SKELETAL MUSCLE FUNCTION
–
INTERVENTIONS ATTACKING ACUTE AND OVERUSE INJURIES
–
SUMMARY

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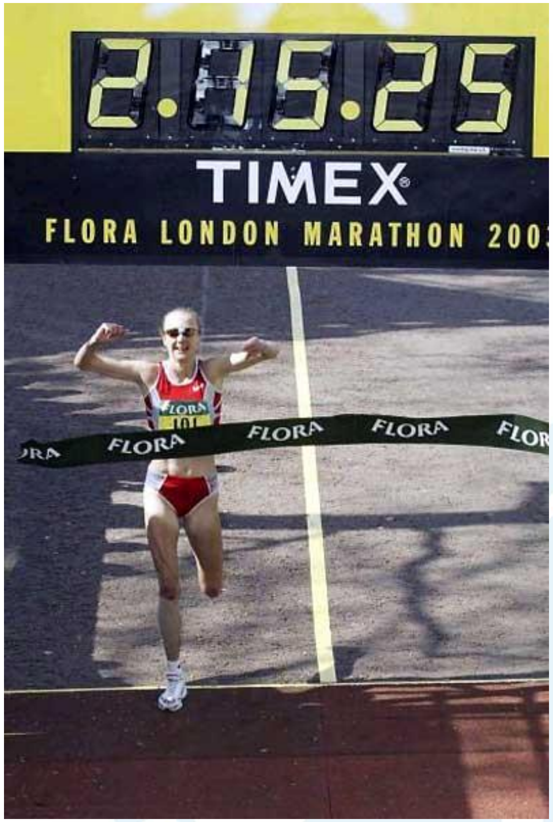
Background

Oxygen consumption is decisive for distance running performance

Main approach: Cardiovascular training

→ Training methods!

However, mechanical alterations may provide a basis for further increases: BW, technique, footwear



Background

No gain by using an 'energy return' shoe

(Mercer et al 2003)

1.1% decrease in VO_2 consumption

(Morgan et al 1996)

Oxygen consumption can be varied by 1 – 2%

(Frederick 1984)

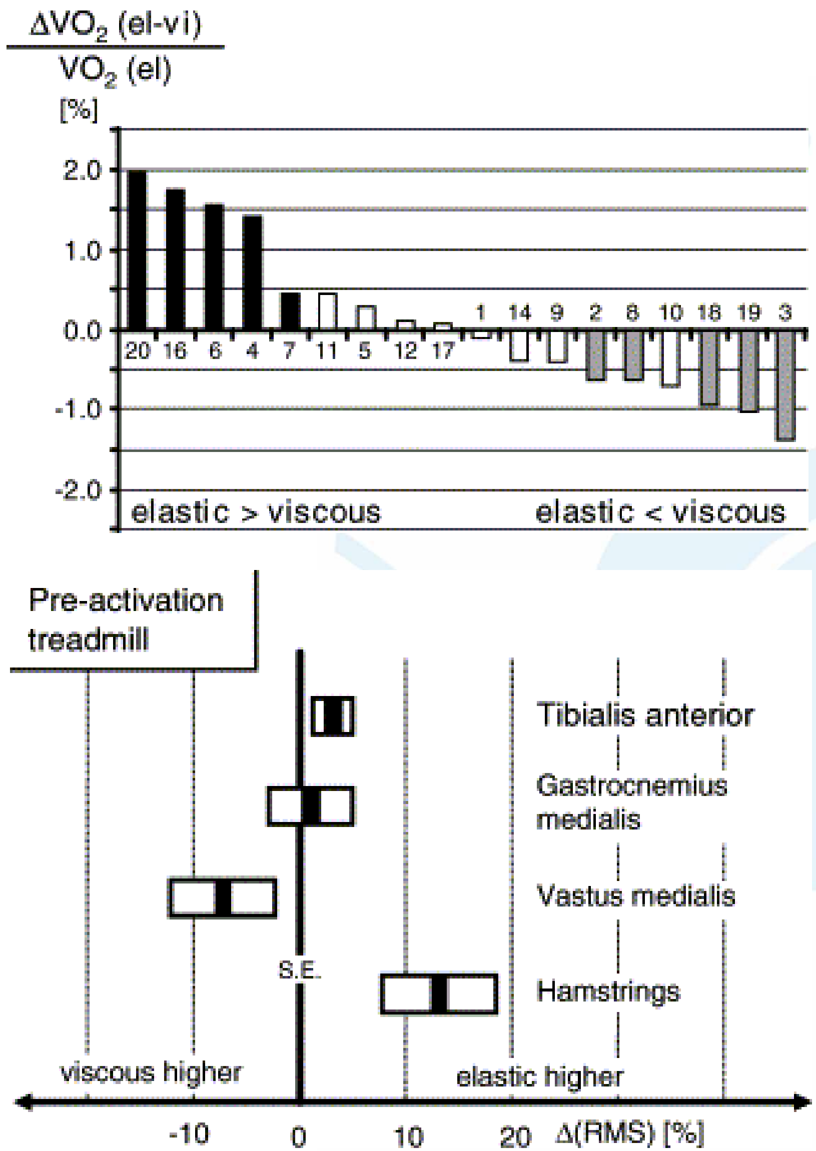
Background

- Comparison of VO_2 and EMG changes by elastic versus viscous midsole:
- VO_2 and EMG not systematically changed
- Individual response partly explained by EMG

(Nigg et al 2002)

- Significant differences between most and least comfortable shoe

(Nigg 2001)



Purpose

Relate effects of medial and lateral heel inserts on rearfoot motion, VO_2 consumption, muscle activation and comfort during treadmill running.

Hypotheses

Individual responses!

VO_2 changes relate to changes of neuromuscular effort

VO_2 changes relate to perceived comfort

Methods

Participants

9 recreational runners

age = 23 - 40 yrs

BW = 70.6 ± 7.1 kg

height = 1.74 ± 0.07 m

Regular training ≥25 km/wk

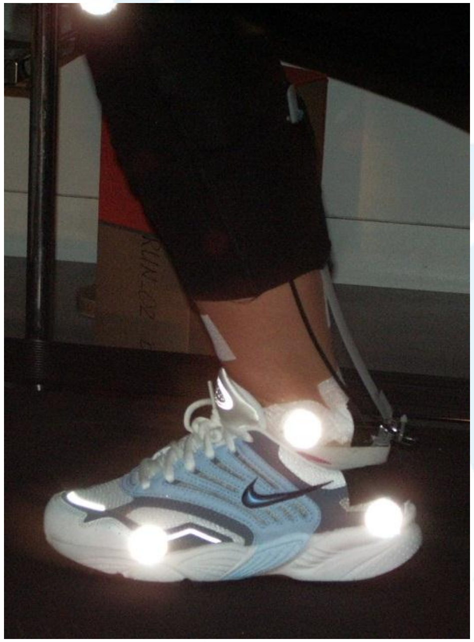
No injuries >3 yrs, ‘neutral’ feet

Methods

Electromyography

Bipolar surface EMG (biovision) from 8 muscles; left thigh & leg

VM, VL, BF, TA, PE, GM, GL, SO



Kinematics

Customised rearfoot goniometer

Sagittal plane video (Basler, 101 Hz)

Tibial accelerometer & synch unit (biovision)

→ Recorded onto datalogger (compaq)

Methods

Oxygen Consumption (VO_2)

MOXUS VO_2 analyser system; expiratory volumes of CO_2 and O_2 (15 s intervals)

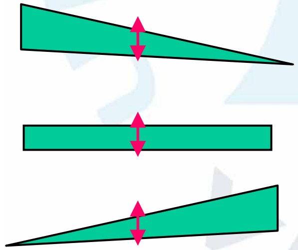
Protocol

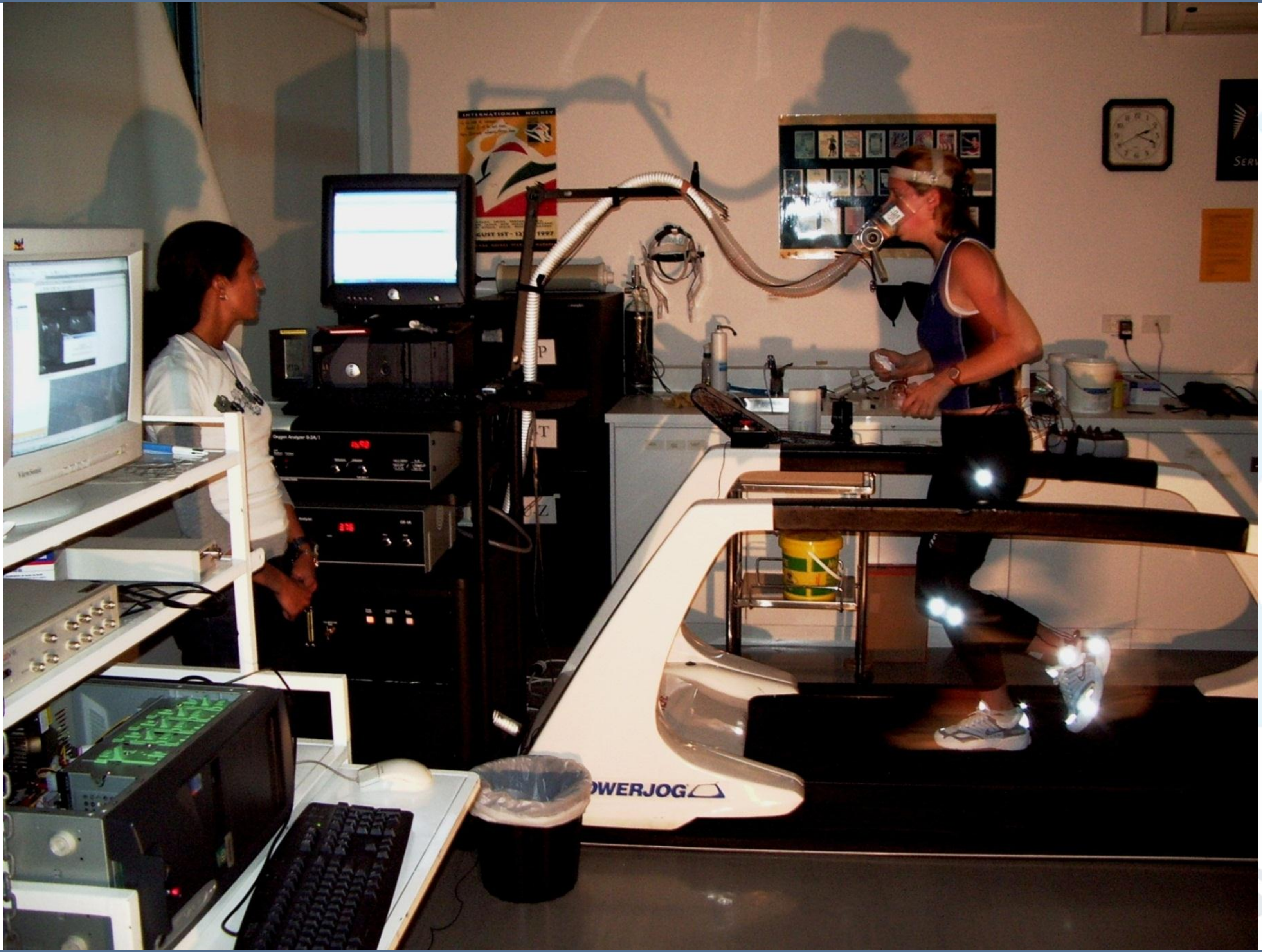
Preparation

Familiarisation (5 – 10 min) (Quinton treadmill)

Run at ~70% of 5k time

For 3 x 16 min with 6 – 8 min breaks




OWERJOG

Assessment/Analysis

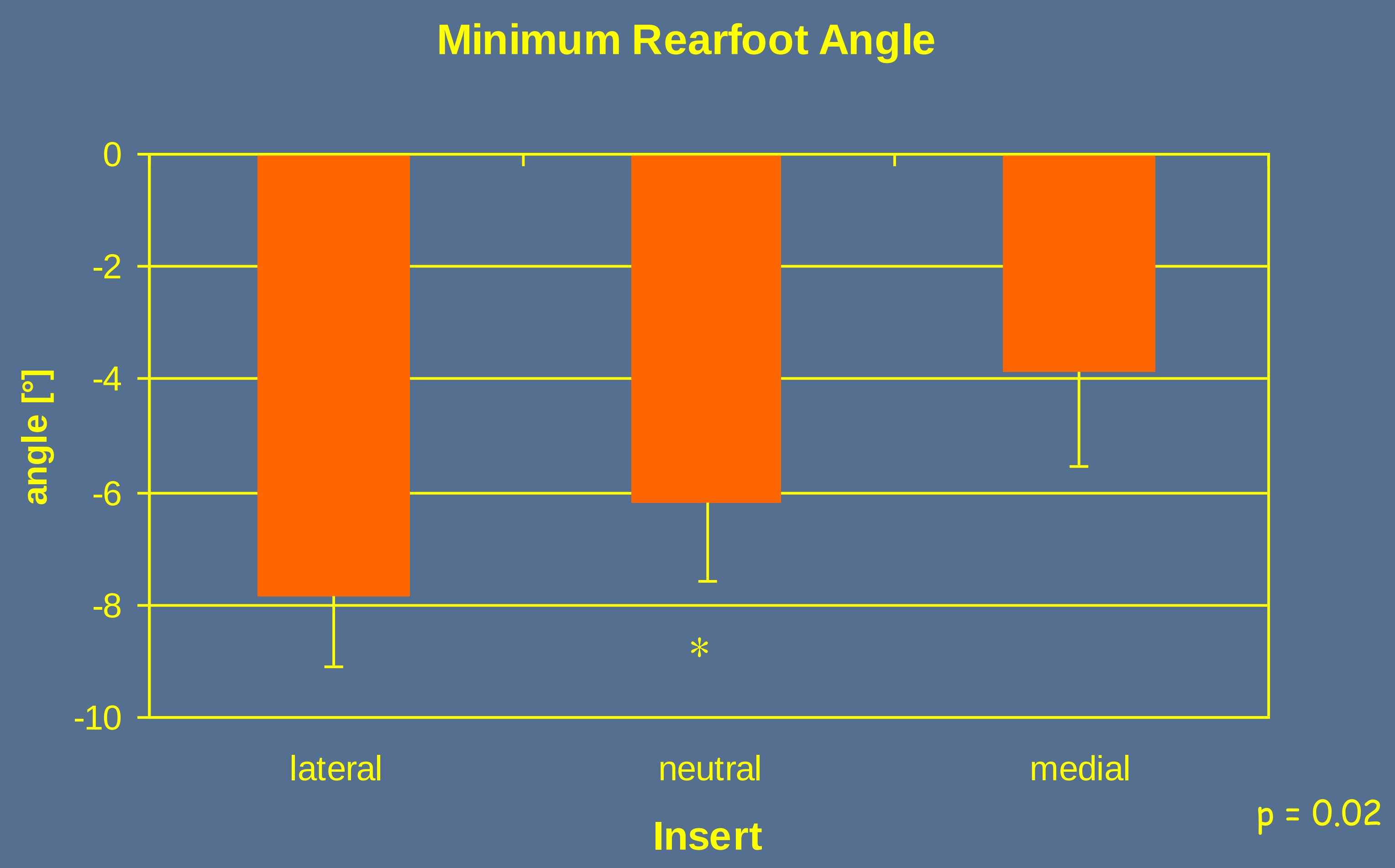
EMG: rectified, integrated over stride cycle → 'neuromuscular effort'

(Moritani et al 1993)

- Maximum eversion from barefoot reference
- Stride frequency, knee and ankle kinematics
- VO_2 (average: 10^{th} & 11^{th} minute)
- VAS (0 – 10) of perceived exertion and comfort
- Heart rate

Results

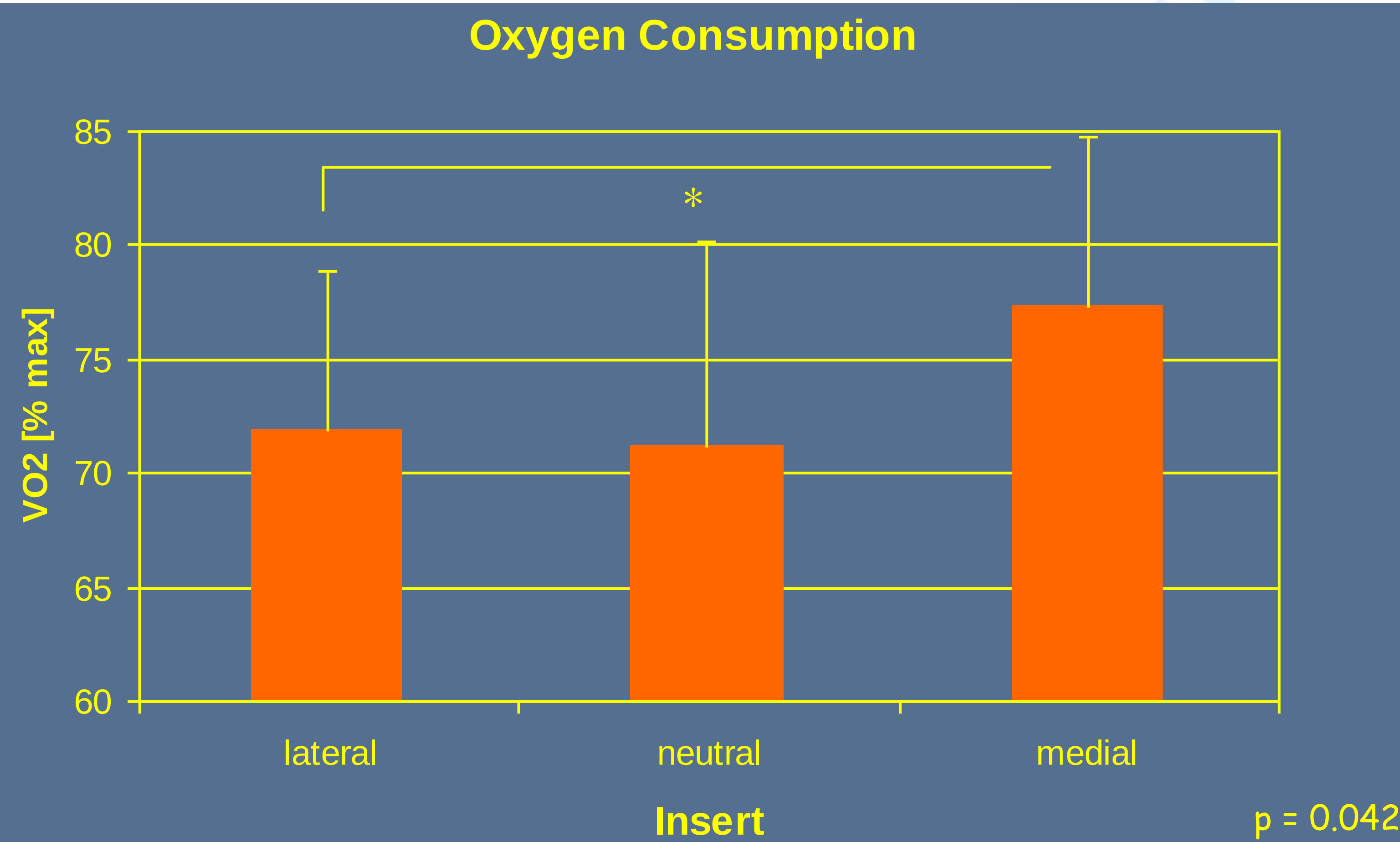
No alterations in knee or talocrural joint kinematics



Results

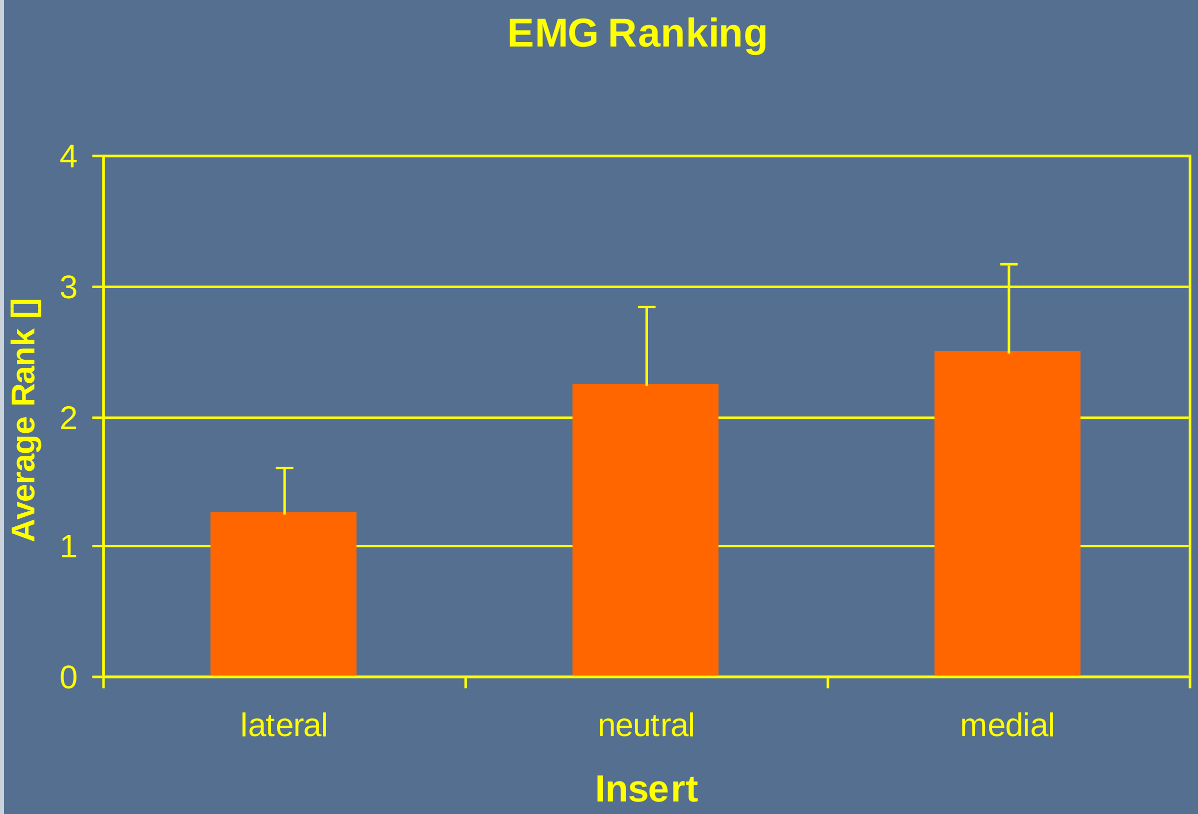
Vo$_2$: no order effects

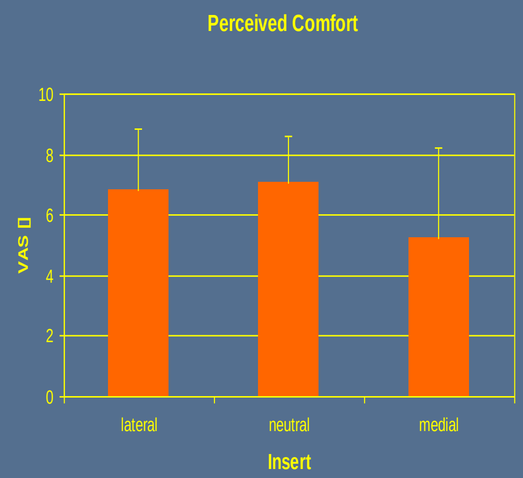
→ subjects were running at steady state



Results

160 - 105 – 149 mVs → 3 – 1 – 2 ; 8 muscles





Discussion

Rearfoot motion was systematically altered

Magnitude of changes was overall 'smaller' than the intervention

Oxygen consumption varied significantly: medial shoe demonstrating highest values

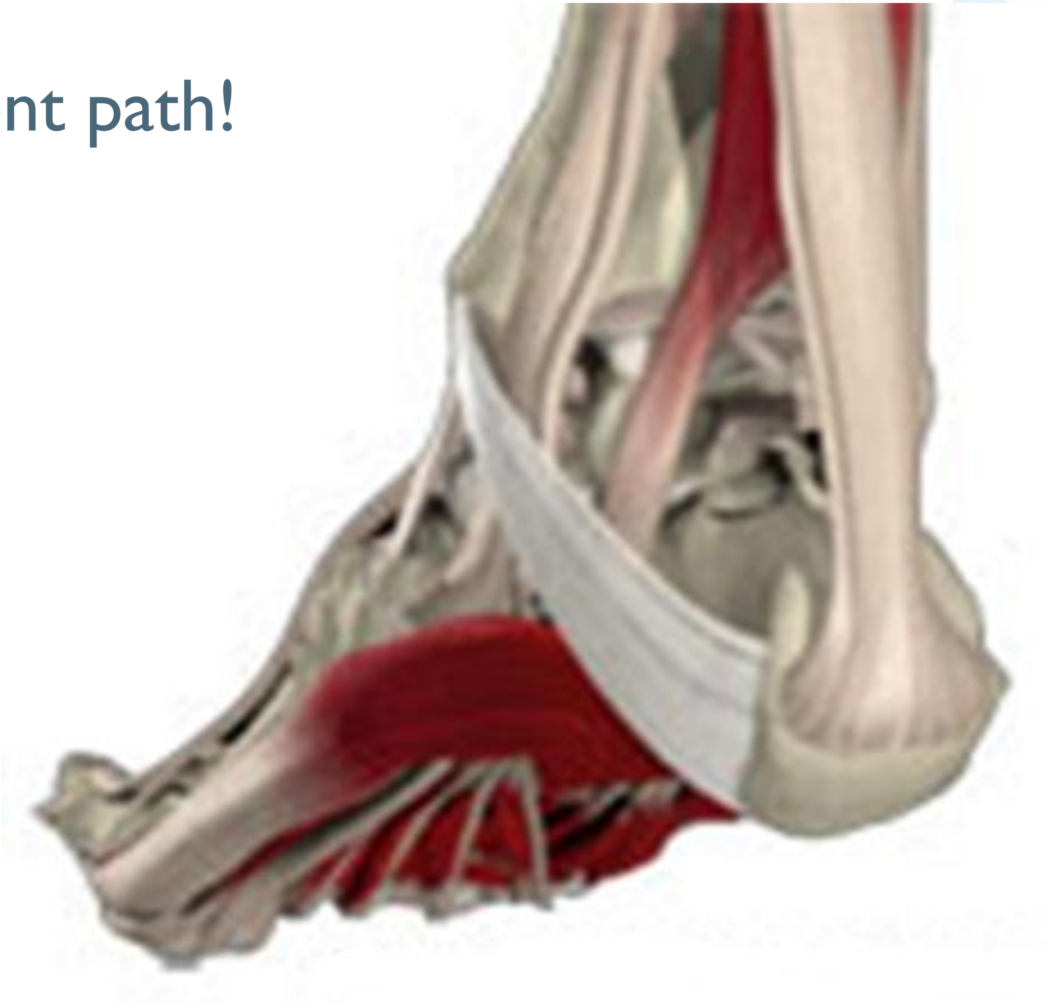
Integrated EMG corresponds to VO_2

At best, a trend for perceived comfort relating to energy expenditure was observed

Discussion

Explanation?

Preferred movement path!



Discussion

Explanation?

Preferred movement path!

Muscle forces needed to maintain joint congruence

Soft tissue vibrations?

Implications for fatigue → injury

Conclusion

Footwear induced alterations of rearfoot movement affect muscle activity and total energy consumption

A certain amount of physiological pronation is necessary

Musculoskeletal system may attempt to maintain joint congruence by muscle forces

Need to identify factors determining the 'preferred movement path' of individuals

The effect of 'controlled' slip on muscular activity and GRF during change in direction tasks

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DEPARTMENT OF HEALTH SCIENCE AND TECHNOLOGY

Introduction

- Lateral ankle sprains =
  - most common injury in many sports
- Importance considered
  - less than knee injuries (ACL)
- Long-term effects often under-estimated

(Larsen et al., 1999)

- Injury mechanism of non contact ankle sprains
  - unknown

(Bahr & Krosshaug, 2005)

Introduction

Combined plantar-flexion & inversion → Supination torque exceeds structural limits of ankle joint complex

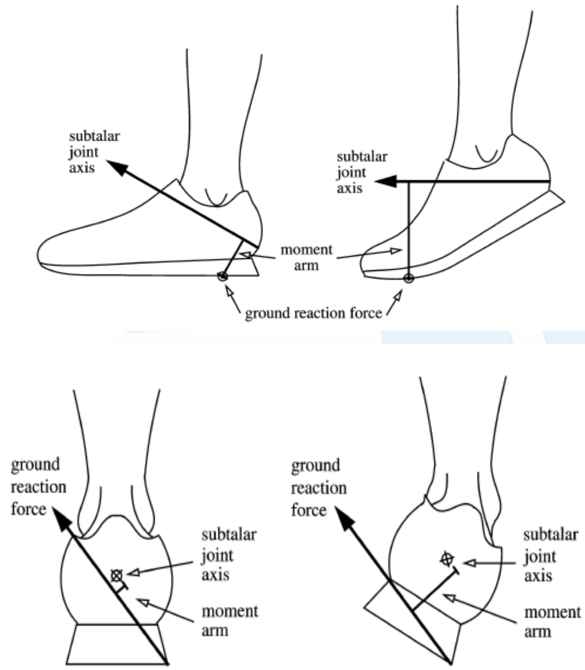
Factors?

Passive stiffness of ankle joint

Muscle activation pre and during contact → Reflexes

Foot position at TD (Wright et al., 2000)

Joint loading in early contact phase

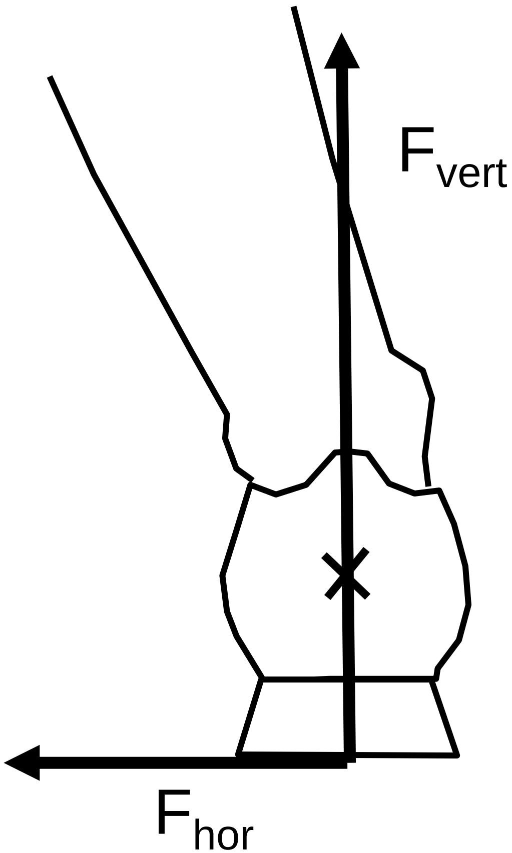


Early contact

Traction/Friction?

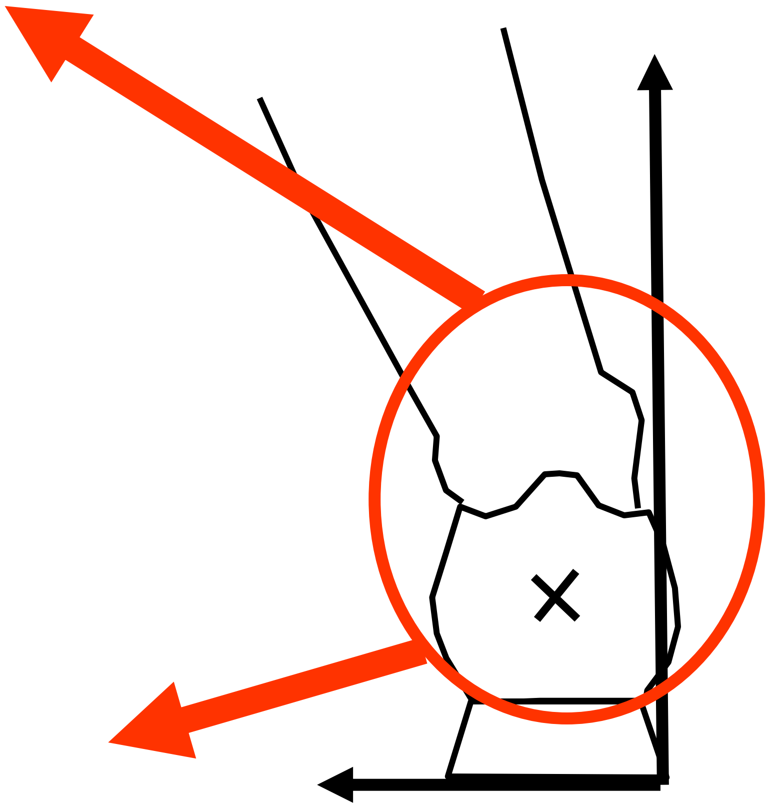
Sliding?

Rest of the body?



Early contact

GRF, vertical and horizontal components



Traction/Friction?
Sliding?
Rest of the body?

Muscles, mainly PL, TS, TA

PURPOSE

To assess the effect of small slip episodes during early ground contact in turning movements

How do ground reaction forces alter?

What changes can be observed in the EMG of lower extremity muscles?

Methods

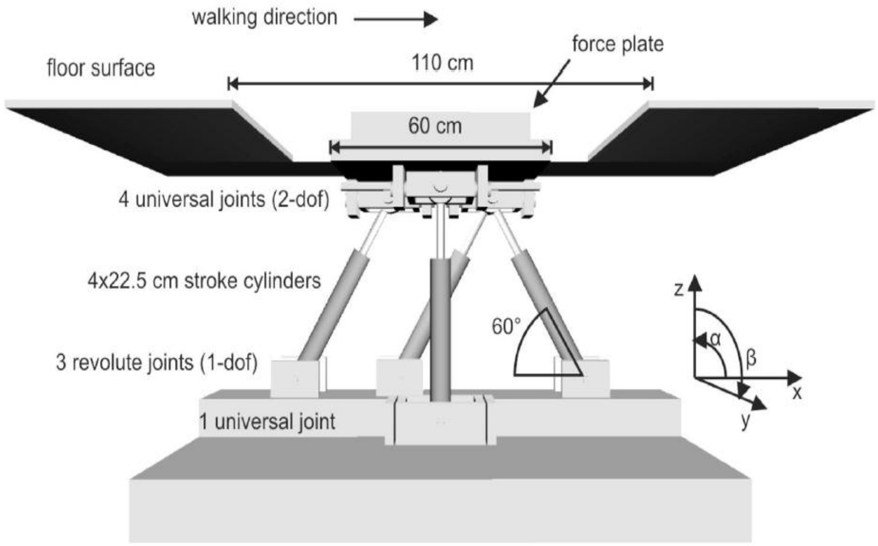
Subjects

	N	BM [kg]	Height [m]	Age [y]	Shoe Size	current train [h/w]	previous train [h/w]
Mean	13	73.3	1.75	32	41.2	3.5	6.4
SD		12.5	0.09	8.3	2.7	2.5	3.1

Perturbator:

- 4 hydraulic actuators
- AMTI force plate on top
- reaction time: 13 – 15 ms

(Doornik & Sinkjær, 2007)



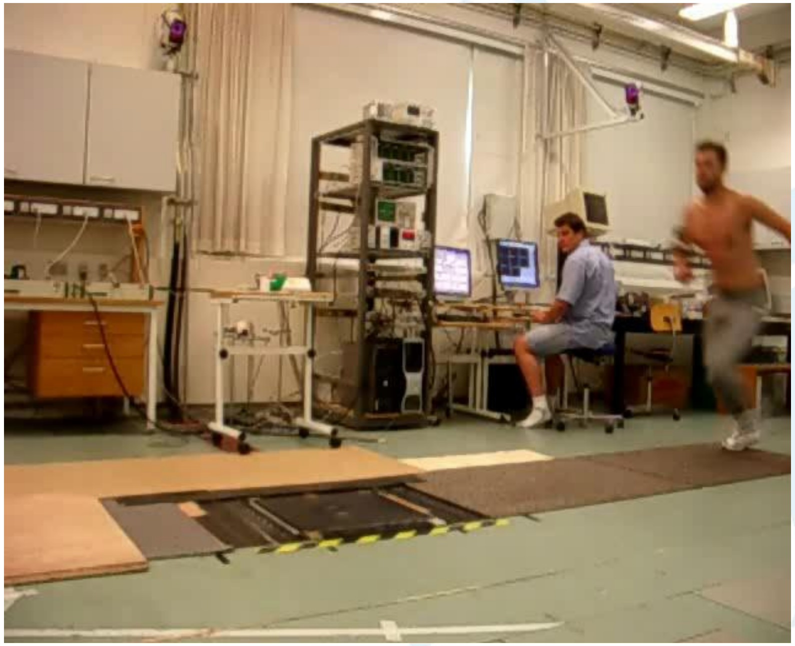
Data collection & analysis

GRF (2400 Hz); corrected for inertia effects of moving platform (MatLab 7.4), filtered at 65 Hz

- Min1 and Max1 of horizontal and vertical components

EMG (2400 Hz); Noraxon Telemyo, bandpass filtered (20 – 600 Hz), rectified, integrated:

TA,GM,GL,SO,PL,VM,RF,BF



0 ms - 120 ms: 'reflex'

120 ms - TO: 'voluntary'

Experimental procedure

Warm up – instructions & no platform movement

Familiarization – incl. platform movement

Measurement - 40 valid trials, 8 per condition

- foot on platform, no double contact
- random application of platform movements:

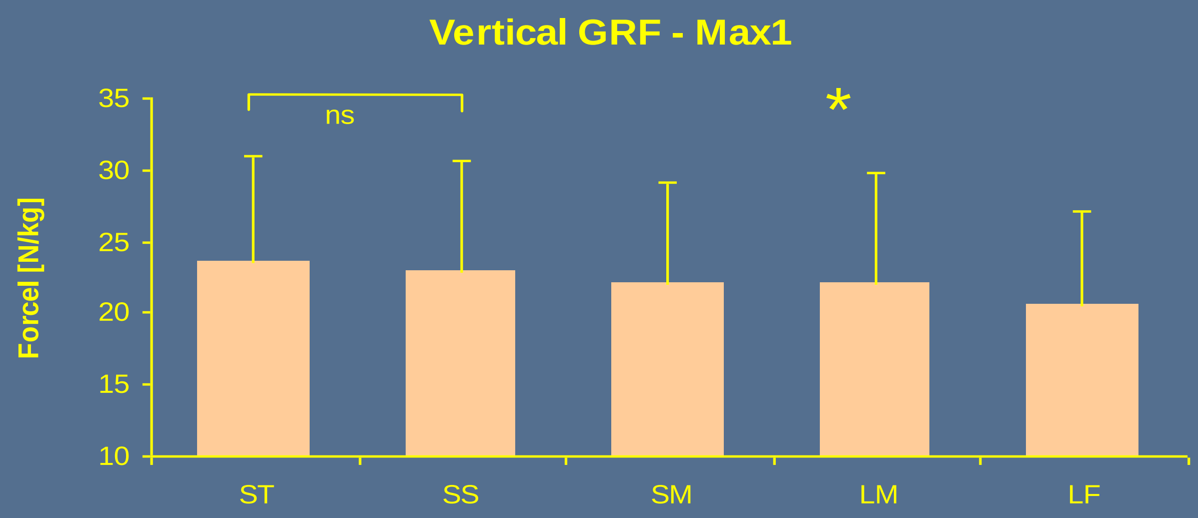
still (ST)

3 cm/242 ms (SS) 3 cm/121 ms (SM)

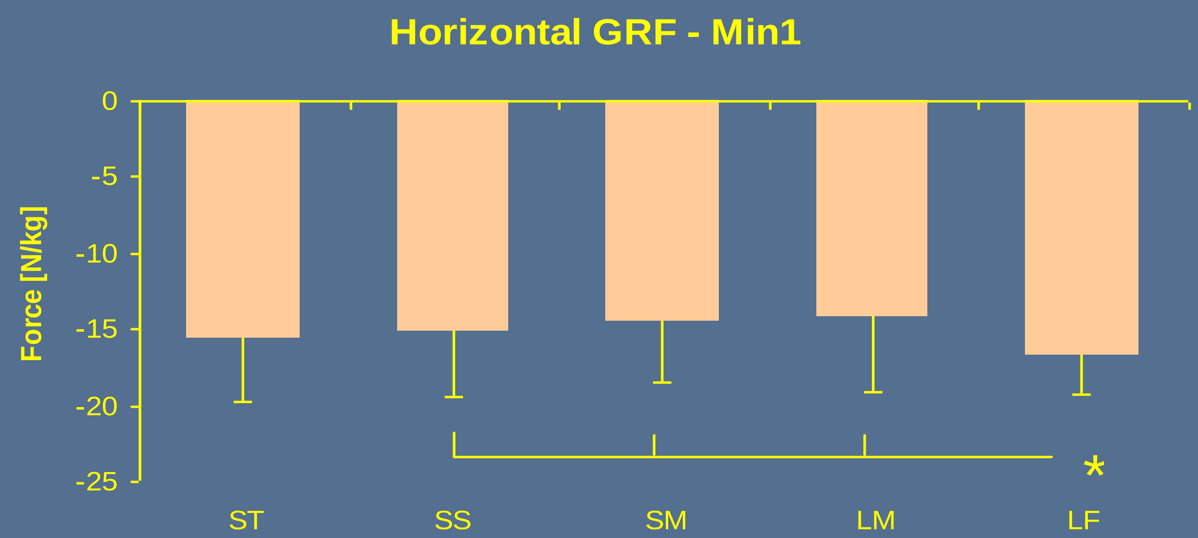
6 cm/242 ms (LM) 6 cm/121 ms (LF)

Results

vertical GRF decreases with increasing slip amplitude and velocity (15%)

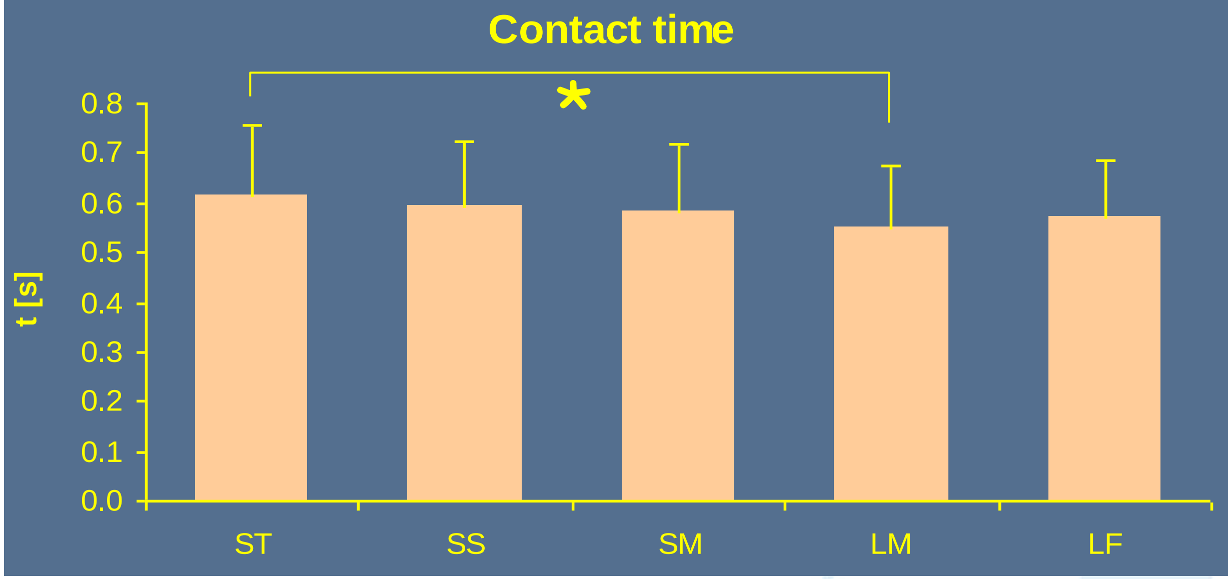


horizontal GRF decreases ’similarly’ but maximum value at LM slip (16%)



Results

contact time decreases with minimum at LM (10%)

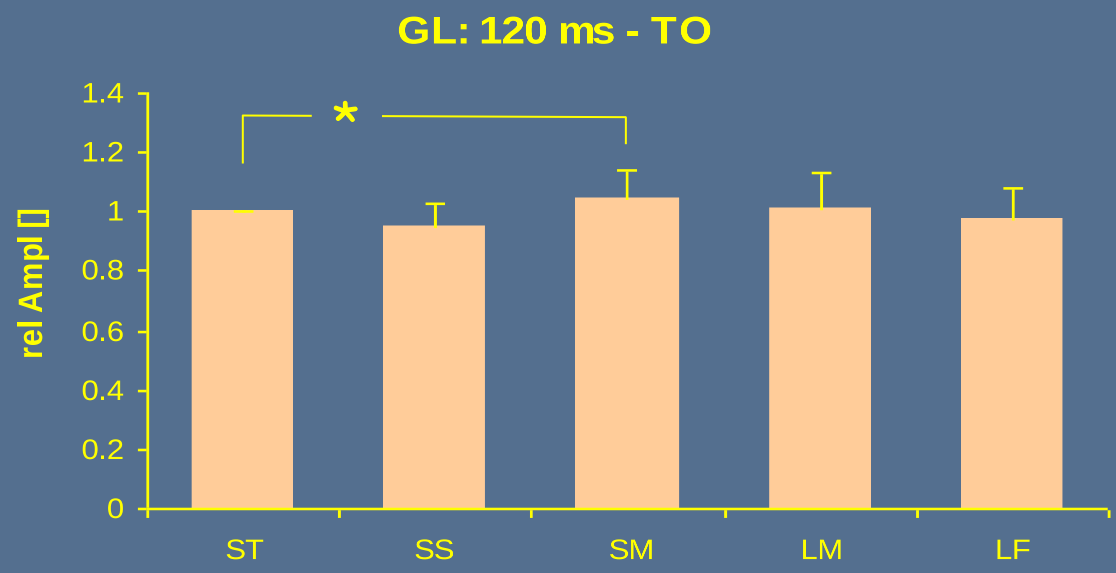


Muscular activity

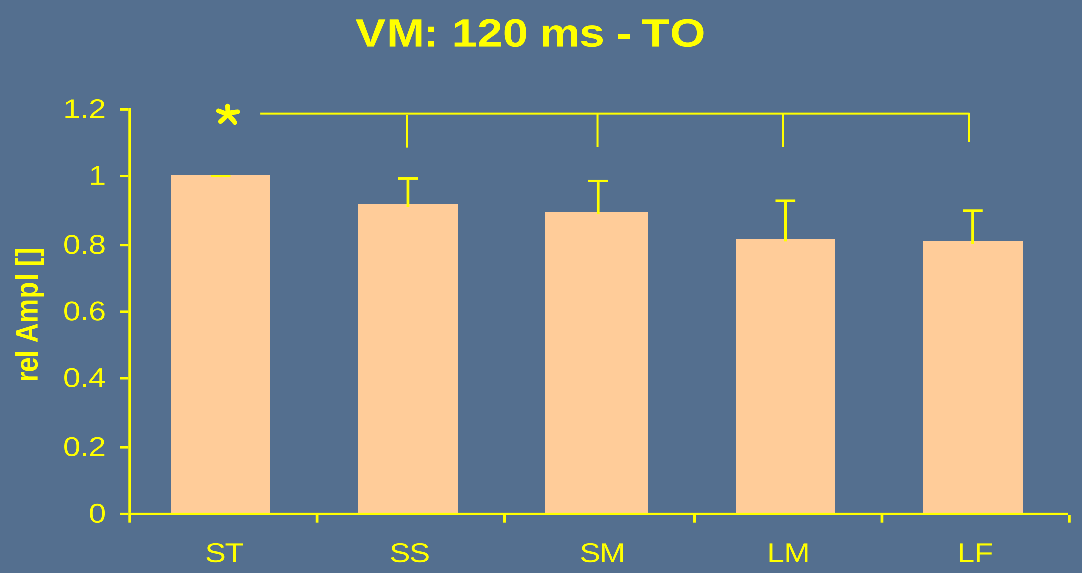
- no change in pre-activation EMG (-150 ms – TD)
- no modulation of EMG in reflex window (0 - 120 ms after slip onset)

Voluntary

GL significantly elevated in SM condition (9%)



VM consistently decreases with increasing amplitude and velocity



Discussion

- GRF reduction bears the potential to reduce joint loading
- Horizontal forces are minimal for LM → optimum slip condition!
- Shorter contact time indicates better use of stretch shortening cycle
- No EMG alterations during typical reflex time window
- Changes in EMG: knee extensors show lower activation → more efficient movement!

Conclusion

- New method; suited to comprehensively assess loading under slipping conditions
- Slipping reduces GRF maxima and changes alignment of force vector
- No modulation in reflex; BUT significant changes in voluntary activity in key muscles
- Further research: joint loading – individual muscle contributions - slip at different times

Acknowledgements

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spar nord tættere på

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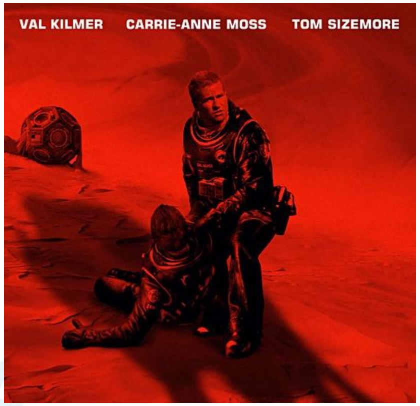
Summary

Muscle activity is affected by medio-lateral movement changes → fatigue, overloading, long term effects need to be addressed

Muscle activity is affected by 'slipperiness' of surface immediately during execution of cutting manouevres → safety options for sport surfaces, footwear & performance

Mission to Mars?



Travel Time: 214 days (one way)

Gravity on Mars: 38% of surface of our planet

What happens when exposed to micro gravity for short or considerable time periods?

- To skeletal muscle
- To tendon (other tissues, other systems)

Explain based on the information provided in the course! (2 pages)

How to counteract (before, on the trip and retraining on earth)?

- What training paradigms can be used to 'address' the different tissues?
- What devices/programs have been suggested?

Suggest the obvious from the course contents – add from additional literature! (2 pages)