Development of overuse injuries at the foot & knee in sport

- Solutions to prevent or rehabilitate with orthoses and shoes -

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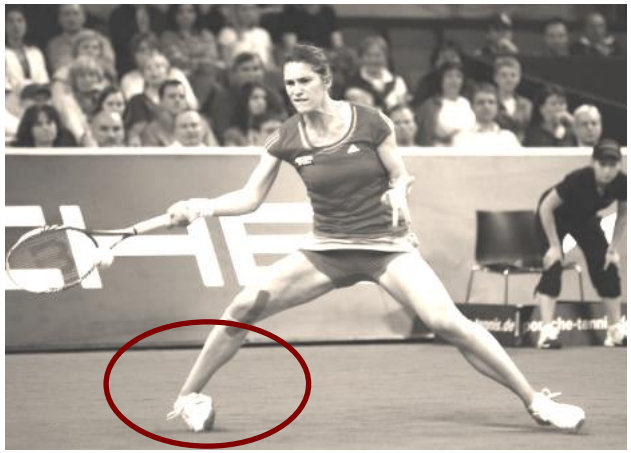
Definition **SPORT INJURY:**

Sudden trauma leads to damage of the skeleton (Fracture, Luxation, Ligament Rupture).

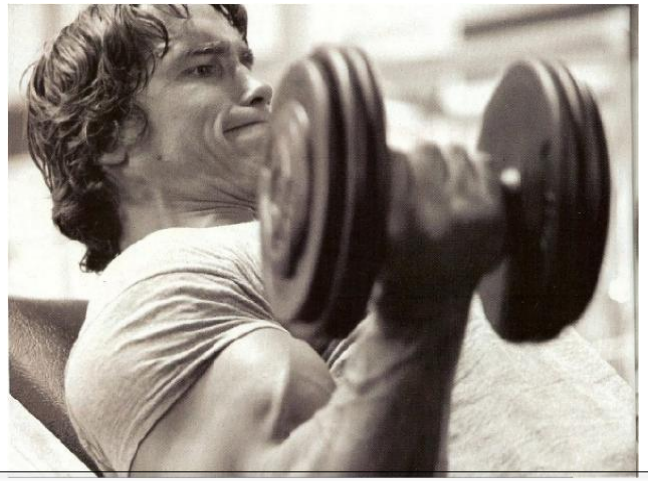


http://sportbild.bild.de/SPORT/sportmix/tennis

Definition **OVERUSE:**

Continuous micro traumata leads to limited damage of the skeleton. Dysbalance between repetitive stress and ability of tissues such as ligaments, bands, muscles, bones and apophysis to regenerate.

(Wernberg, 2005)



http://www.ironmagazine.com

Next to acute traumata, (chronical) overuse injuries at the musculskeletal system are responsible for reduction or drop-out from training/competition and loading capacity in elite and recreational sports (all sports)

Running shows particularly high incidence rates
- 30-65% of all runners generate an overuse injuries per year

- 70-80% of overuse injuries are at the lower extremities

Hein et al. 2014

Soccer also shows particular high incidence rates
-26-76% Overuse injuries per year

Junge et al. 2004, Hawkins et al. 2001, Dupont et al. 2010

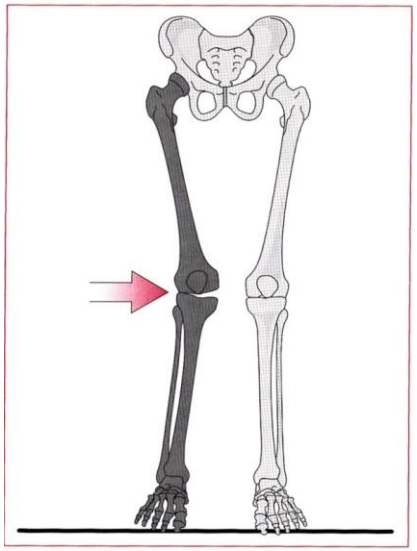
Development of overuse injuries multi factorial:

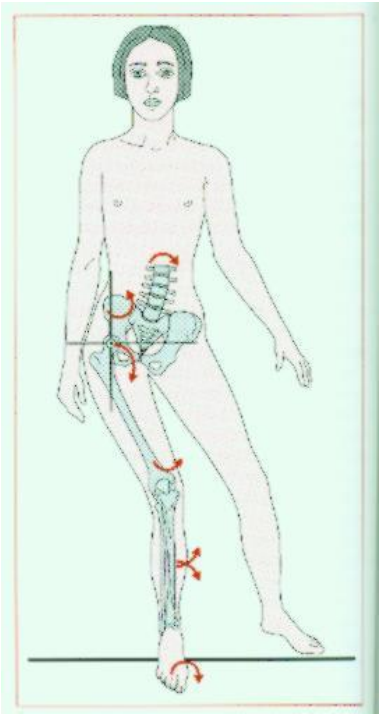
- Biomechanics
- Clinics
- Training

Biomechanical riskfactor 1: Leg alignement (stability vs. Instability)

Valgus leg axis in dynamics and „Medial Collapse“

- Increased Adduction und Internal rotation of Femur
- Increased drop of pelvis on opposite side
- Increased internal rotation of tibia
- Increased subtalar pronation





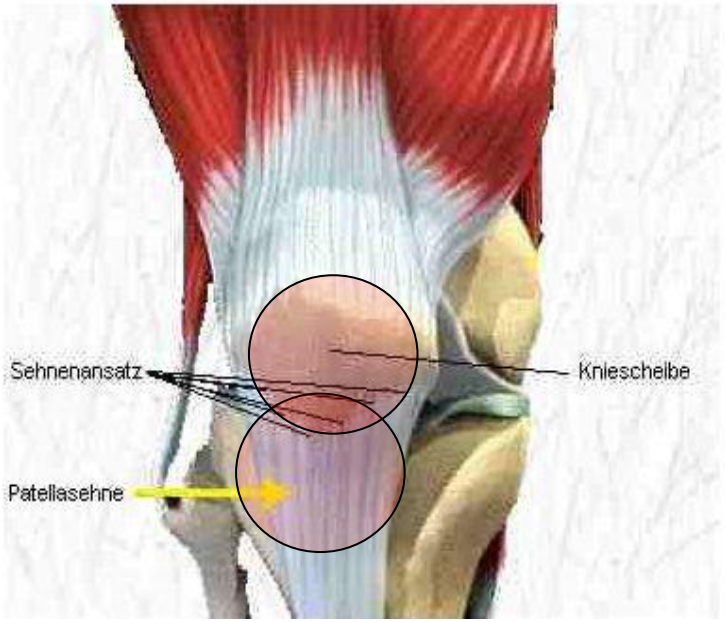
-> Lead to increased tension of muscles (Triggerpoints), typically tractus iliotibialis, gluteal/piriformis, lumbal, calf

Krauss, I. et al. 2007

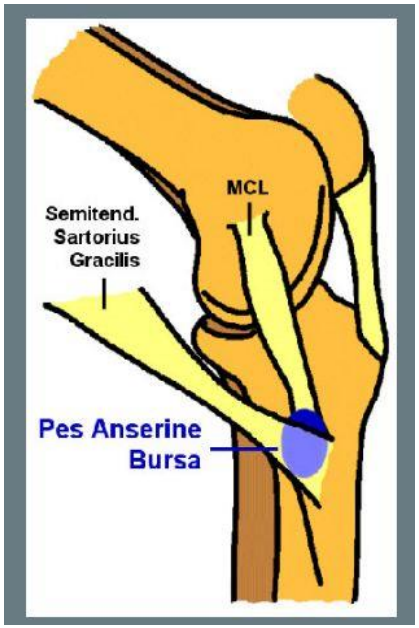
Noehren et. al et al. 2007

Possible & common location of pain (valgus)

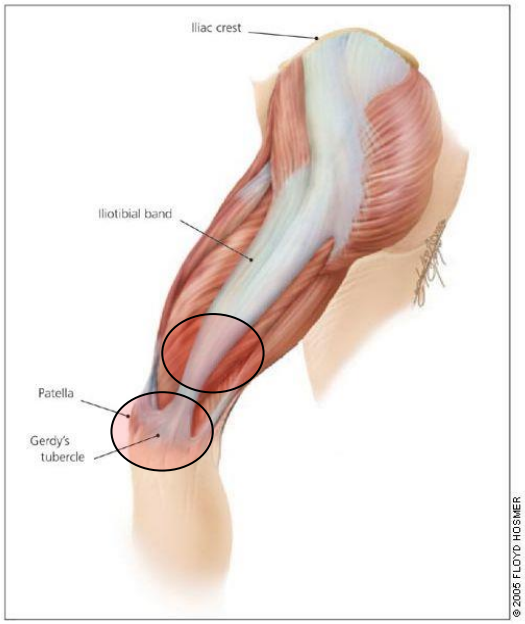
Tip of Patella, retropatellar



Pes anserinus



Iliotibial Band



Causes of Instability of Leg Axis

- Deficits of hip stabilizing muscles and leg muscles
- Dysbalance of hip stabilizing muscles and leg muscles (Agonist-Antagonist; right-left)
- Coordination Deficits in stabilazing leg axis
- Increased Mobiliy at the hip (internal/external rotation)
- Overcrossing (Running style)

			Below average	Ref. area	Above average
Mobility	Hip and knee	200 Knee extension right		+2%	
		200 Knee extension left		+2%	
		200 Knee flexion right		+3%	
		200 Knee flexion left		+3%	
		310 Abduction		0.0%	
Strength	Hip and knee	200 Knee extension right		+4%	
		200 Knee extension left		-2%	
		300 Knee flexion right			+21%
		300 Knee flexion left			+16%
		310 Abduction			+12%
		320 Adduction			+5%

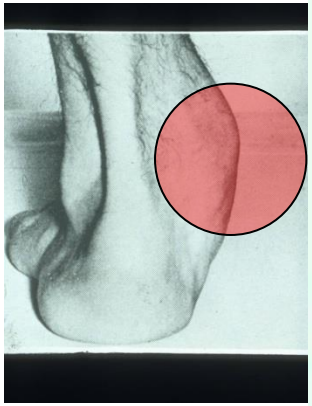
Noehren et al. 2007, Grau et al. 2008

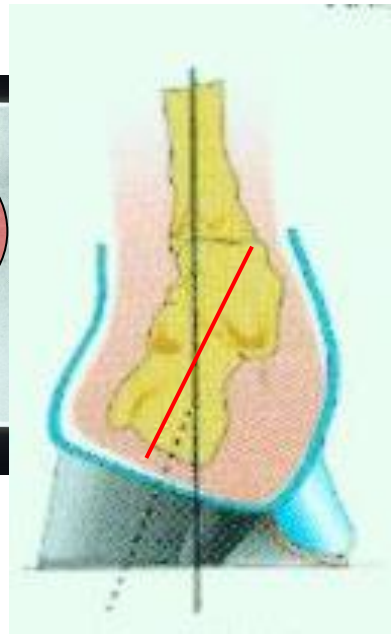
Biomechanical riskfactor 2: Ankle alignement (stability vs. Instability)

„Overpronation“ at stance phase

Lowering of longitudinal arch and increased inversion of calcaneus and lowering of metatarsal bones (+ velocity)

-> Increased internal rotation of shin (lower leg) (coupled movement)





Lead to increased tension of muscles (Triggerpoints), typically at the calf (also hardening of calf)

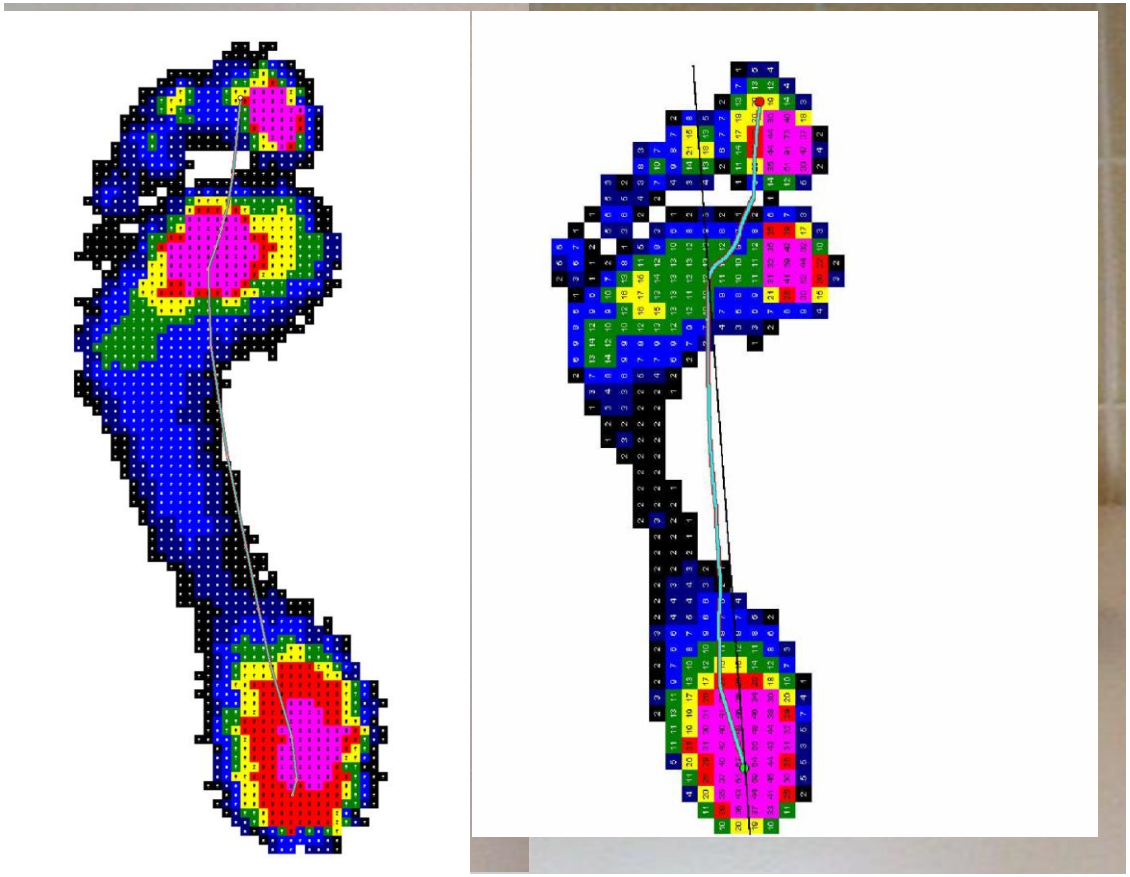
Davis et al. 2010

Krauss, I. et al. 2007

Grau, S. et al. 2008a,b,c

Videos overpronation

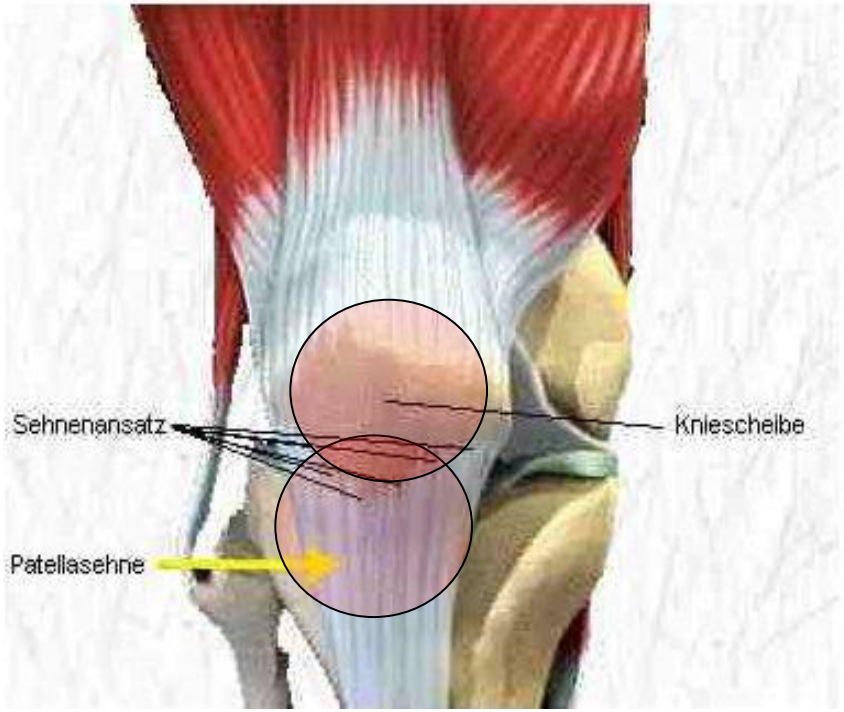
- Further Aids (Methods, used shoes, used orthotics)



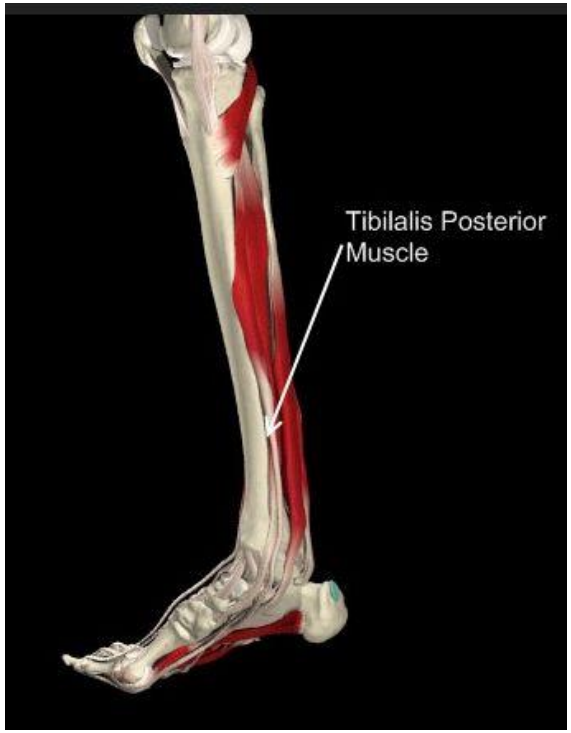
Possible & common localization of pain

Achilles Tendon (Paratendon and Tendon itself)

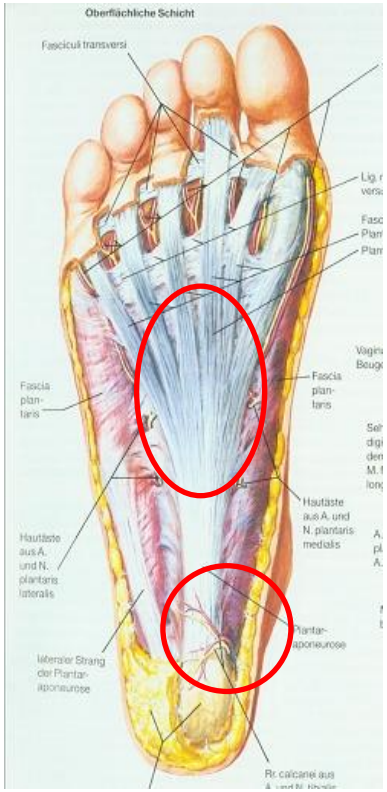
Tip of Patella, retropatellar



Shin medial



Plantarfascia



Causes of Instability

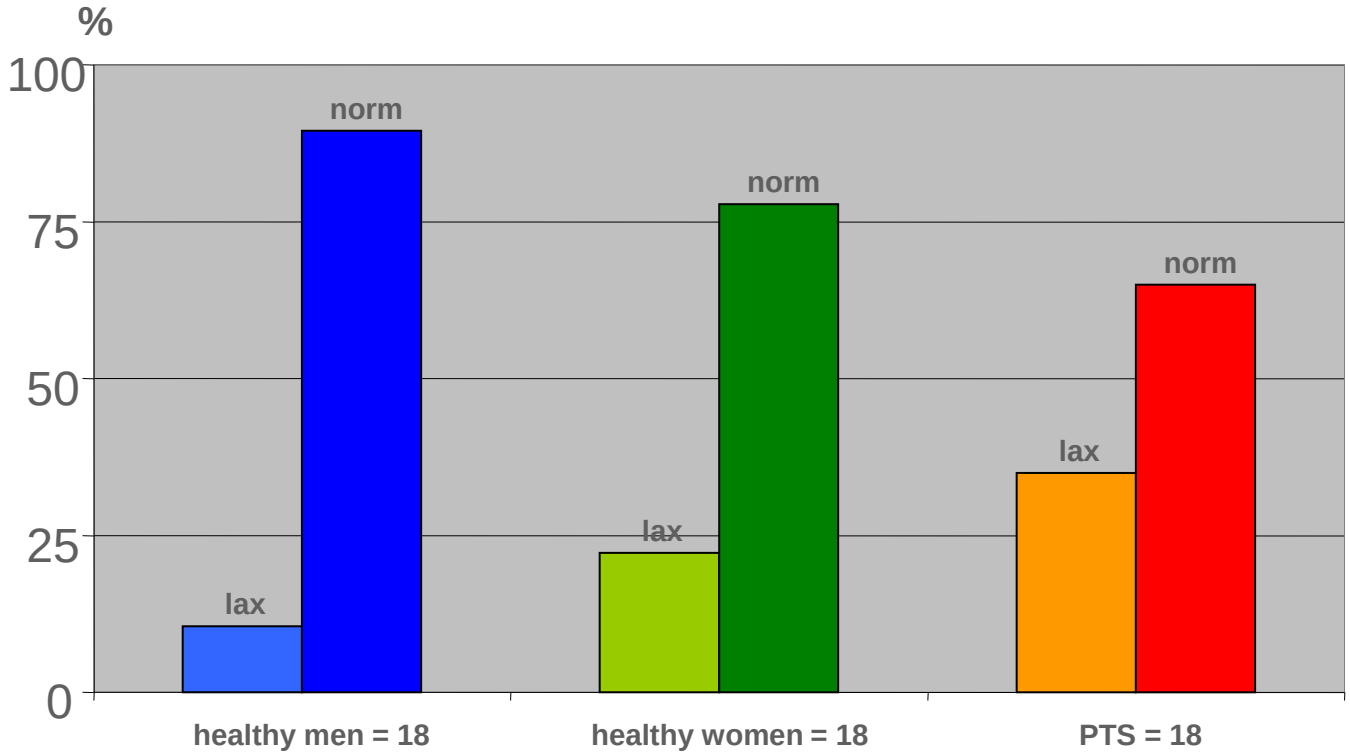
- Deficits or Dysbalances of ankle stabilizing muscles
- Coordination Deficits foot and leg axis
- Hypermobility at the ankle joint (frontal)

Krauss, I. et al. 2007

Grau, S. et al. 2008a,b,c

Clinical riskfactors (examples)

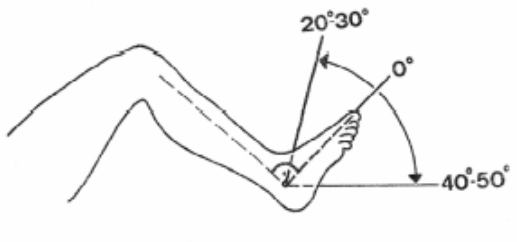
Laxity of Ligamentum Collaterale (e.g. PTS)



Krauss, I. et al. 2007

- Shortened muscles, mostly hamstrings, calf & hip flexors (rectus & iliopsoas)
- Decreased ROM ankle

Ankle Dors./Plan.



Normal: Dext: 20-30

Plan: 40-50

Training risk factors (examples)

Training variables (all overuse injuries, here PTS)

	T-amount (Km/w)	T-Velocity (km/h)	T-Units (week)	T-Time (h/week)
KO (n=18)	26	11.1	3.1	3.0
PTS (n=18)	37	11.3	3.4	3.4

Grau, S. et al. 2008c

Sport surface hard (PTS, ITBS), soft/uneven (AS, SS, PF)

	Soft (uneven)	Medium (slightly uneven)	Hard (even)
KO (n=18)	27%	37%	36%
PTS (n=18)	15%	40%	45%

Grau, S. et al. 2008c

Prevention and/or Therapy

a) Stabilization Leg axis

Active:

- Stabilization Training Ankle (e.g. theraband balance pad) and leg axis

Prevention and/or Therapy

a) Stabilization Leg axis

Active:

- Stabilization Training Ankle (e.g. theraband balance pad) and leg axis
- Strengthening of muscle deficits (hip abductors, quadrizeps), concentric and eccentric
- Reduction of muscular dysbalances

Active und passive (Physiotherapist):

- Improvement of Mobility/Flexibility (if decreased ROM) and Stretchung (if shortened muscles), typically hip flexors and hamstrings

Active:

- Muscle Detoning („Myofascial Release“, blackroll), typically
  Tractus iliotibialis, Gluteal/piriformis, Quadrizeps, Lumbal area, Calf

Passive (Physiotherapist):

- Muscle Detoning (Triggerpoints), typically

Tractus iliotibialis, Gluteal/piriformis, Quadrizeps, Lumbal area, Calf

b) Stabilization Ankle Joint

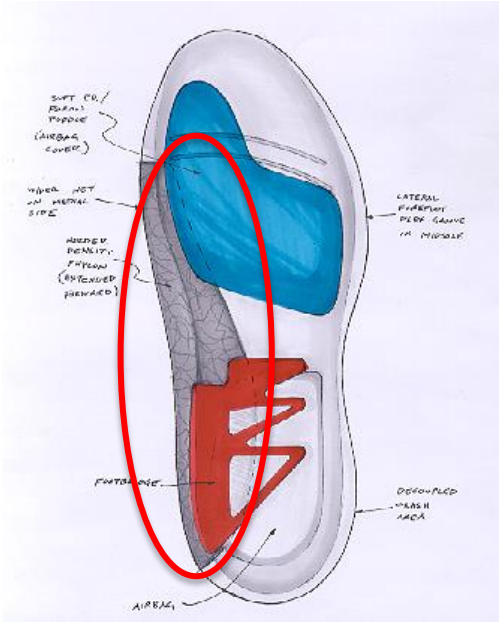
Active:

- Stabilization Training Ankle (e.g. auf Theraband Mat) and leg axis
- Strengthening of supinators (Tibialis Posterior, Soleus, Flexor hallucis longus, if possible also eccentrically) reduction of muscular dysbalances (left vs. right, Agonist vs. Antagonist)
- Barfoot Walking, walking in „Barfoot Shoes“ (e.g. Nike Free)

Passive:

Sport shoes, Running shoes

- Little torsion midfoot area
- Dual Density (running) not helpful



Heel cups

Firm and large heel cups (attached to binding)

Passive:

Sport shoes, Running shoes

Low rearfoot height (Spring Offset e.g. 10mm)

Rounded heel (only running)

Medial

Lateral

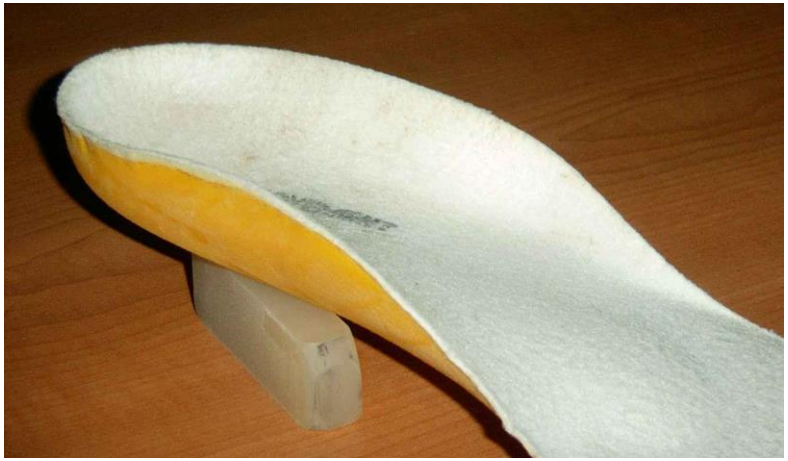
Passive:

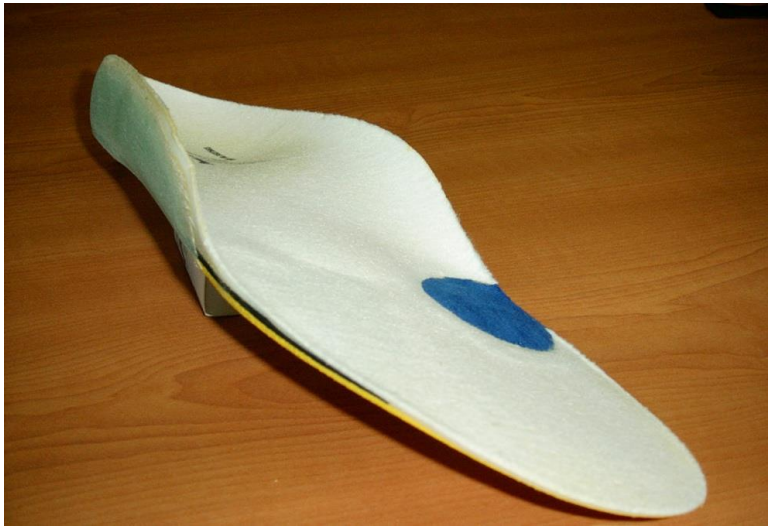
• Orthotics

- Heelcuped orthotics (plus firm material)

- Longitudinal arch support

- Detorsion Wedge





Passive:

- Orthosis
  - medio-lateral stability

  (fixation as in taping)

Muscle Detoning:

c) Optimization of Training

- Running-/Sport Surface (choose carefully)
- Amount of running/Training/loading within individual threshold
- Increase of Amount of running/Training/loading slowly
- Reduced downhill running (at least slowly)

Conclusion Overuse Injuries (take home message)

Decisive for prevention of overuse injuries (but also for performance enhancement), additionally to running

1. Strengthening of muscles (also eccentrically)
2. Stretching of muscles (before AND after training) and „Myofascial Release“ (afterTraining; blackroll)
3. Improvement of mobility/flexibility and coordination
4. Appropriate sport shoes & orthotics
5. Development of overuse injuries typically complex combination of biomechanical, clinical and trainings specific causes

	Training-Variables				Biomechanical Variables				
	T- Age	Km/week	Downhill/week	Surface (hard)	HAD_{max}	AEV_{max}	$AVEL_{EV}$	$KVEL_{FL}$	Total
CO 1	M	M	L	L	L	M	M	L	0,4,4
CO 2	L	L	L	M	M	H	M	L	1,3,4
CO 3	H	M	M	M	L	M	M	M	1,6,1
CO 4	H	L	L	M	M	L	L	M	1,3,4
CO 5	L	L	L	L	M	M	M	M	0,4,4
CO 6	L	L	L	M	M	M	M	L	0,4,4
CO 7	M	L	L	M	H	L	L	M	1,3,4
CO 8	M	M	M	L	L	L	L	L	0,3,5
CO 9	L	M	L	M	L	L	L	M	0,3,5
CO 10	L	M	L	M	L	L	L	L	0,2,6
CO 11	M	H	M	L	M	M	M	M	1,6,1
PTS 1	H	H	L	L	M	L	M	M	2,3,3
PTS 2	M	H	H	M	M	M	H	M	3,5,0
PTS 3	**M**	**H**	**H**	**M**	**H**	**M**	**H**	**M**	**4,4,0**
PTS 4	M	L	L	M	H	M	H	M	2,4,2
PTS 5	M	M	M	M	M	M	H	H	2,6,0
PTS 6	**M**	**M**	**M**	**M**	**H**	**H**	**H**	**H**	**4,4,0**
PTS 7	M	L	L	L	H	H	M	H	3,2,3
PTS 8	L	M	M	H	M	M	H	M	2,5,1
PTS 9	**H**	**H**	**M**	**H**	**M**	**H**	**M**	**M**	**4,4,0**
PTS 10	**M**	**H**	**H**	**M**	**M**	**H**	**M**	**H**	**4,4,0**
PTS 11	M	M	H	H	M	M	M	M	2,6,0

What is important for the future?

1. “Comprehensive” analysis and evaluation of clinical, biomechanical and training specific variables in order to match variability and complexity of injury patterns

2. Development of a multi-dimensional matrix to find out best orthotics

3. Recommendations for additional training (e.g. strength, flexibility) and equipment (shoes) next to orthotics