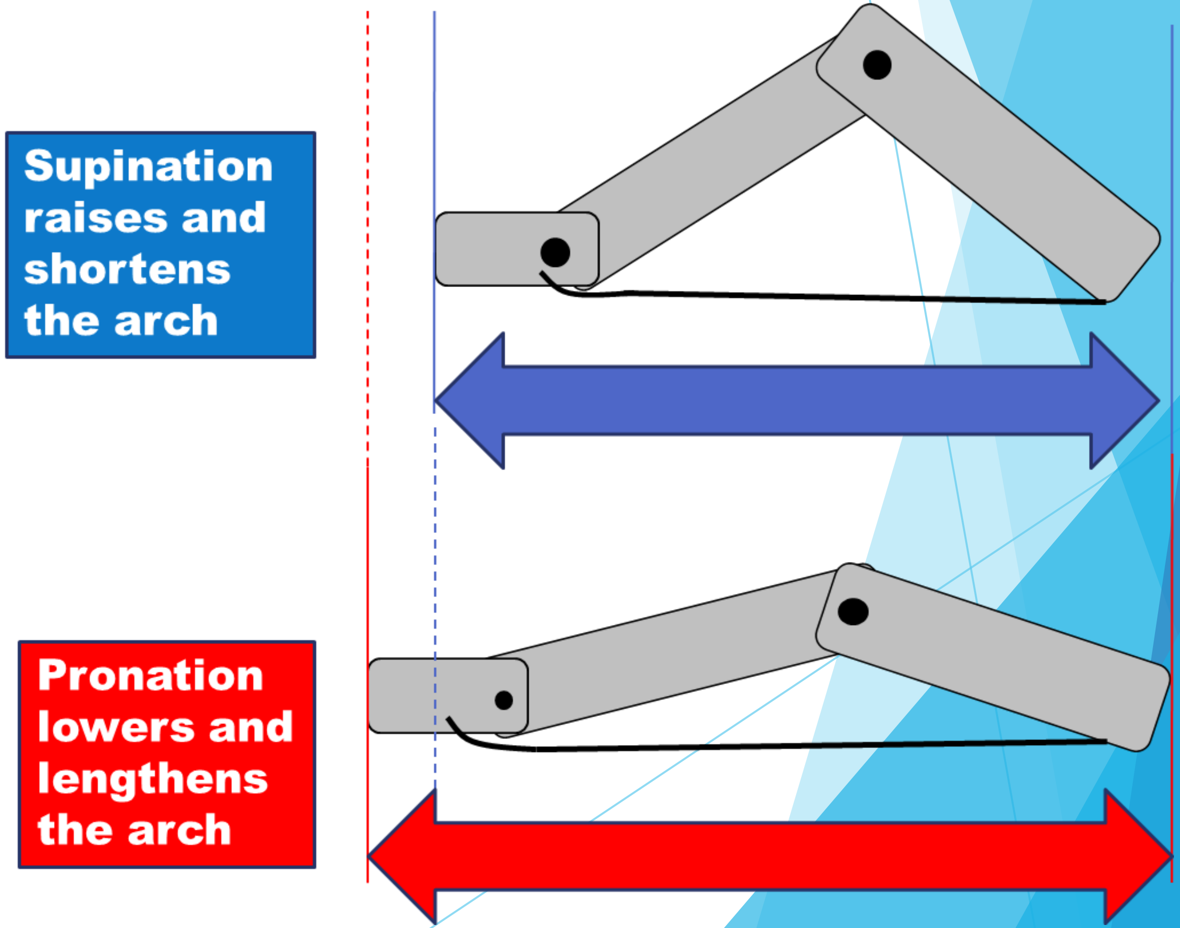
- Foot and ankle structures which reduce pronation moments, and therefore may become symptomatic in standing with increased pronation, include:

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

Abnormal Foot Function in Standing

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

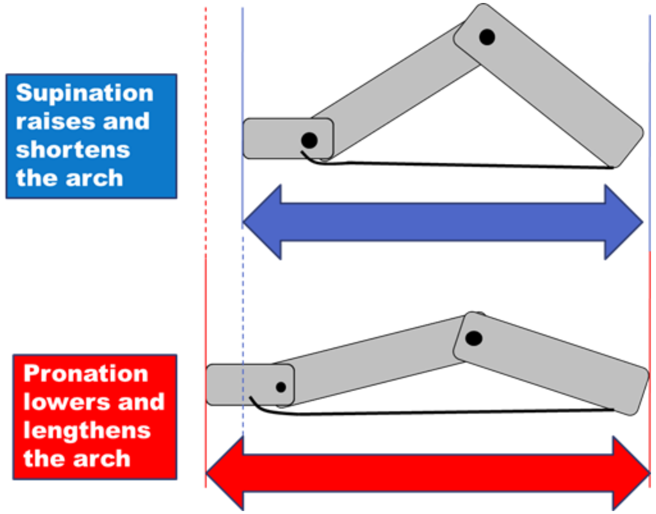
1) Plantar fascia
2) Plantar foot ligaments which cross the midtarsus



Abnormal Foot Function in Standing

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

1) Plantar fascia
2) Plantar foot ligaments which cross the midtarsus



Abnormal Foot Function in Standing

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

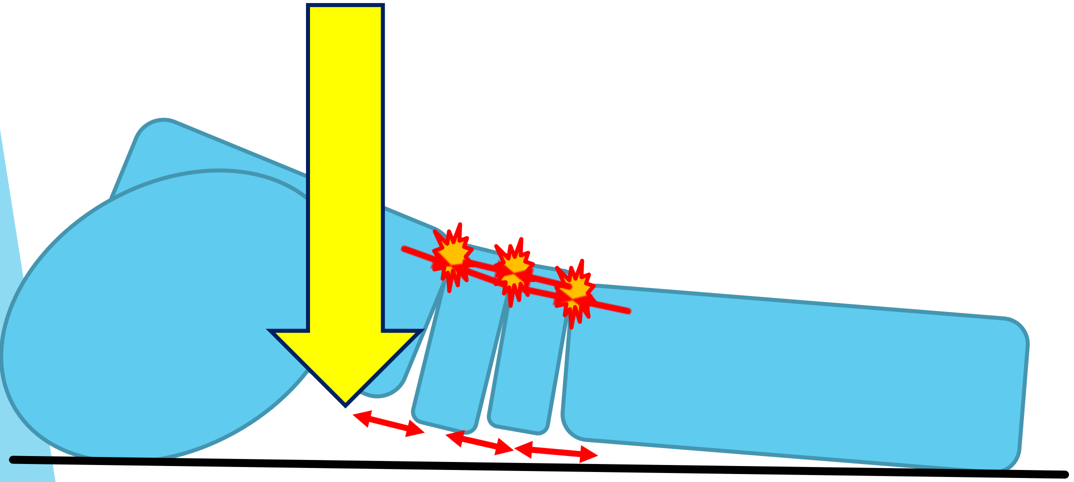
3) Posterior Tibial Muscle and Tendon

Abnormal Foot Function in Standing

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 at a magnitude to cause symptoms. Increased pronation increases dorsal midfoot interosseous compression forces



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 MSK foot injury or sporting ability I am aware of associated with any of these ethnic groups

Standing tests not dependant on visual observation (Kinematics versus Kinetics)

- Keep this simple and practical:

1. Supination Resistance Test (how hard is the patient pronating in stance)
2. Maximum Pronation Test (how far is the patient pronating in stance)

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

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 pronation moment
Moderate	With moderate effort, the foot is supinated slightly	Normal
Hard	With moderate effort, the foot cannot be supinated	Abnormally large pronation moment

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

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

Group Practical 3

- Supination resistance test
- Maximum pronation test

Webinar plan - An introduction to:

1. Basic functional anatomy
2. Theories of foot function
3. The unified theory of foot function
4. Normal foot function in stance
5. Abnormal foot function in stance
6. Normal walking gait
7. Foot related gait dysfunction with commonly linked symptoms
8. Foot orthotics and other foot related treatment options

Normal Walking Gait

Walking is a mans best medicine

Hippocrates

Everywhere is walking distance, if you have the time

Steven Wright

Unless it hurts?!

Walking

- Walking has been classed as the commonest physical activity (Chaudhry et al, 2020).

- A review of 32 studies published between 1980 and 2000 (Tudor-Locke & Myers, 2001) indicated that healthy younger adults (approximately 20-50 years of age) take 7,000-13,000 steps per day.

- A more recent study including data from all ages and health status across 95 countries and including over 100,000 participants found adult average steps per day to vary between 3,500 (Indonesia) and just under 7,000 (Hong Kong) (Althoff et al, 2017).

- The UK is towards the top of the steps-per-day league, at an average of 5,444 steps a day

Walking

- Physical activity such as walking reduces all-cause mortality and delivers important prevention and treatment benefits for many different physical and psychological conditions (WHO, 2018).

- Cross-sectional studies have shown strong associations between steps per day and health variables, leading to increasing daily steps being recommended for a variety of health-related issues (Tudor-Locke et al, 2011; Bassett et al, 2017).

- Normal foot function is essential for healthy walking (Kuo and Doneland,2010; Harradine and Bevan, 2009; Perry and Burnfield, 2010).

Walking is not just a chosen exercise (such as running), it is an essential daily activity.

- However, foot problems can make gait painful or problematic.

- Population representative meta-analysis has reported a 20% prevalence of foot and ankle pain in adults of middle and old age, with two-thirds reporting moderate or worse disability with daily activities such as walking (Thomas et al, 2011).

- A recent study investigating foot pain across an international consortium of population-based cohorts reported the incidence of foot pain ranged from 13 to 36% (Gates et al, 2019).

Walking is not just chosen exercise (such as running), it is an essential daily activity.

- Those who treat sports injuries understand the mental health issues often involved in situations that require a cessation to running / sporting participation.

- Patients who must cease walking activity may not only have a similar exercises withdrawal response, but also lose the ability to perform normal and often essential daily activities such as work, socializing and maintain general independence (shopping etc.).

- Do we need more time and resources invested into walking research and MSK related injury? Or is it just not young and shiny enough?

The Gait Cycle

Normal Foot Function in the Dynamic Walking theory

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 the dynamic walking theory

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

2. Internal hip rotation and foot pronation

- The medial longitudinal arch (MLA) lowers and lengthens initially during the stance phase of walking gait.

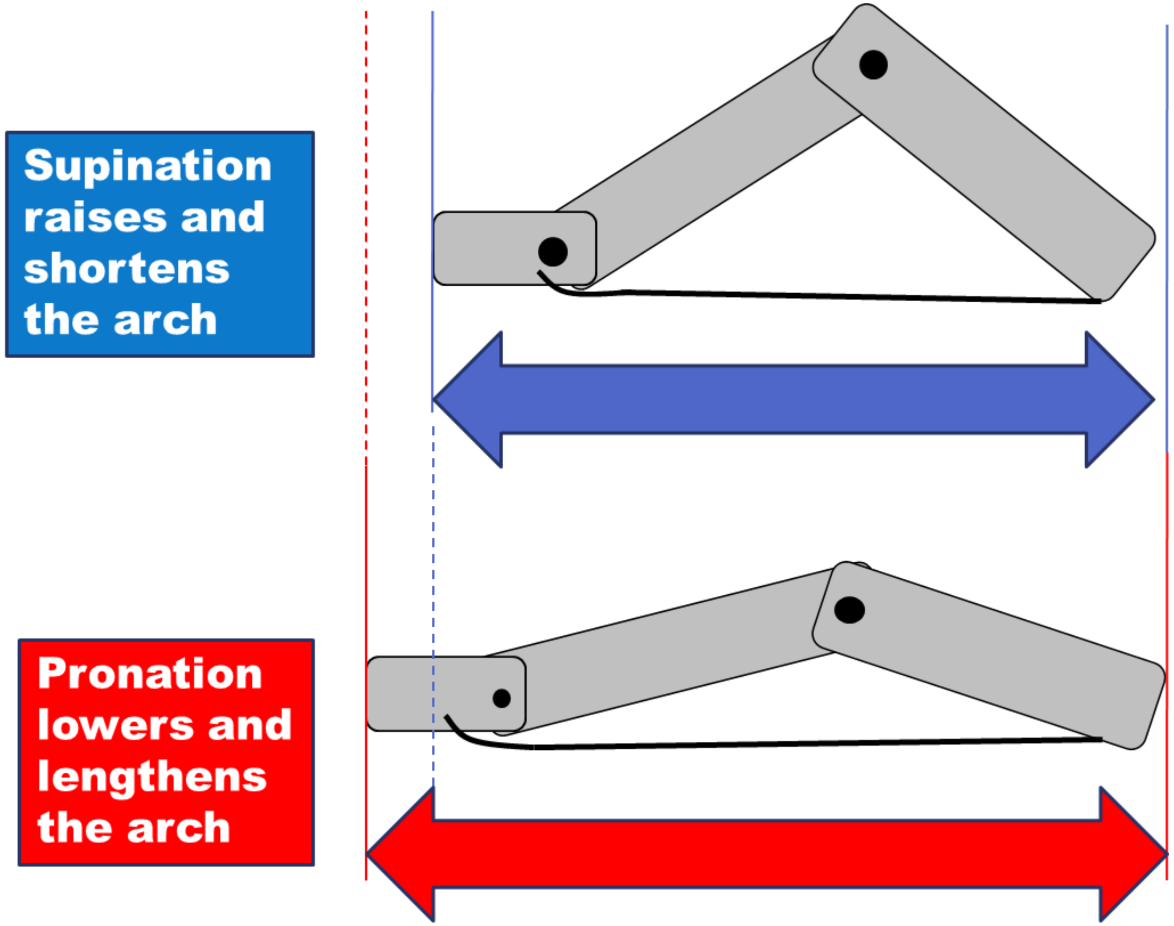
- The rearfoot everts (pronates) and then inverts (supinates) through a normal stance phase. Eversion occurs for the first 50-60% of the stance phase, followed by inversion (Leardini et al, 2007).

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

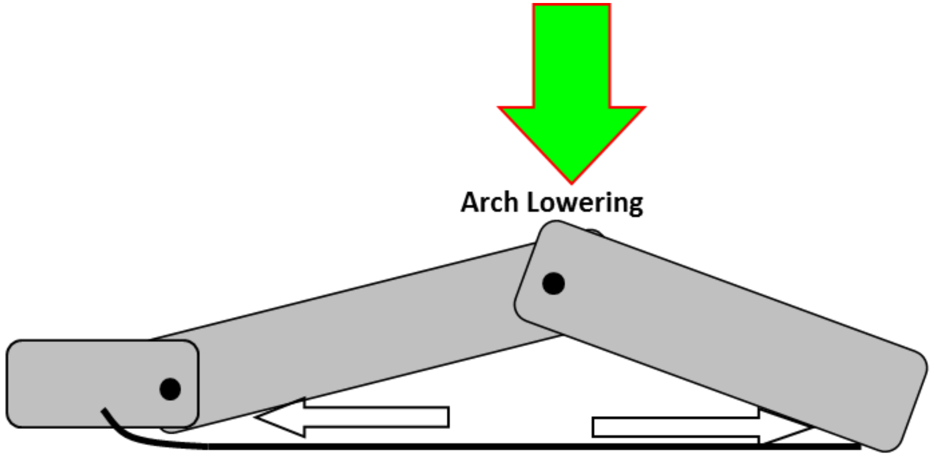
2. Internal hip rotation and foot pronation

- 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).

3.The reverse windlass

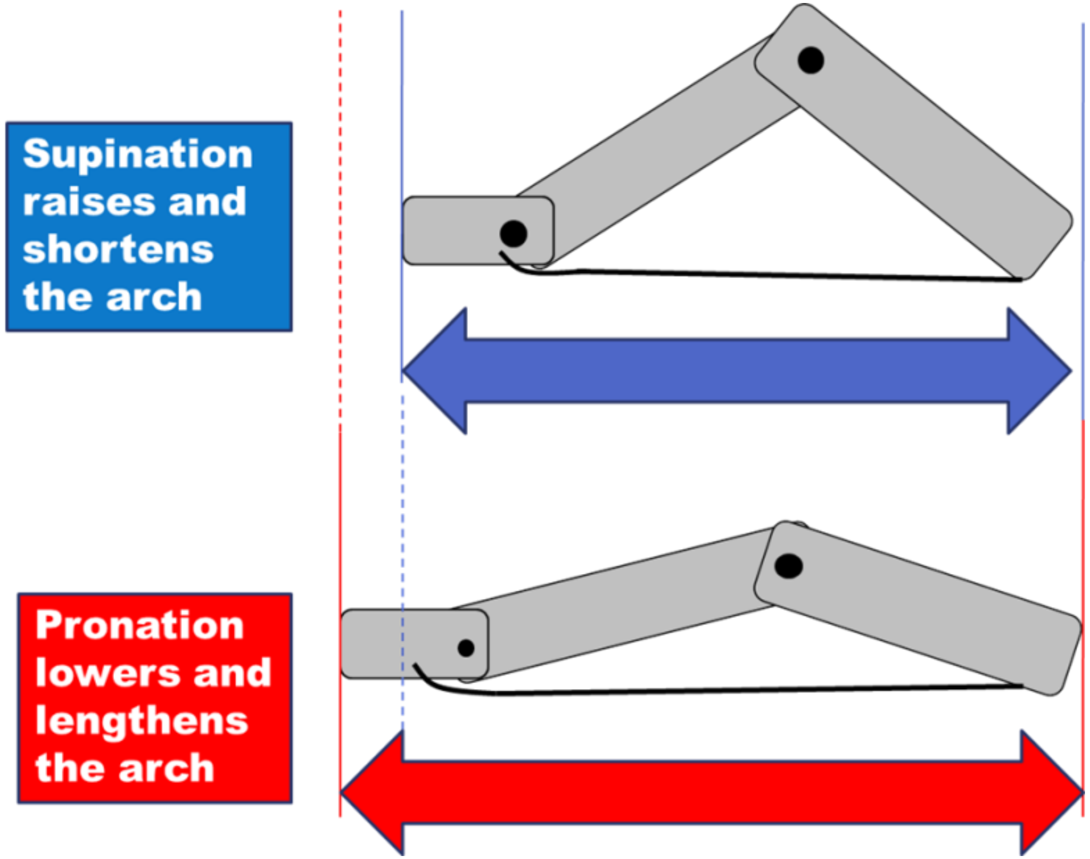


3.The reverse windlass

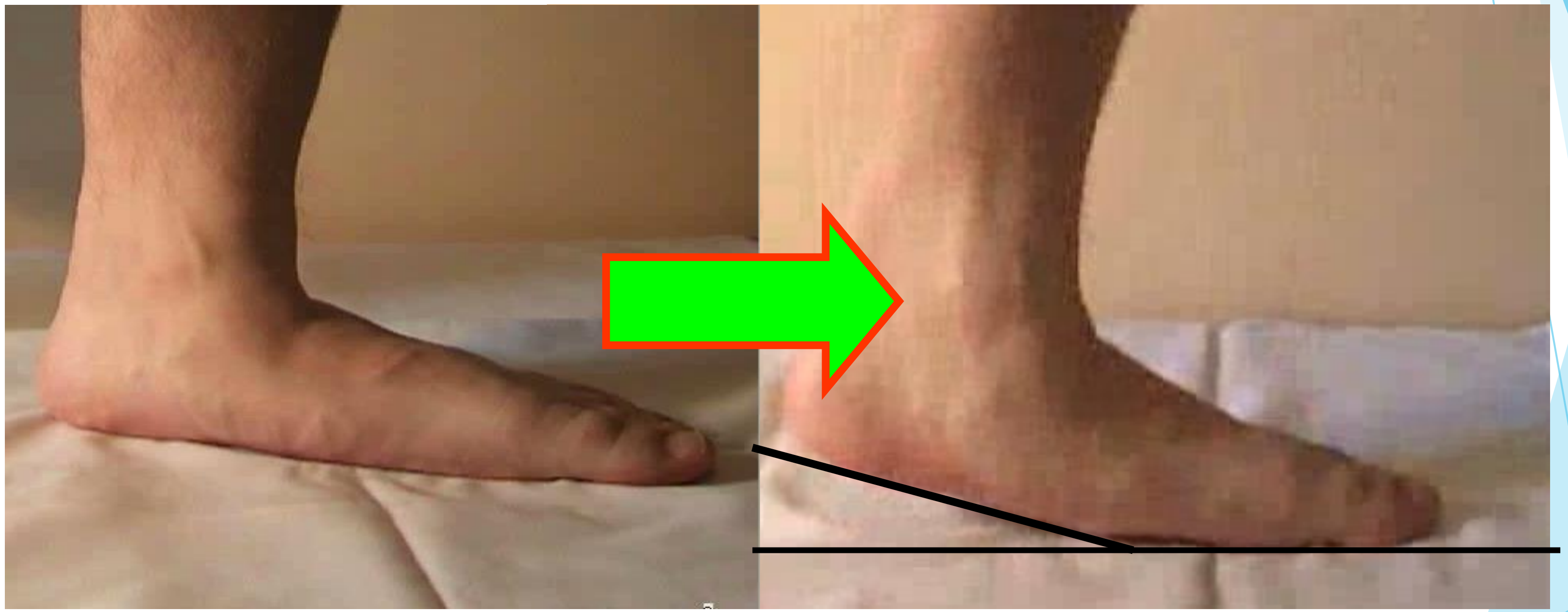


- As the arch lowers it becomes longer and the plantar structures (in this example the plantar fascia) become more taut. This in turn applies a compressive force longitudinally

3.The reverse windlass



Without midfoot stability / the reverse windless, the arch may not raise…and may in fact lower



Midtarsal Joint Dorsiflexion

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 dorsiflexes to ensure ground clearance of the swing limb

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).

6. The 3rd (Digits) Rocker

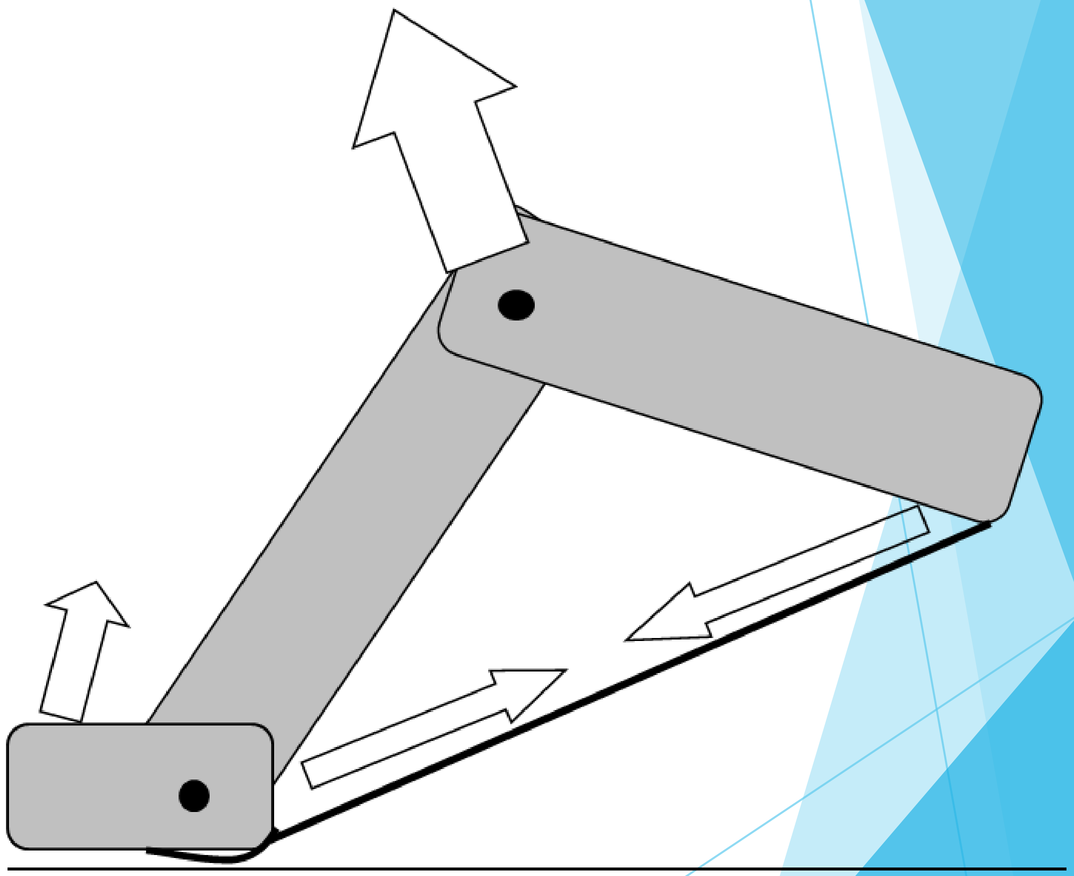
- Dorsiflexion of the digits provides this third rocker, allowing the foot to pivot correctly and the lower limb to obtain normal hip and knee extension.

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)

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)



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)

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)

9. 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)

9. AND the Lower back and Pelvis

- 3D kinematic studies during walking have demonstrated the same general lateroflexion on each side per cycle in the frontal plane (Feipel et al, 2001; Lamoth et al, 2002; Ceccato et al, 2009; Crossley et al, 2017; Kumala et al, 2017).

- The mean pelvic drop of these studies is 5 degrees, agreeing well with the amount theoretically proposed by Perry and Burnfiled (2010).

9. AND the Lower back and Pelvis

- Although some amount of motion is seen as aiding efficiency in the gait of a healthy population (the spinal engine), clinical emphasis is placed upon high values of frontal plane pelvic stance phase motion in relation to injury and abnormal foot function (Carter et al, 2003; Leetun et al, 2004; Elphinston, 2008; Snyder et al, 2009; Souza et al, 2010; Chuter et al, 2012; Souzza et al, 2016).

- But transverse plane motion is also clinically important

9. 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

- It has been commented that most modelling studies on gait seem to ignore arm swing altogether (Pieter et al, 2013), resulting in a relative lack of research based arm swing values

- Maximum extension is reached during ipsilateral heel contact, and peak flexion occurs with contralateral initial contact (Murray et al, 1967).

9. AND the Upper Limb!

- The total range of motion ranged between a mean of 46 degrees (Plate et al, 2015) and 50 degrees (Mirelman et al, 2015). Of this total amplitude, there is slightly increased extension compared to flexion.

- Faster walking increases the total arc of motion (Murray et al, 1967; Hejrati et al 2016).

What have those last slides about the knee, hip, back and arms got to do with normal foot function?

- Without the foot working as a rocker, more proximal structures may be unable to function normally

- When assessing gait, this permits a more holistic observational approach to both diagnosis and kinematic outcomes following intervention

- If arm swing improved with orthotics…have you got it right? If arm swing decreased with orthotics…have you got it right then?

- I’ll be mentioning this in abnormal foot function

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
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

A suggested summary of numbers….for our eyes to observe (Standard Reference Values)

Body Segment	Plane of Motion	Direction of motion	Observation	Amplitude (in degrees) or direction of motion used as the SRV
Foot	Frontal	Eversion or Inversion	Contact period rearshoe direction of motion	Eversion
	Frontal	Eversion	Rearfoot maximum eversion	5 or less
	Frontal	Inversion	Midstance maximum rearshoe inversion	Less than 0
	Frontal	Eversion or Inversion	Rearshoe direction of motion after contact phase	Inversion before toe off
Ankle	Sagittal	Dorsiflexion	Maximum Shoe to leg dorsiflexion angle	10 or more
Knee	Sagittal	Flexion	Maximum flexion and midstance	3 degrees or less
	Sagittal	Extension	Hyperextension in stance phase	1 degree or more
	Transverse	Internal or external rotation	Contact period knee direction of motion	Internal rotation
	Transverse	Internal or External rotation	Midstance and propulsive period direction of motion	External rotation before toe off
Hip	Sagittal	Extension	Maximum contact period extension	15 or more
Pelvis	Frontal	Lateral Rotation	Maximum stance phase lateral pelvic tilt	1 to 5 degrees
Arm	Sagittal	Extension	Maximum stance phase extension	26 or more
	Sagittal	Flexion	Maximum stance phase flexion	20 or more

A summary of numbers….for our eyes to observe (Standard Reference Values)

- I fully understand these numbers seem ridiculous to "measure " with the naked eye…but how do we know that? How inaccurate are we?

- And even though we may not be able to "measure" hip extension to the degree with our eyes (although we might…), can we detect a change following intervention towards or away from the SRVs?

- Without trying to establish SRVs, we simply cant tell

- Evidence of absence, or absence of evidence?

- Or is there a better way

Yes…there is a better way. Symptom Specific Guidelines. But as there's only one in production at the moment and we still need to work with something!

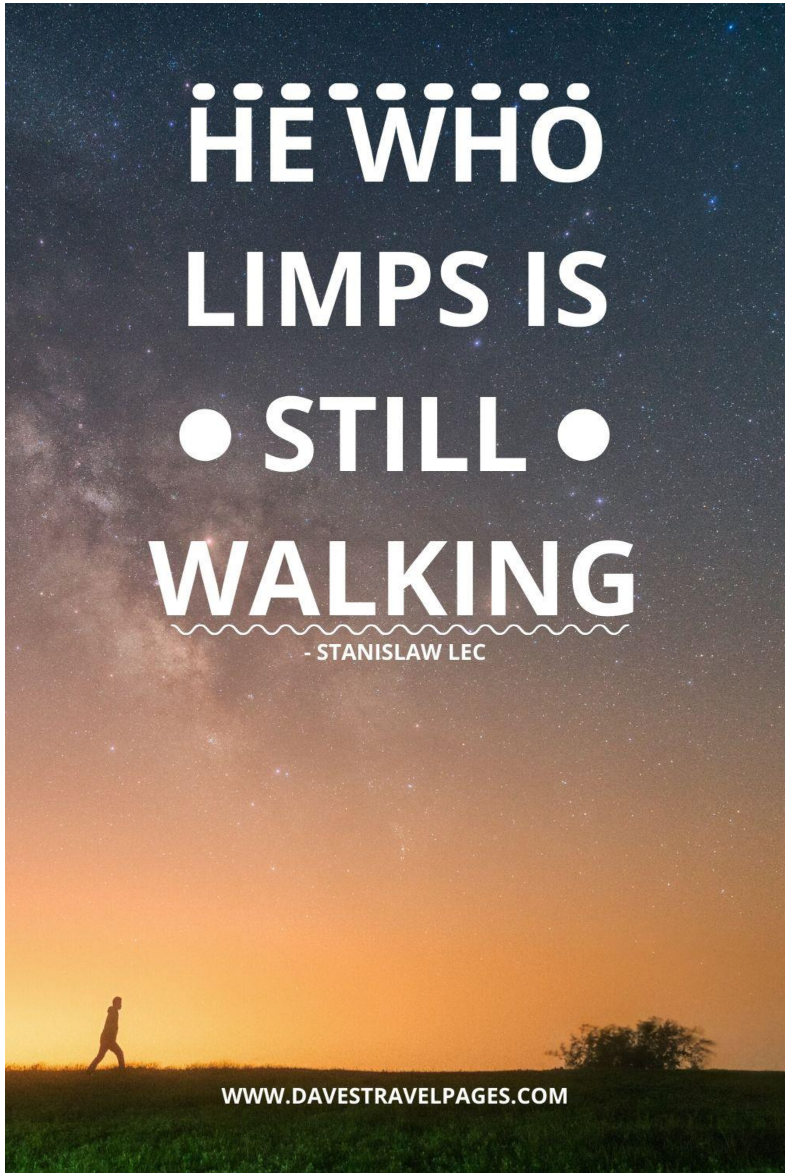
Body Segment	Plane of Motion	Direction of motion	Observation	Amplitude (in degrees) or direction of motion used as the SRV
Foot	Frontal	Eversion or Inversion	Contact period rearshoe direction of motion	Eversion
	Frontal	Eversion	Rearfoot maximum eversion	5 or less
	Frontal	Inversion	Midstance maximum rearshoe inversion	Less than 0
	Frontal	Eversion or Inversion	Rearshoe direction of motion after contact phase	Inversion before toe off
Ankle	Sagittal	Dorsiflexion	Maximum Shoe to leg dorsiflexion angle	10 or more
Knee	Sagittal	Flexion	Maximum flexion and midstance	3 degrees or less
	Sagittal	Extension	Hyperextension in stance phase	1 degree or more
	Transverse	Internal or external rotation	Contact period knee direction of motion	Internal rotation
	Transverse	Internal or External rotation	Midstance and propulsive period direction of motion	External rotation before toe off
Hip	Sagittal	Extension	Maximum contact period extension	15 or more
Pelvis	Frontal	Lateral Rotation	Maximum stance phase lateral pelvic tilt	1 to 5 degrees
Arm	Sagittal	Extension	Maximum stance phase extension	26 or more
	Sagittal	Flexion	Maximum stance phase flexion	20 or more

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

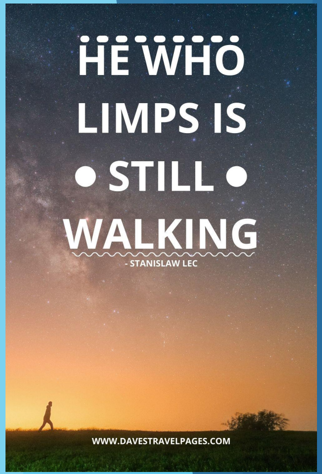
Webinar plan - An introduction to:

1. Basic functional anatomy
2. Theories of foot function
3. The unified theory of foot function
4. Normal foot function in stance
5. Abnormal foot function in stance
6. Normal walking gait
7. Foot related gait dysfunction with commonly linked symptoms
8. Foot orthotics and other foot related treatment options

Foot Related Gait Dysfunction



Foot Related Gait Dysfunction



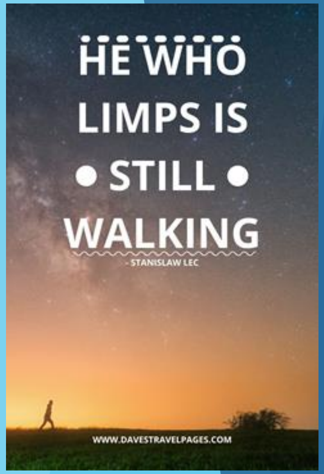
This doesn’t mean we are ignoring other structures such as, for example, the hip:

- **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.**

- **And any structural or functional weakness that decreases the hips ability in internally and the externally rotate at correct timings in the stance phase**

We are mostly focussing on the foot today

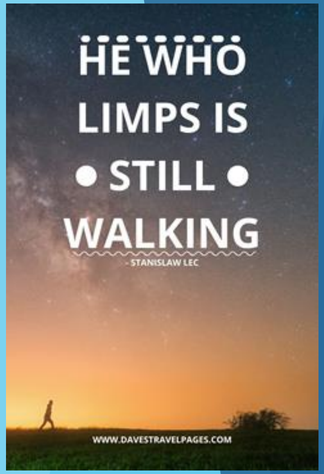
So, with the foot, gait abnormality arises if:



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

- Any structural or functional abnormality that will decrease the foots ability to pronate and then supinate at the correct timing during the stance phase

So, with the foot, gait abnormality arises if:



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

- Any structural or **functional** abnormality that will decrease the foots ability to pronate and then supinate at the correct timing during the stance phase

Increased Pronation as a functional abnormality

1. Increased pronation links to increased functional dorsiflexion stiffness of the 1st MTPJ (Harradine and Bevan, 2000; Scherer et al, 2006; Durrant and Chockalingam, 2009; Gatt et al, 2014)

2. Increased pronation increases internal lower limb rotation (Bowling et al, 2009; Snyder et al, 2009; Souza et al, 2010)

3. Increased pronation decreases the ability of the foot to resupinate in the stance phase (Harradine and Bevan, 2009; Harradine et al, 2006)

Other functional abnormality would include increased supination, which we will return to briefly later.

For now, we are grouping increased pronation moments and movements under the term "increased pronation"

Increased Pronation as a functional abnormality

1. Increased pronation links to increased functional dorsiflexion stiffness of the 1st MTPJ (Harradine and Bevan, 2000; Scherer et al, 2006; Durrant and Chockalingam, 2009; Gatt et al, 2014)

2. Increased pronation increases internal lower limb rotation (Bowling et al, 2009; Snyder et al, 2009; Souza et al, 2010)

3. Increased pronation decreases the ability of the foot to resupinate in the stance phase (Harradine and Bevan, 2009; Harradine et al, 2006)

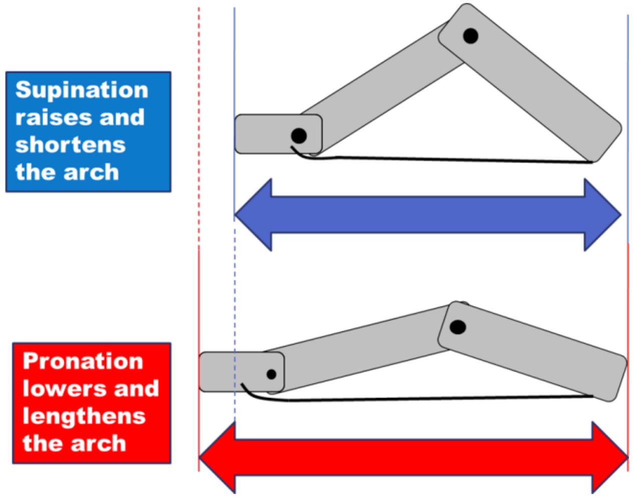
Other functional abnormality would include increased supination, which we will return to briefly later.

Symptoms related to increased dynamic pronation link to

1. Excessive load on structures that oppose pronation
2. Excessive load due to resultant gait dysfunction
3. A combination of the above

Symptoms related to increased dynamic pronation link to

1. Excessive load on structures that oppose pronation. E.g. Plantar fasciitis and posterior tibial tendon dysfunction



Return to these later is symptom examples

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Foot based gait dysfunction theory amalgamated into gait analysis

There is a critical lack of guiding literature relating to practical gait analysis including:

- Normative data
- Clinical Practice Guidelines
- Diagnostic tests
- General reliability and validity
- Knowledge of current practice

Foot based gait dysfunction theory amalgamated into gait analysis

There is a critical lack of guiding literature relating to practical gait analysis including.

If you think any book or paper tells you how to perform gait analysis for adult MSK injury including methods, normative data, outcome observations etc then you are wrong! (Harradine et al, 2018)

Foot based gait dysfunction theory amalgamated into gait analysis

Absence of evidence is not evidence of absence

“One must instead seriously question whether the absence of evidence is a valid justification for inaction” (Altman and Bland, 1995)

Foot based gait dysfunction theory amalgamated into gait analysis

“Remember that all models are wrong; the practical question is how wrong do they have to be not to be useful”

Or

“**Essentially, all models are wrong, but some are useful**”

(Box G,1987)

Common gait analysis options

Real Time Clinical Gait Analysis (RTCGA). RTCGA is the assessment of gait conducted within a clinical setting without the use of any recording, play back or computerised equipment (Harradine et al, 2018)

Clinical Gait Analysis (CGA). CGA includes all gait analysis which requires computerised recording or analysis. Common CGA includes 2D kinematic playback technology and plantar pressure measurement systems

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Including examples of symptoms linking to the gait dysfunction

Excessive internal hip rotation

Theoretical symptom examples include:

- Patellofemoral pain syndrome
- Piriformis syndrome
- Greater Trochanter Pain Syndrome

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Lack of resupination / external hip rotation

Lack of resupination / external hip rotation

Theoretical symptom examples include:

- Patellofemoral pain syndrome
- Piriformis syndrome
- Greater Trochanter Pain Syndrome
- Posterior tibial tendonopathy / dysfunction
- Plantar fasciitis

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Excessive rearfoot eversion

Excessive rearfoot eversion

Theoretical symptom examples include:

- Posterior tibial tendinopathy / dysfunction
- Lateral impingement syndrome / Chronic sinus tarsi syndrome
- Plantar fasciitis

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL →

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Excessive forefoot abduction

Excessive forefoot abduction

Theoretical symptom examples include:

- Lateral column compression syndrome

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Large medial bulge

Large medial bulge

Theoretical symptom examples include:

- Posterior tibial tendinopathy / dysfunction

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Excessive arch lowering

Not arch height! Does it raise again?

Excessive arch lowering

Not arch height! Does it raise again?

Theoretical symptom examples include:

- Plantar fasciitis
- Plantar ligament strain
- Posterior tibial tendinopathy / dysfunction
- Dorsal interosseous compression syndrome

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Abductory twist

Theoretical symptom examples include:

- Diffuse metatarsalgia
- Forefoot blisters

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Gait dysfunction due to a FnHL

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

→ FnHL →

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Excessive Pelvic Rotation

Theoretical symptom examples include:

- Greater Trochanter Pain Syndrome
- Aggravating factor in mechanical and gait related LBP

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Flattened Lordosis ,Lack of Hip and Knee Extension and Vertical Heel Lift

Theoretical symptom examples include:

- Patellofemoral pain syndrome
- Aggravating factor in mechanical and gait related LBP

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

MTJ Dorsiflexion

MTJ Dorsiflexion

Theoretical symptom examples include:

- Plantar fasciitis
- Plantar ligament strain
- Posterior tibial tendinopathy / dysfunction
- Dorsal interosseous compression syndrome

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

1st IPJ Dorsiflexion

1st IPJ Dorsiflexion

Theoretical symptom examples include:

- Hallux IPJ synovitis / OA
- Plantar IPJ skin Corns / Skin irritation

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL →

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Lateral Column Propulsion

Lateral Column Propulsion

Theoretical symptom examples include:

- Lesser MTPJ synovitis / capsulitis
- Plantar pedal neuralgia (e.g. Mortons Neuroma)
- Plantar lesser MTPJ Corns / Skin irritation
- Lesser metatarsal stress response / fracture

Foot based gait dysfunction theory

Increased pronation pattern

1. Excessive internal hip rotation
2. Lack of resupination / external hip rotation
3. Excessive rearfoot eversion
4. Excessive forefoot abduction
5. Large medial bulge
6. Excessive arch lowering
7. Abductory twist

FnHL

Sagittal plane blockade pattern

1. Excessive Pelvic Rotation
2. Flattened Lordosis
3. Lack of Hip and Knee Extension
4. Vertical Heel Lift
5. MTJ Dorsiflexion
6. IPJ Dorsiflexion
7. Lateral Column Propulsion
8. Side Sway

Side Sway

Theoretical symptom examples include:

- Greater trochanter syndrome
- Aggravating factor is mechanical gait related LBP

Group Practical 4

- RTCGA
- Sagittal and frontal
- Look for changes with footwear or orthotics you may already have

Webinar plan - An introduction to:

1. Basic functional anatomy
2. Theories of foot function
3. The unified theory of foot function
4. Normal foot function in stance
5. Abnormal foot function in stance
6. Normal walking gait
7. Foot related gait dysfunction with commonly linked symptoms
8. Foot orthotics and other foot related treatment options

Lets jump straight into foot orthotics orthotics, and then introduce other options after

The aims of a foot orthotic to treat a symptom related to increased pronation

- **Reduce first ray dorsiflexion moment ("let the first ray drop") allowing the 3rd rocker to function**

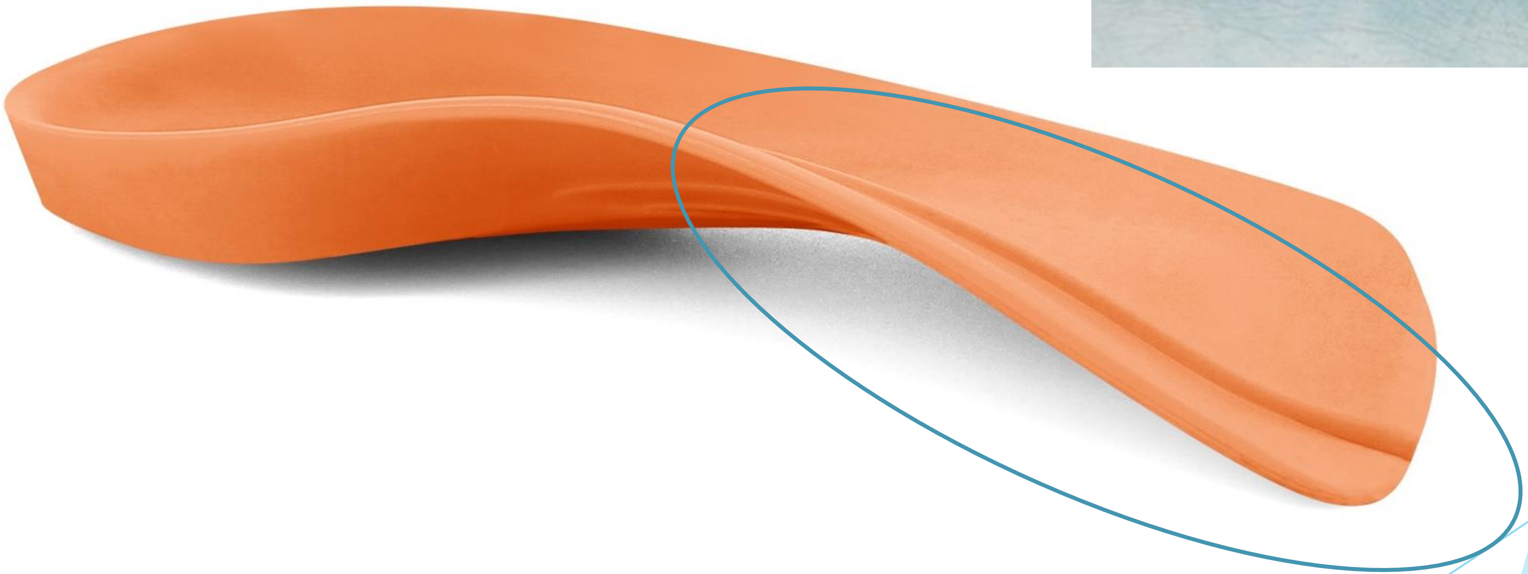
- **Reduce pronation (or supination) moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation**

Whilst….

1. Not actually Impinging first ray function
2. Having a shell shape that is both supportive and comfortable
3. Having modifications to decrease pronation moments by a lot or a little
4. Be low bulk permitting regular footwear choice
5. Not wear down or fall apart quickly

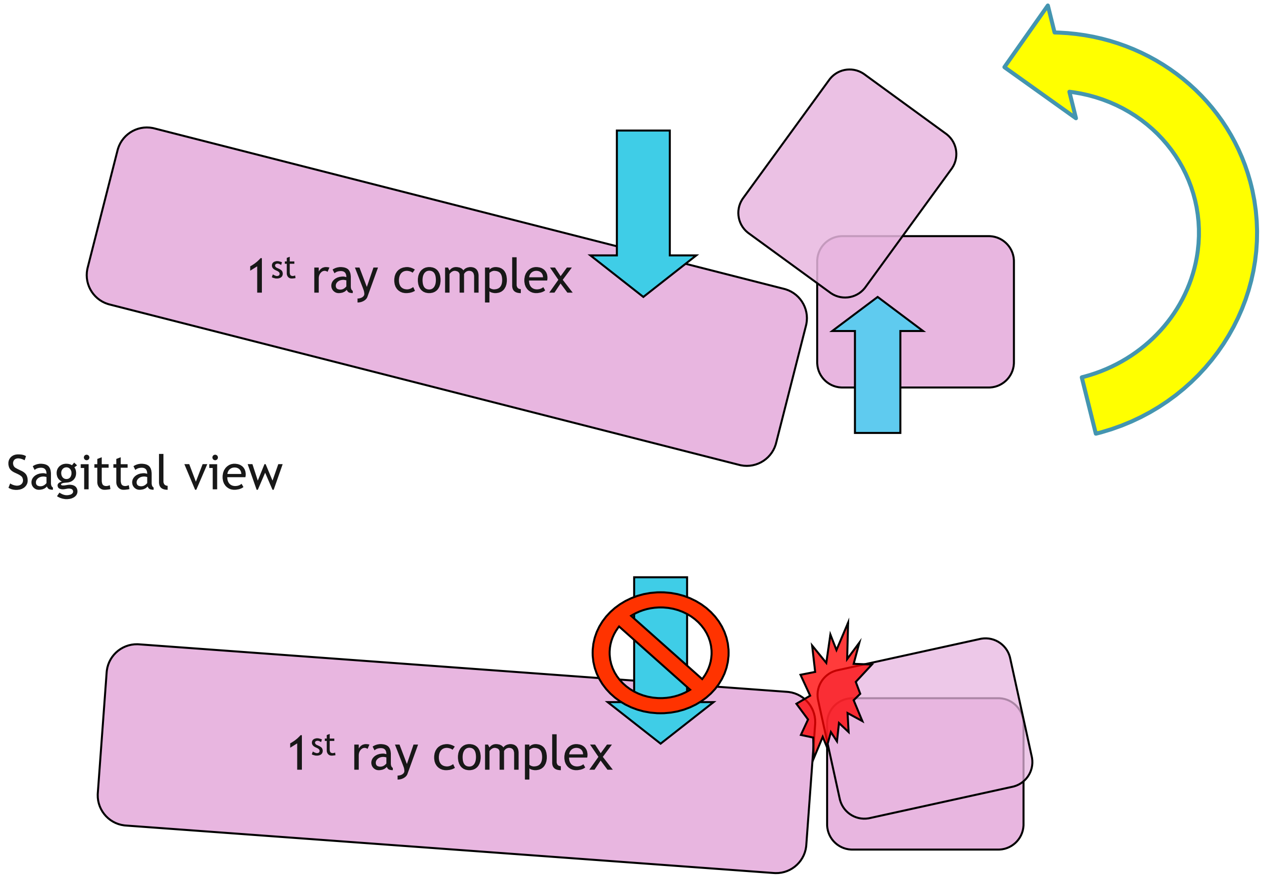
Reduce first ray dorsiflexion moment ("let the first ray drop") allowing the 3rd rocker to function

- First Ray Groove / dell / cut out



Note: The appliance is still full width. This prevents the shell moving medially which can occur with the more traditional first ray cut out.

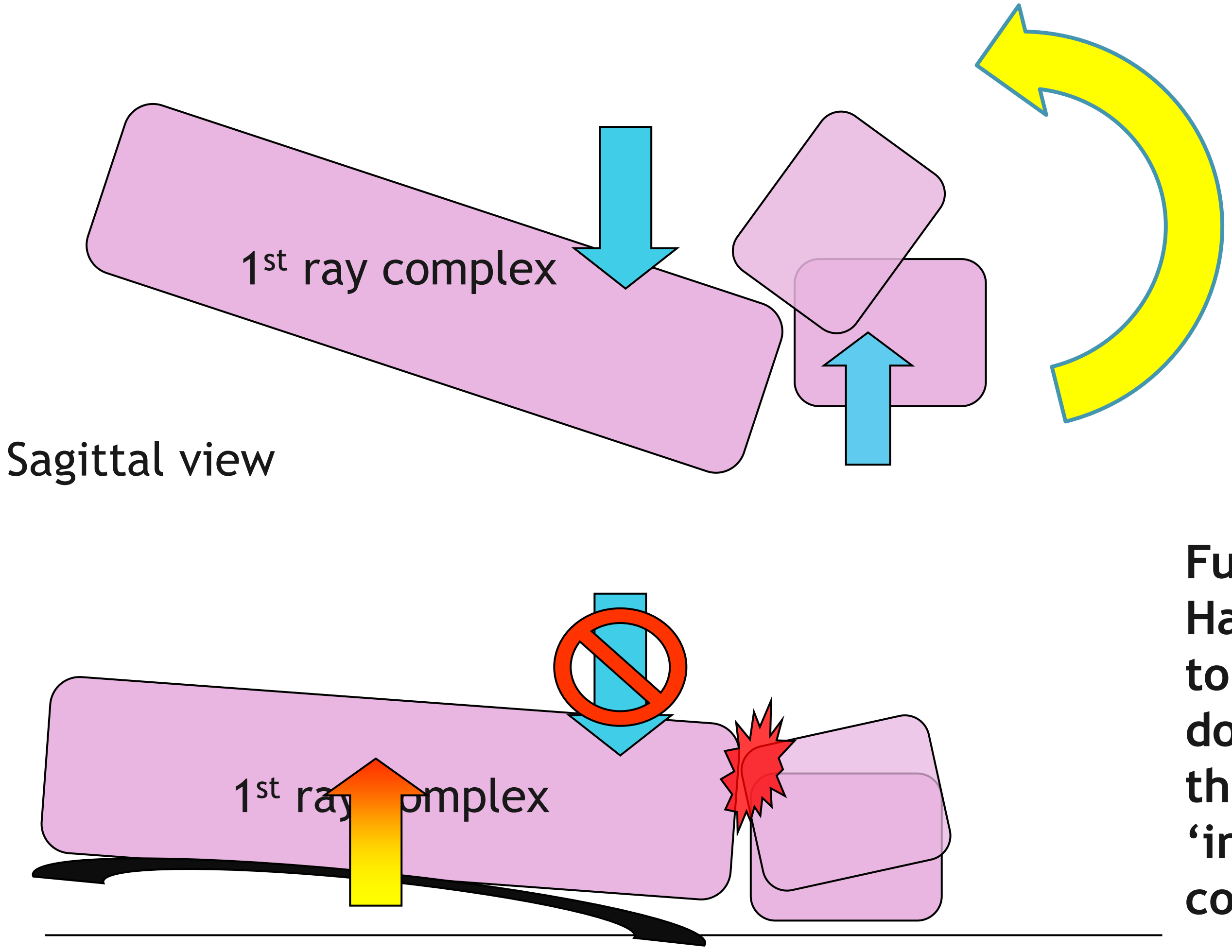
Dorsiflexion at the 1st MTPJ is proposed to be dependant on the position of the first ray



Normal Hallux dorsiflexion with first ray plantarflexion

Functional Limitation of Hallux dorsiflexion with lack of first ray plantarflexion

Orthotics, for example those with a high distal medial arch contour or a full width or long forefoot varus posting, may impinge on first ray function.



Normal Hallux dorsiflexion with first ray plantarflexion

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

Reduce first ray dorsiflexion moment (“let the first ray drop”) allowing the 3rd rocker to function

- First Ray Groove / dell / cut out

Note: The appliance is still full width. This prevents the shell moving medially which can occur with the more traditional first ray cut out.

The aims of a foot orthotic to treat a symptom related to increased pronation

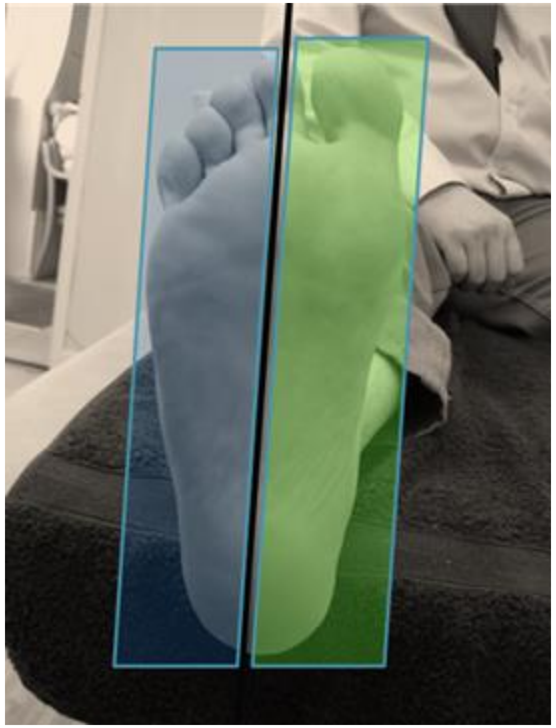
- **Reduce first ray dorsiflexion moment ("let the first ray drop") allowing the 3rd rocker to function**

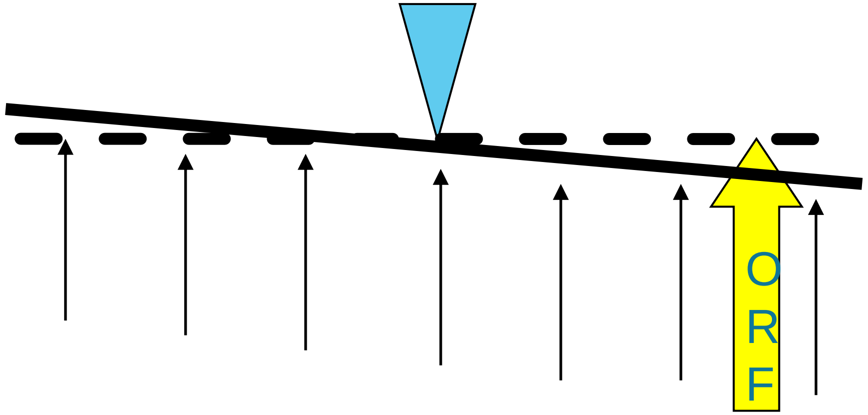
- **Reduce pronation moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation**

Whilst….

1. Not actually Impinging first ray function
2. Having a shell shape that is both supportive and comfortable
3. Having modifications to decrease pronation moments by a lot or a little
4. Be low bulk permitting regular footwear choice
5. Not wear down or fall apart quickly

Reduce pronation moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation



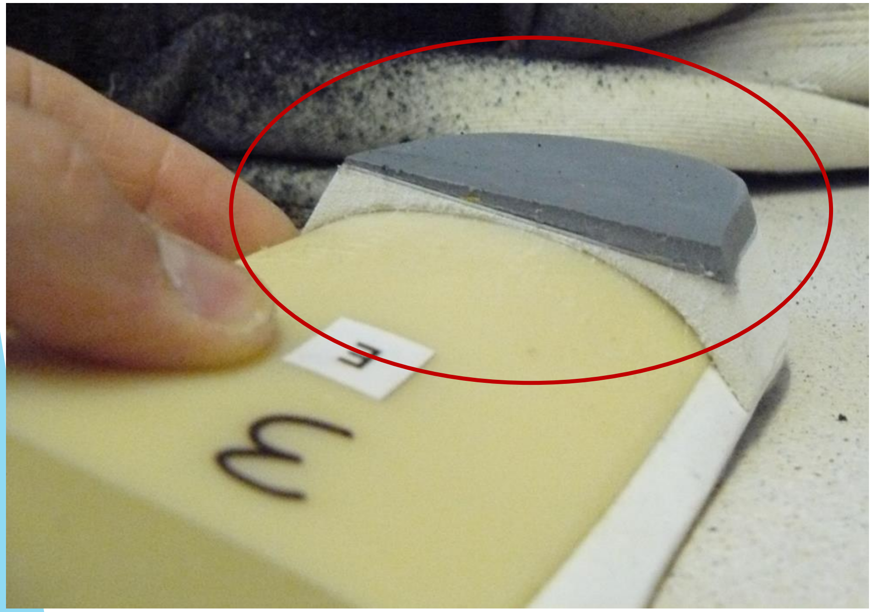


Force Lateral to the axis

Force medial to the axis

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).

Reduce pronation moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation



The aims of a foot orthotic to treat a symptom related to increased pronation

- Reduce first ray dorsiflexion moment ("let the first ray drop") allowing the 3rd rocker to function
- Reduce pronation (or supination) moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation

Whilst….

1. Not actually Impinging first ray function
2. Having a shell shape that is both supportive and comfortable
3. Having modifications to decrease pronation moments by a lot or a little
4. Be low bulk permitting regular footwear choice
5. Not wear down or fall apart quickly

Reduce pronation moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation

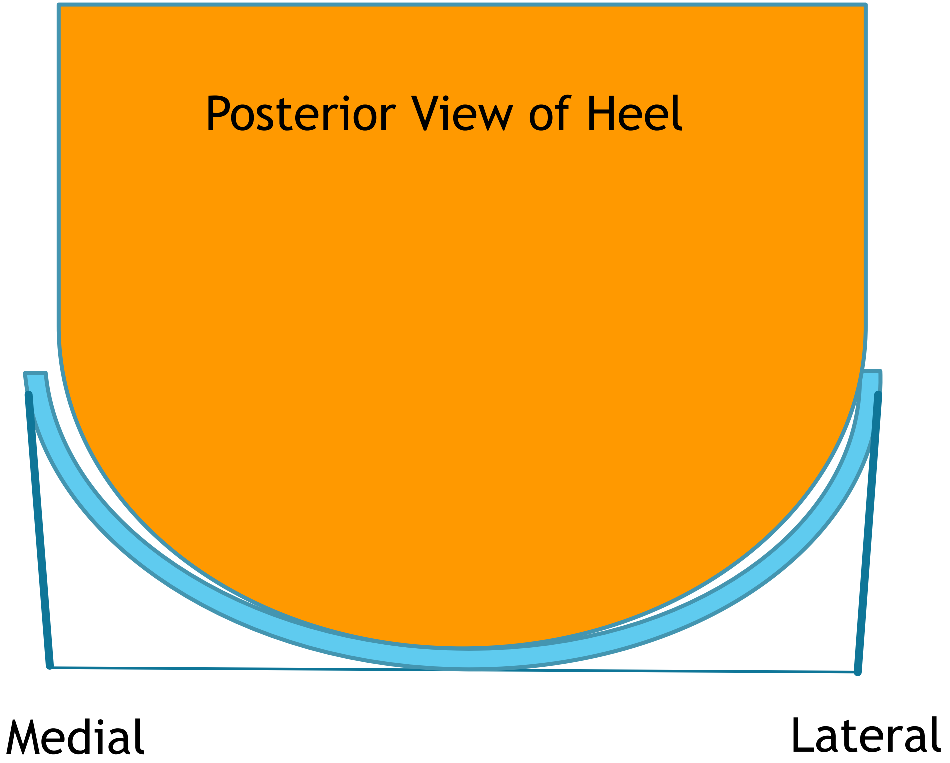
The aims of a foot orthotic to treat a symptom related to increased pronation

- Reduce first ray dorsiflexion moment ("let the first ray drop") allowing the 3rd rocker to function
- Reduce pronation (or supination) moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation

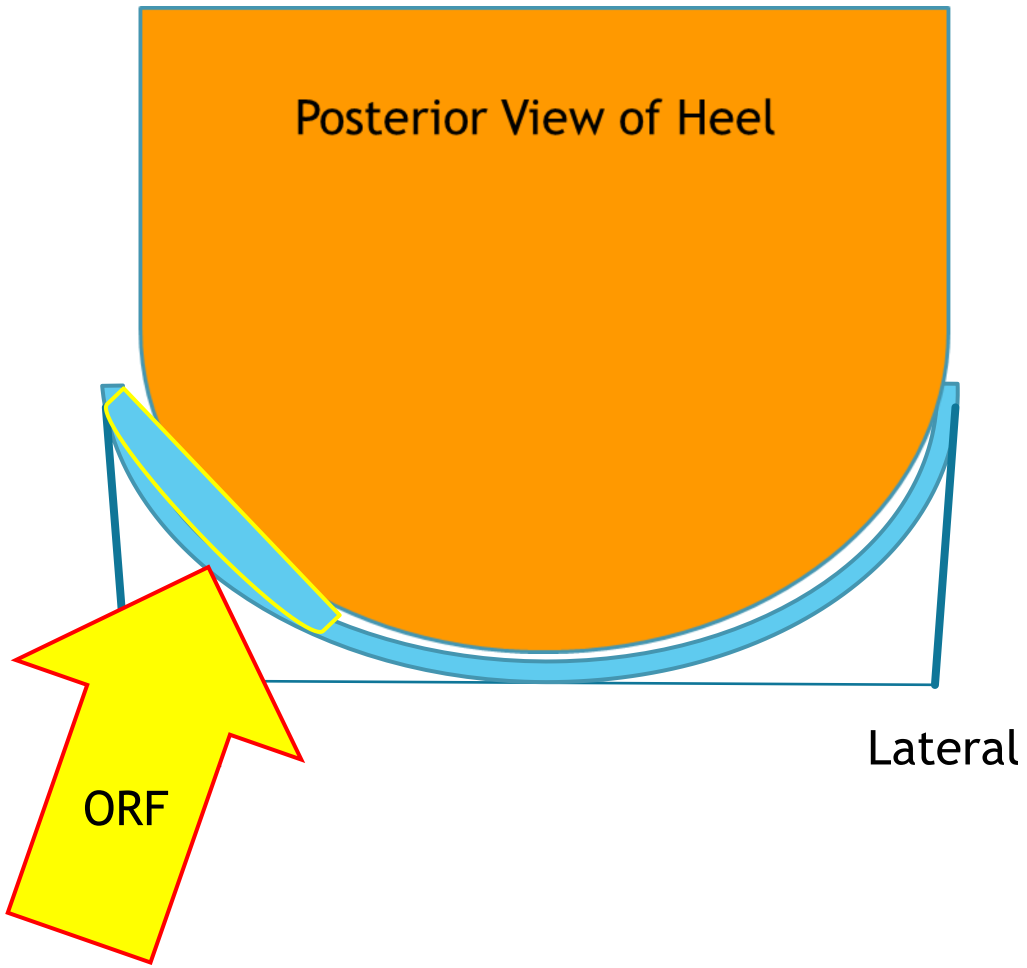
Whilst....

1. Not actually Impinging first ray function
2. Having a shell shape that is both supportive and comfortable
3. Having modifications to decrease pronation moments by a lot or a little
4. Be low bulk permitting regular footwear choice
5. Not wear down or fall apart quickly

Applying ORF optimally? The Medial Heel Skive (Kirby, 1994)



Applying ORF optimally? The Medial Heel Skive (Kirby, 1994)



Custom or prefab….if the aims of a foot orthotic to treat a symptom related to increased pronation are met, then does it matter?

- **Reduce first ray dorsiflexion moment ("let the first ray drop") allowing the 3rd rocker to function**

- **Reduce pronation (or supination) moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation**

Whilst….

1. Not actually Impinging first ray function
2. Having a shell shape that is both supportive and comfortable
3. Having modifications to decrease pronation moments by a lot or a little
4. Be low bulk permitting regular footwear choice
5. Not wear down or fall apart quickly

Custom or prefab….it can be difficult to meet these aims for all patients using a prefab.

- **Reduce first ray dorsiflexion moment ("let the first ray drop") allowing the 3rd rocker to function**

- **Reduce pronation (or supination) moment ("to improve gait and take the stress off the injured structure") allowing normal internal and external leg rotation**

Whilst….

1. Not actually Impinging first ray function
2. Having a shell shape that is both supportive and comfortable
3. Having modifications to decrease pronation moments by a lot or a little
4. Be low bulk permitting regular footwear choice
5. Not wear down or fall apart quickly

Custom MOSI vrs Non-custom MOSI

- A poor budget does not have to mean poor outcomes, it is possible to supply excellent non-custom orthoses.

So we've jumped into orthotics, but what about other foot based options?

So we've jumped into orthotics, but what about other foot based options?

- Footwear
- Taping
- Splints / AFOs

Footwear

Trainers are ideal…

‘Stability’ or ‘Motion Control’ Trainers

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

Decent ‘upper’ stiffness

And don’t let them get old!

Taping

Splints / AFOs

Splints / AFOs

Webinar plan - An introduction to:

1. Basic functional anatomy
2. Theories of foot function
3. The unified theory of foot function
4. Normal foot function in stance
5. Abnormal foot function in stance
6. Normal walking gait
7. Foot related gait dysfunction with commonly linked symptoms
8. Foot orthotics and other foot related treatment options