

Sports Medicine Association of Serbia and Montenegro

Running injuries, biomechanics, insoles, orthotics and running shoes

Novel concepts in 2004


Prof M P Schweltnus
MRC/UCT Research Unit for Exercise Science and Sports Medicine
Sports Science Institute of South Africa




Prevention of running injuries

Risk factors for running injuries

1. Incorrect training and preparation
2. Past history of a running injury
3. Biomechanical "abnormalities"
4. Inappropriate training surfaces
5. Inadequate warm-up
6. Inflexibility
7. Incorrect or worn running shoes
8. Muscle weakness and imbalances
9. Inadequate nutrition



Questions

1. Do running shoes reduce the risk of running injuries?
2. What are the mechanisms by which running shoes may reduce the risk of injuries?
3. Do soft commercial insoles reduce the risk of running injuries?
4. What is the mechanism by which soft insoles reduce the risk of injuries?
5. Do custom made orthoses reduce the risk of running injuries?
6. What is the mechanism by which custom made orthoses reduce the risk of injuries?

The Sports Shoe Selection System (SSSS)

A unique system matching the runner to the correct running shoe

Choosing a running shoe

Evaluate the runner

Lower limb alignment
(rearfoot valgus/varus, forefoot valgus/varus, tibial varus/valgus, genu valgus/varus, Q angle)
Lower limb flexibility
Dynamic assessment

Evaluate the shoe

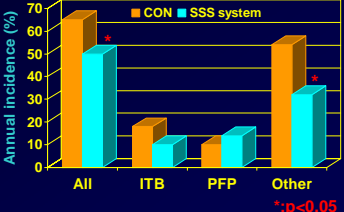
"Anti-pronation" features
(last shape, board lasted, medial wedges, arch supports, medial midsole density, heel cups)

Match

Does the SSSS reduce the annual risk of running injuries?

Sports Shoe Selection system

- Lower limb alignment assessment
- Running shoe assessment
- Shoe advice given to athlete with choice
- 83 Control and 94 SSS athletes followed for 1 year
- Incidence of injuries recorded



Category	CON (%)	SSS system (%)
All	~65	~50*
ITB	~20	~10
PFP	~15	~10
Other	~55	~35*


*p<0.05

Stubbs G, BSc Hons, 2000

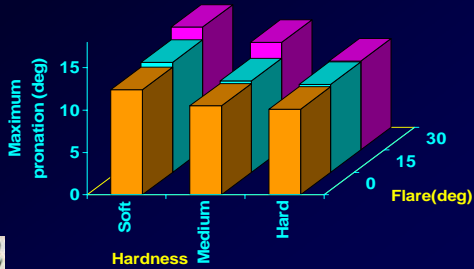
Conclusion 1

There is limited scientific evidence to support the hypothesis that

What about the other 50% of injuries?



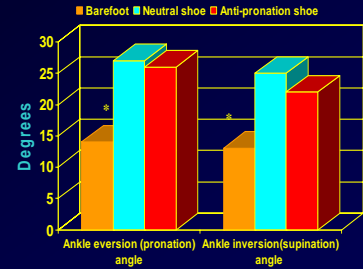
Does heel flare and midsole hardness alter maximum pronation?



Clarke et al, Med Sci Sports Ex, 1983

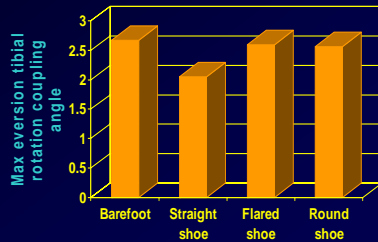
Do running shoes (anti-pronation vs. neutral) alter pronation and supination?

- 12 healthy non-injured "neutral" runners
- Underwent 3D biomechanical testing
- Barefoot, Anti-pronation shoe, Neutral shoe



Arendse R, SchwelInus M, et al, 2001

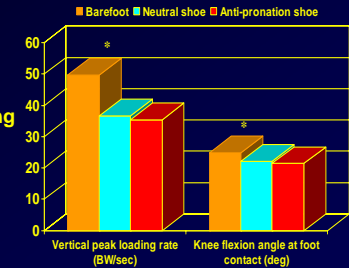
Do different modern running shoes alter lower limb running biomechanics using bone pin fixation techniques?



Stacoff et al, J Biomechanics 33, 2000

Do running shoes (anti-pronation vs. neutral) alter peak vertical loading rate and knee kinematics during running?

- 35 healthy non-injured runners
- Underwent 3D biomechanical testing
- Barefoot, Anti-pronation shoe, Neutral shoe

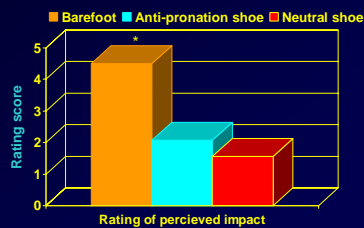


Arendse R, SchwelInus M, et al, 2003

Why does it feel "good" to run with running shoes?

Can a runner's brain distinguish between different types of shoes?

- 35 healthy non-injured runners
- Randomized into running barefoot or with a neutral and an anti-pronation shoe
- Rating or perception of impact

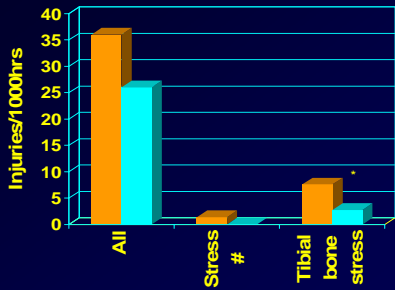


Arendse R, SchwelInus M, et al, 2003

Conclusion 2

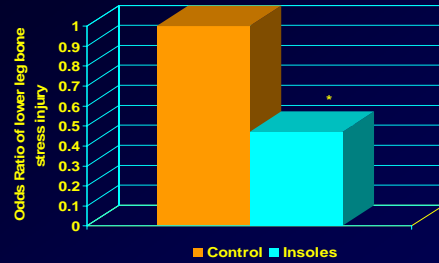
- There is little scientific evidence to support the hypothesis that running shoes alter "pronation" through "anti-pronation" features
- Compared with barefoot running, running shoes do decrease the loading rate (force is applied over a longer time period)
- A runner can distinguish between different shoes based on perceived impact
- Perceived impact is related to loading rate

Does a soft “shock absorbing” insert decrease the risk of overuse injuries?



Schwellnus et al Am J Sports Med 6(2), 1990

Does a soft “shock absorbing” insert decrease the risk of bone stress injuries of the lower leg?



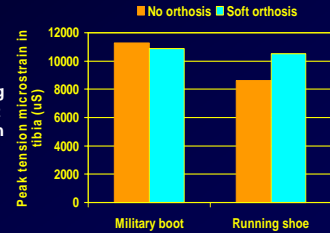
Gillespie WJ, Grant I. Interventions for preventing and treating stress fractures and stress reactions of bone of the lower limbs in young adults (Cochrane Review). In: The Cochrane Library, Issue 1, 2003

Conclusion 3

- There is strong scientific evidence to support the hypothesis that soft insoles reduce the risk of bone stress injuries of the lower leg during running

Do soft orthoses alter peak microstrain in the tibia during running with running shoes and with military boots?

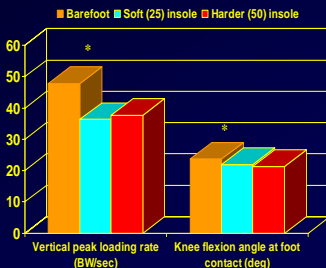
- 9 healthy uninjured males
- Treadmill walking at 5 km/hr and serial 2-km treadmill runs at 13 km/hr under 3 conditions: Running shoes with and without soft orthoses, military boots with and without soft orthoses
- In vivo strain in the tibia during runs (Tibial strain tension and compression)



Ekenman I, Milgrom C, Finestone A, et al: Am J Sports Med, 2002; 30(6): 866 - 870

Do soft insoles alter peak vertical loading rate and knee kinematics during running?

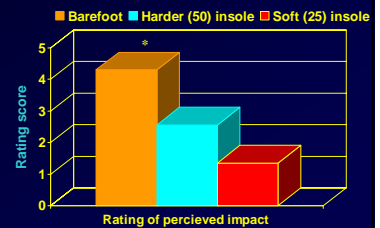
- 10 healthy non-injured runners
- Underwent 3D biomechanical testing
- Barefoot, Soft (shore 25) and harder (shore 50) insoles



Arendse R, Schwellnus M, et al, 2003

Can the runner’s brain distinguish between different types of soft insoles?

- 10 healthy non-injured runners
- Randomized into running barefoot and with soft (25), and harder (50) insole
- Rating or perception of impact

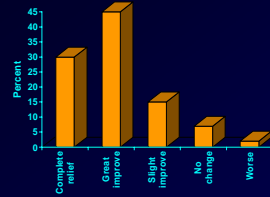


Arendse R, Schwellnus M, et al, 2003

Conclusion 4

- There is good scientific evidence to support the hypothesis that soft insoles reduce the risk of injuries by a reduction in the vertical impact loading rate
- Soft insoles reduce the rating of perceived impact
- The brain (central nervous system) can “sense” the impact reducing effects of soft insoles

Are orthotic shoe inserts effective in the treatment of running injuries?



- Not a controlled study
- No group with no inserts for comparison
- Low scientific value



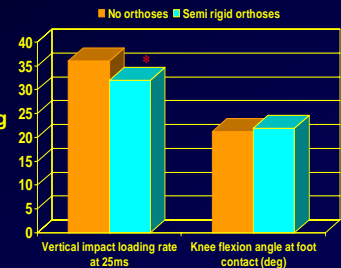
Gross et al, Am J Sp Med, 1991

Conclusion 5

- There is only anecdotal evidence to suggest that semi-rigid orthoses reduce the risk of running injuries (poor quality and small number of studies)

Do semi-rigid orthotics alter peak vertical loading rate and knee kinematics during running?

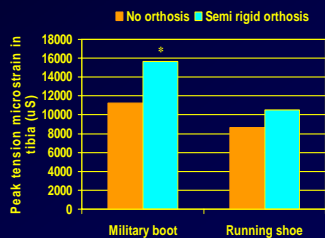
- 12 healthy non-injured runners
- Underwent 3D biomechanical testing
- No orthoses and custom made semi-rigid orthoses



Arendse R, Schwelinus M, et al, 2003

Do semi-rigid orthotics alter peak microstrain in the tibia during running with running shoes and with military boots?

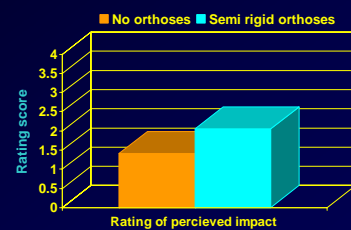
9 healthy uninjured males
Treadmill walking at 5 km/hr and serial 2-km treadmill runs at 13 km/hr under 3 conditions:
Running shoes with and without semi-rigid orthoses, military boots with and without orthoses
In vivo strain in the tibia during runs (Tibial strain tension and compression)



Ekenman I, Milgrom C, Finestone A, et al; Am J Sports Med, 2002; 30(6): 866 - 870

Can the runner's brain distinguish the impact when running with an orthotic?

- 12 healthy non-injured runners
- Randomized into running barefoot and with soft (25), and harder (50) insole
- Rating or perception of impact



Arendse R, Schwelinus M, et al, 2003

Conclusion 6

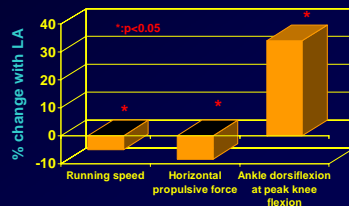
- There is some evidence that semi-rigid orthoses alter foot biomechanics and decrease “pronation”
- There is some evidence that semi-rigid orthoses increase peak tibial microstrain
- Semi-rigid orthoses do not reduce rating of perceived impact compared to bare foot running
- There is no reduction in the perception of impact when wearing semi-rigid orthoses

Summary

- The conventional model (anti-pronation model) of running injuries does not fully explain the beneficial effects of shoes, inserts and orthotics on running biomechanics and injuries
- The central nervous system (brain) can distinguish footwear characteristics, in particular “impact”
- Impact is related to the rate of loading on the lower limb

How does the nervous system sense impact and does this influence running biomechanics?

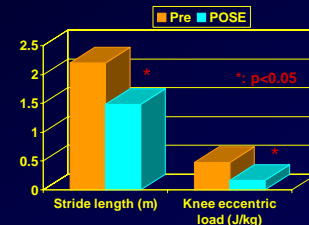
- 10 healthy non-injured runners
- Randomized into running with local anesthetic applied to the foot (LA) or control (CON)
- Lower limb kinematics and kinetics assessed in controlled laboratory environment (Vicon system)



Rayner R, Schwelinius M, et al: 2003

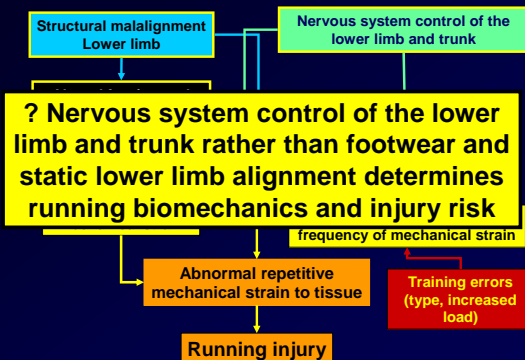
Can a runner's brain be “retrained” to alter running style and therefore running biomechanics?

- 20 healthy non-injured runners
- Underwent biomechanical testing
- Training for 1 week (4 hours) in a novel running style (POSE)
- Re-tested in biomechanics laboratory



Arendse R, rAzevedo L, Schwelinius M, et al, MSSE, Feb 2004

2003 “Nervous system control” era



Guidelines for prescriptions of running shoes, inserts and orthoses (2003)

1. Conventional evaluation of runner lower limb alignment (biomechanics)
2. Match the runner limb alignment to the running shoe
3. Comfort and perception of sensation (impact) is most important
4. Biomechanical testing in the laboratory

Running shoe, insoles and orthoses prescription in the future?

1. The current set of **criteria** used for biomechanical evaluation of a runner to determine injury risk is **changing**
2. Running shoes, insoles and orthoses that enhance the **nervous system control** of biomechanics likely will become important (**Proprioception**)
3. Running shoe construction will change from focus on the shoe/surface interface to the **sole/shoe interface**
4. The role of orthoses will become more important (**different model**)



Thank you for
your attention

