New Trends in the Prevention of Running Injuries

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Disclosure

The Running Clinic™ and all speakers have NO financial relationships with commercial interests relative to the footwear industry.
Evidence Based

Monthly update

(> 100 systematic reviews, >2000 scientific articles)

Evolution of Man

Bramble & Lieberman, Department of Anthropology, Harvard University

• Our species (Homo Erectus) set itself apart from others 2 million years ago by its capacity for long distance running

• A human’s maximum endurance speed is exceptionally high.

• Characteristic anatomical adaptations
  – Short arms and long legs, short parallel toes, long Achilles tendon, large glutes, etc.
**Most common injuries**

**Long distance**
1. PFP
2. ITBS
3. Fasciopathy
4. Achilles Tend
5. MTSS
6. Patellar Tend

**Short distance**
1. MTSS
2. Achilles Tend
3. Fasciopathy
4. Tibial SF
5. MT SF
6. PFP
7. LBP
Most common injuries

**Beginner**
1. MTSS
2. PFP
3. Achilles Tend
4. Fasciapathy
5. Tibial SF
6. CECS
7. LBP

**Ultra-trail**
1. PFP
2. Achilles Tend
3. Ankle DF
4. ITBS
5. Patellar Tend
6. MTSS
7. Hip flexors
Postulation

THE BODY ADAPTS

As long as the applied stress is not greater than its capacity to adapt
Cause of Overuse injuries

MISADAPTATION

Intrinsic Factors

- Biomechanics
- Muscle dysfunction
- Tissue frailty

Mechanical Stress

Extrinsic Factors

- Running shoes
- Surface

Training errors

Prevention of Overuse Injuries

ADAPTATION

Intrinsic Factors

- Fix faulty biomechanics
- ... and muscle dysfunctions
- Increase capacity of structures

Calculated mechanical stress

Extrinsic Factors

- Appropriate running shoes
- Adequate surface

Be gradual
RUNNING INJURIES: WHY?

↑ Load
- ↑ Speed
- ↑ Mileage
- Changing terrain
- ↑ Uphill training
- ↑ Downhill training
- Changing footwear
- Changing mechanics
- ↑ Other activities

Misadaptation

↓ Capacity
- ↓ Rest
- ↓ Sleep
- Depression
- Medications
- ↑ Stress / Anxiety
- Systemic factors
- Nutrition / Smoking
- ↓ Tissue tolerance

Assessment

Diagnostic

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Assessment

1. Precise diagnostic or list of problems
2. Treatment plan
3. Find the cause
   - Tissue overload
   - Intrinsic factors
   - Extrinsic factors

Subjective Assessment

• General questions
  - # of years running, km/week, best performance, plantar orthoses, …

• Recent changes?
  - Volume, intensity, surface, hills, running shoe, fatigue-stress

• Past history?

• Special questions (e.g. female athlete triad)
Functional ROM

• Flexion: Squat test

• Extension: Long strike on step
Functional ROM

• Rotations: **Body torque**

Local Scan

• Observation
• Selective tension tests
  • Active
  • Passive
  • Resisted
• Special Tests
• Palpation
**Knee : Lateral Pain**

2005-Hosch, 1995-James, 1996-Orchard

**OA** (Bone) tibia + fibula + femur + patella  
(Joints) PFJ, TFJ, sup Tib-Fib  
(Ligaments-capsule) LCL, PLC, CL  
Lat. meniscus, bursae, fat pad

**MT** biceps femoris, popliteus,  
ITB + lateral retinaculum  
tibialis ant., peroneals, soleus, lat. gastroc, quadriceps (lat.)

**NM** common fibular nerve = superficial + deep  
cutaneous intermediate + lateral of the thigh

**V** -

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**Functional Analysis**

2010-Magrum

- Weight bearing control tests  
  **Step down** / Single-leg squat

- Running drills  
  **ABCD’s**
Assessment

Biomechanics

Performance
Running economy by better biomechanical efficiency

Injuries
Reduction of impact forces and optimal alignment
Efficient Technique
(Minimal energetic cost)


Inefficient Technique
(High energetic cost)


Initial contact close to center of gravity

- Braking phase
- Ground reaction force (VLR)
- Ground contact time (?)
- Vertical displacement (?)
- Step rate

Initial contact ahead of center of gravity

- Close to midfoot strike (?)
- Impact force moderation
- Ground contact time (?)
- Vertical displacement (?)
- Freely-chosen step rate… around 180

Foot strike pattern & Performance

Beg: Voluntary MFS only if other indirect interventions not successful for moderating impact

Exp: No voluntary changes. Running drills.

2013-Ogueta-Alday (I-n20, 1/2M runners)
2013-Gruber (I-n37, good level runners)
2014-DiMichel (C-sectional-n14)
2013-Kasmer (O-n1991, marathon)
2012-Hayes (O-n181, 800-1500m)
2013-Kasmer (O-n165, 50k-trail)

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Optimal cadence higher than freely-chosen cadence

+10% : 180
I n6, RE idem – 6w (2015-Hafer)

170-174
n20, OSF RR or Ath (2013-DeRuiter)

173
n16Ath, VO2-60 (2007-Hunter)

175-180
n9-Sk-18'30", jogTM (2011-Snyder)

173
n151Mar exp (2006-Conoboy)

174
n16Ath, Nat team (2012-Tartaruga)

177
n18-Mara exp (2013-Padulo)

182
n87-SkRace exp (2005-Gerlach)

190-200
n19-SkRace elite (2012-Larson UP)

Safe running gait

Lower vertical loading rate

Optimal control and stability of the lower limb

injuries

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Safe running gait

**CLINICAL MEASURES**

- Vertical loading rate (tibial accelerometer)
- Briefly evaluate kinematics

**INTERVENTIONS**

- Foot sensations
- Run softer
- Cadence
- Strengthening

Lower vertical loading rate

Optimal control and stability of the lower limb
### Ground Reaction Force

#### Vertical Force (Bodyweights)
- 10% 40% 100%
- Measured using force plates (runway or instrumented treadmill)

#### Horizontal Force (Bodyweights)
- 0% 40% 100%
- Measured using force plates (runway or instrumented treadmill)
Running shoe **cushioning**... increases mechanical stress on the skeleton (except on the foot)...


... or doesn’t decrease it!


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Running shoe **cushioning** decreases stress (peak pressure) on the foot.

The vertical loading rate (VLR) of the ground reaction force is related to kinematics (foot strike pattern)…

But the main influence on kinematics (reduced impact moderating behavior) comes from shoe cushioning.

2013-Shih: Is the foot striking pattern more important than barefoot or shod conditions in running
2015-Almeida: Biomechanical Differences of Foot Strike Patterns During Running: A Systematic Review With Meta-Analysis
2016-Rice: Footwear Matters: Influence of Footwear and Foot Strike on Loadrates During Running
**Science**

**Midfoot** and forefoot striking could **decrease** the incidence of some injuries (?)...

(Lower VLR vs tissue load transfer: less stress on the ant. leg, knee, hip and lower back)


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**Science**

**Midfoot** and forefoot striking could **increase** the incidence of some injuries (?)...

(Tissue load transfer: more stress on the foot, calf, Achilles tendon)

2013-Rooney, 2012-Williams
**Impact moderating behaviors**

- Close to center of gravity
- Knee flexion
- Vertical tibia

**Beg**: Integrate good impact moderating behaviors (run softly).

**Exp**: Modify only if injured?

*Gait retraining*

*Impact forces (VLR) & Injuries*

- **2011-Zadpoor**: (RS-n13R, Stress Fracture)
- **2012-Bredeweg**: (P-n210, RRI-9w)
- **1989-Bahlsen**: (P-n131, acute injuries-6m)
- **2016-Esculier**: (I-n21, PFPS-8w)
- **2016-VanDerWorp**: (RS-n18R, All pathologies)
- **2016-Davis**: (n249, RRI-2y)
- **2005-Gerlach**: (P-n87, 1y)
Foot strike pattern vs Injuries

**Beg**: Minimize foot inclination at initial contact for better impact moderating behaviors.

**Exp**: Modifications only if injured to anterior leg, knee, hip and lower back... and non-responder to indirect interventions:
- ↑ cadence, ↓ noise, ↓ shoes

Foot strike angle (Obvious HS vs. Subtle HS) affects VLR (2015-Mercer)

- 2012-Daoud (R-n52, RRI)
- 2012-Diebal (I-n10 + 2, CECS)
- 2014-Warr (Q-n1027, RRI)
- 2012-Goss (Q-n2509, RRI)
- 2003-Kleindienst (R-UP-n471, RRI)
- 2005-Walther (R-UP-n1203, RRI)
- 2012-Cheung (I-n3, PFPS)

Safe running gait

- Lower vertical loading rate
- Optimal control and stability of the lower limb
Is there a relationship between...

- **Anatomical** peculiarities
- **Biomechanical** peculiarities (kinematics)
- Lower limb **strength**

... and lower limb pathologies?

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**Anatomy**

Observation and measurements of static posture

- Foot type, “arch index” or “foot posture index” (pes planus, normal, pes cavus)
- Forefoot (varus or valgus)
- Rearfoot (varus or valgus)
- Knee (varus or valgus)
- Q Angle
- Leg length
- Etc.
There is generally **NO LINK** between anatomical peculiarities and lower limb injuries.

**Except if acutely changed**

**Question**

Is there a relationship between...

- Anatomical peculiarities
- Biomechanical peculiarities (kinematics)
- Lower limb strength

... and lower limb pathologies?
Biomechanics
Observation and Dynamic Measurements (Kinematics)

- Navicular drop
- Observing foot motion (pronator, normal, supinator)
- Tibial rotation (internal)
- Knee (Dynamic valgus or varus)
- Hip (adduction, internal rotation)
- etc.

Foot dynamics & Injuries

Supination
Pronation

Beg - Exp: Perform (or not) foot strengthening exercises.
Inj: Short-term support for acute foot pathologies.

2014-Neal (RS-n21P. Injuries)
2013-Tong (RS-n29, P+R, Injuries)
2013-Newman (RS-n10, P, MTSS)
2015-Gijon (RS-n25, P+R, Injuries)
**Uninjured**: Maybe perform lower limb strengthening / control exercises.

**Injured**: Perform lower limb strengthening / control exercises / gait retraining.

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**Hip/Knee Kinematics & Injuries**

There is generally **NO LINK** between biomechanical peculiarities and lower limb injuries.

**Except if acutely changed**
Is there a relationship between...

- **Anatomical** peculiarities
- **Biomechanical** peculiarities (kinematics)
- **Lower limb strength**

... and lower limb pathologies?

**Uninjured**: Maybe perform lower limb strengthening / control exercises.

**Injured**: Perform lower limb strengthening / control exercises / gait retraining.
- **Methods**: Databases searched for prospective and case-control studies evaluating the association of hip strength & PFP
- **Results**: 21 case-control (and 3 prospective studies) indicate:
  - Mod-Strong evidence (prospective) that isometric hip strength is not associated with PFP
  - Moderate evidence (cross-sectional) that men and women with PFP have lower isometric hip strength
- **Conclusion**: This review highlights a discrepancy between prospective & cross-sectional studies. Reduced hip strength may be a result of PFP rather than a cause.

**Summary of Assessment**

- Identify **recent changes**
- **Briefly** evaluate ROM and biomechanics
- **NO** systematic static or dynamic measurements
- Evaluate lower extremity biomechanics with **functional tests** (e.g. step down)
Correction (LLD)
How? How much? Why?

- Measurement errors
- LLD is universal
- 2 literature reviews
  >20 mm is necessary to negatively affect the patient (Pain, function, biomechanics)
- Effects of correction: unknown

Many authors suggest correcting half of the difference (?)
How does our « modern » running shoe, with its specifications for support, stability and cushioning, prevent injury?

Has nature gotten it completely wrong?

Have we been wholly misconceived?
Footwear providing minimal interference with the natural movement of the foot with its high flexibility, low weight, stack height and heel to toe drop, and the absence of motion control and stability technologies.
1. Weight

5 = less than 125g  
4 = from 125g to less than 175g  
3 = from 175g to less than 225g  
2 = from 225g to less than 275g  
1 = from 275g to less than 325g  
0 = 325g and more

2. Stack height

5 = less than 8 mm  
4 = from 8 mm to less than 14 mm  
3 = from 14 mm to less than 20 mm  
2 = from 20 mm to less than 26 mm  
1 = from 26 mm to less than 32 mm  
0 = 32 mm and more
3. Heel to toe drop

5 = less than 1 mm
4 = from 1mm to less than 4 mm
3 = from 4 mm to less than 7 mm
2 = from 7 mm to less than 10 mm
1 = from 10 mm to less than 13 mm
0 = 13 mm and more

4. Stability and motion control technologies

5 = None
4 = 1 device
3 = 2 devices
2 = 3 devices
1 = 4 devices
0 = 5 or 6 devices
5. **Flexibility** *(longitudinal)*

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>Minimal resistance to longitudinal bending (the shoe can be rolled on itself more than 360 degrees)</td>
</tr>
<tr>
<td>2.0</td>
<td>Slight resistance to longitudinal bending (anterior tip of shoe sole reaches posterior tip of shoe sole in a maximal bending of 360 degrees)</td>
</tr>
<tr>
<td>1.5</td>
<td>Moderate resistance to longitudinal bending (anterior tip of shoe sole doesn’t reach posterior tip of shoe sole, but anterior and posterior parts of the shoe can form an angle of at least 90 degrees)</td>
</tr>
<tr>
<td>1.0</td>
<td>High resistance to longitudinal bending (anterior and posterior parts of the shoe can form an angle between 45 and 90 degrees)</td>
</tr>
<tr>
<td>0.5</td>
<td>Very high resistance to longitudinal bending (longitudinal deformation is possible, but anterior and posterior parts of the shoe form a maximum angle of 45 degrees)</td>
</tr>
<tr>
<td>0</td>
<td>Extreme resistance to longitudinal bending (longitudinal forces don’t significantly change the orientation of the anterior part of the shoe relative to the posterior part)</td>
</tr>
</tbody>
</table>

5. **Flexibility** *(Torsional)*

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>Minimal resistance to torsion (anterior part of the shoe is turned 360 degrees; anterior outsole faces inferiorly after a complete twist while posterior outsole faces inferiorly)</td>
</tr>
<tr>
<td>2.0</td>
<td>Slight resistance to torsion (anterior part of the shoe is turned at least 180 degrees but less than 360 degrees; anterior outsole faces at least superiorly while posterior outsole faces inferiorly)</td>
</tr>
<tr>
<td>1.5</td>
<td>Moderate resistance to torsion (anterior part of the shoe is turned more than 90 degrees but less than 180 degrees; anterior outsole faces at least laterally while posterior outsole faces inferiorly)</td>
</tr>
<tr>
<td>1.0</td>
<td>High resistance to torsion (anterior part of the shoe is turned more than 45 degrees but less than 90 degrees; anterior outsole can’t face laterally while posterior outsole faces inferiorly)</td>
</tr>
<tr>
<td>0.5</td>
<td>Very high resistance to torsion (torsional deformation is possible, but anterior part of the shoe reaches less than 45 degrees)</td>
</tr>
<tr>
<td>0</td>
<td>Extreme resistance to torsion (torsional forces don’t significantly change the orientation of the anterior part of the shoe relative to the posterior part)</td>
</tr>
</tbody>
</table>
Transitioning to ...

**Beg**: Start with minimalist shoes (MI > 60%).

**Exp**: No change if uninjured and not seeking better performance.

**Inj**: Maximalist to protect the foot (short term).

Science & shoes

New technologies promoted annually by shoe companies are **NOT** supported by published scientific evidence.

*2012-Schelde, Richards 2008(SR)*
Running shoes **change natural biomechanics.**

* More likely to heel strike


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Running shoes **change natural biomechanics.**

* Decreased cadence


Maximalist running shoes

Increase load on
Maximalist running shoes

Decrease load on

Cushioned shoes may **fragilize** foot tissues and weaken foot muscles.

(Indirect evidence: minimalism strengthens the foot and increases its muscle volume)


Science & shoes

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Transitioning to minimalist shoes increase the incidence of injuries if done too quickly.

(Protection & reduction of mechanical stress = tissue frailty)

Transitioning to minimalist shoes

1-min more / training
1 month for every 10-20% change in MI

Comfort & fitting

Shoes are responsible for certain foot deformities (hallux valgus, hammer toes, callus…)

Running shoes increase O$_2$ consumption!

0.7 – 1.0% per 100g

The lighter the better!
Depending on individual habits and comfort: protection from the environment, adequate traction, slight cushioning, moderate rigidity… without changing natural biomechanics!
For whom?
SELECTING THE RIGHT RUNNING SHOES

SHOES

ENTER YOUR SEARCH  ROAD
60-80%  SORT BY MINIMALIST INDEX

INOV-8 | 155
SHOE TYPE: ROAD
MINIMALIST INDEX: 75%

NIKE | FREE 4.0 FLYKNIT
SHOE TYPE: ROAD
MINIMALIST INDEX: 70%
Listing of Running Shoe Stores Boasting a Practice based on Scientific Evidence

1. A choice that mirrors client request
   It is important not to destroy the beliefs of the client with unfounded arguments or with recommendations based upon our own beliefs. It is also paramount to respect any prescription that may have been issued previously by a specialist.

2. A scientific and logical selection that supersedes marketing incentives
   The concepts taught to any client must be centered on science-based evidence or, in the event of a lack of data in that regard, on evidence stemming from a clinical reasoning coupled with a rich professional experience. Commercial influences and profits related to the sale of a specific type of shoe should never influence salespeople in the choices they submit to clients.

3. A choice primarily based on ergonomics
   Comfort, absence of pressure points respect of the size, width and shape of the foot (both when static and dynamic).

4. A choice geared toward ultra-minimalism for children

5. A minimalist selection for beginner

6. A choice not based on the arch of the foot

7. A choice not based on an individual's weight

Safe running gait

- Lower vertical loading rate
- Optimal control and stability of the lower limb

TheRunningClinic.com
**Safe running gait**

**INTERVENTIONS**
- ✔️ foot sensations
- ✔️ Run softer
- ✔️ ✈️ cadence
- ✔️ Strengthening

**Lower vertical loading rate**

**Optimal control and stability of the lower limb**

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**Minimalist Index & biomechanics**

- The closer to barefoot, the higher the probability to promote better impact moderating behaviours
  - MI score < 50% often not enough
  - MI score > 70% often enough
- Automatic changes are more durable
- Changes are not necessarily immediate
Gait retraining


- Accelerometry can be used successfully as a feedback tool
- Portable equipment available
- Clinician-guided feedback as efficient as accelerometry-based feedback

Run softer!

(TheRunningClinic.com)
Beg: Run at **180** steps/min (+/-10).
Exp: Increase cadence (if < 160).
Inj: Increase cadence

**Shin injuries**
2016-Luedke

**Knee symptoms**
2017-Esculier.PFP, 2016-Esculier.PFP

**Vertical GRF (VLR)**

**Lower limb load**
2015-Willy, 2011-Heiderschelt

**Knee load**

**Hip load**
(2005-Gerlach)

**Foot load**
(2014-Wellenkotter, 1985-Clark)

**Soreness**
(2001-Rowlands)

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**Biomechanics**

**Analysis**

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Clinical analysis


4-6 minutes of warm-up
(kinematics + " running shoe adaptation ")
Comfortable speed during assessment (jog 30’)
Usual shoes

• Quantify impact forces (NOISE / VLR)
• Determine cadence
• Visual analysis – Bottom-up (Anterior)
• Visual analysis – Top-down (Lateral)

Clinical analysis

1. Identify the problem(s)
2. Test interventions to fix the problem(s)
3. Personalization, Prescription, Practice

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Fix the problem

The KISS Principle

• Positive effects on knee symptoms
• Clinical applicability of 8 sessions over 2 weeks?
Clinical Effectiveness

The efficiency of a clinician is not necessarily related to the size of his tool box (number of techniques and knowledge he has acquired) or to the tools he owns, but rather to the proper choice of the tool needed for the job at hand.

Quantification of Mechanical Stress

Tool #1

TheRunningClinic.com
Mechanical Model

Stress = Degeneration

Biological Model

Stress = ADAPTATION
Adaptation of cartilage

Moderate repetitive **loading** is **necessary** to maintain healthy articular **cartilage**

Griffin et al., 2005

Joint **overload** or **trauma** increase the likelihood of early onset **knee osteoarthritis**

Griffin et al., 2005

**Stimulating** knee structures within the **envelope of function** will stimulate **adaptation**

Dye et al., 2005

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Immediate effects

**Cartilage thickness**

Tibia, Femur, Patella


**Cartilage volume**

Tibia, Femur, Patella


**T2 Relaxation time**

Tibia, Femur, Patella

Subburaj et al 2012, Mosher et al 2010, Mosher et al 2005

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TheRunningClinic.com
Short-term effects

**Tibial and patellar cartilage volume**

MRI → 20 km run → MRI → 1 hour → MRI

**Baseline**

Tibia: -5.1%
Patella: -7.0%

Tibia: +4.3%
Patella: +5.3%

*Values returned to baseline only 1 hour after the run!*

Repeated exposure

**N=10 novice runners**

**N=9 sedentary controls**

**dGEMRIC: changes in GAG content**

dGEMRIC → 10 weeks Start to run vs. control → dGEMRIC

**Baseline: No differences between groups**

significant difference ($P=0.006$) between
runners: $+11.66 \text{ ms (95\% C.I. } -25.29, 44.43)$
controls: $-9.56 \text{ ms (95\% C.I. } -29.55, 5.83)$

Correlation between self-reported physical activity change and dGEMRIC index change ($r = 0.741$, $P<0.001$).
Long-term exposure

**Running and Knee Osteoarthritis: A Systematic Review and Meta-analysis**
Kate A. Timmins, Richard D. Leech, Mark E. Batt and Kimberley L. Edwards
DOI: 10.1177/0363546516657531

15 studies included
(11 cohort, 6 retrospectives, et 4 case-control)

Follow-up < 5yrs (n=3), 5-25 yrs (n=4), > 25yrs (n=3)

It is not possible to determine the role of running in knee OA

Meta-analysis suggested a protective effect of running against surgery due to OA
(3 studies, OR=0.46 95%C.I. 0.30-0.71)

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**FUNCTIONAL CARTILAGE MRI T2 MAPPING: EVALUATING THE EFFECT OF AGE AND TRAINING ON KNEE CARTILAGE RESPONSE TO RUNNING**
Timothy J. Mosher, MS, MD, Yi Liu, MD, and Colvin M. Torok, MD

N=22 marathon runners & 15 sedentary controls

Younger & Older Marathoners:
↑ femoral cartilage volume

Cartilages can become thicker and stronger with running!
45 long-distance runners vs. 53 controls
Mean age = 58 years (range 50-72)
X-rays between 1984 and 2002

OA at baseline
Runners: 6.7%
Controls: 0%

OA at follow-up
Runners: 20%
Controls: 32%

1. Cartilages can adapt to mechanical stress
2. Cartilages can sustain relatively high impacts repeatedly
3. Running is not associated with higher rates of OA
4. Even older individuals with or without OA can show cartilage adaptations with exercise (what about running?)
5. Education on the proper quantification of mechanical stress is key in runners with OA (gait retraining and footwear?)
Postulation

THE BODY ADAPTS

As long as the applied stress is not greater than its capacity to adapt

Quantification of stress

Sedentary individual

100%
(Maximum capacity to sustain mechanical stress)

30 minutes of walking

Stress

Time

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Quantification of stress

The marathon runner

100%
(Maximum capacity to sustain mechanical stress)

42 km of running

Stress

Time

Soft Tissue Adaptation

«Un» adaptation Zone

Maximal capacity of the body to sustain mechanical stress

Minimal stress needed to create adaptations

Stress

Time

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Soft Tissue Adaptation

Misadaptation Zone (Less Tolerance)

Maximal capacity of the body to sustain mechanical stress

Minimal stress needed to create adaptations

Soft Tissue Adaptation

Adaptation Zone

Maximal capacity of the body to sustain mechanical stress

Minimal stress needed to create adaptations
Soft Tissue Adaptation

• **Frequency of trainings**
  – Running more often \( \downarrow \) risk of injuries
  
  (2016-Kluitenberg), 2015-Malisoux, 2003-Taunton

• **Weekly mileage / duration**
  – Running more is a protective factor against injuries
  
  2016-Kluitenberg, 2015-Malisoux, 2013-Rasmussen

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**Overstepping maximal capacity is felt by:**
1. Pain during
2. Pain after
3. Morning Stiffness

**Rest Zone**
No stress = No adaptation!

**Adaptation Zone**
Area in which training will help increase the body’s capacity to support stress

100% Max. adaptation

Minimal stress to create adaptations

Individual stress levels according to activities

0% No mechanical stress
Tissue Adaptation

Rest/Sleep | Positive | Cardio | thought | Tissue | Health

NSAID’s

Mechanical stress quantification

Inflammation

Reason?

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NSAID’s (Cyclo-Oxygenase Inhibitor)

- All NSAID’s can create weakness in tissues
  - COX I and COX II inhibitors
- All tissues will be affected
  - bones, ligaments, tendons, muscles, …
- Dosage dependant (# days and quantity)

Modulating Agents

- NSAID’s inhibit the inflammation process. (natural response to soft tissue lesions)
- The IP initiates cellular proliferation which is responsible for repairing damaged tissues.

![Inflammation](TheRunningClinic.com)

- All NSAID’s can create weakness in tissues
  - COX I and COX II inhibitors
- All tissues will be affected
  - bones, ligaments, tendons, muscles, …
- Dosage dependant (# days and quantity)
Tissue Adaptation

++ CARDIO

No NSAID's

Mechanical stress quantification

Training Modulation

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Stress types

• **Physiological Stress**
  – Provoked by acute physiological changes (♥, metabolism, …).

• **Mechanical Stress**
  – Provoked by load (tension, compression, shear, …) applied on the musculoskeletal system.

**Directly linked with running speed**

Running > cross-country skiing > biking > aqua-jogging

Stress types

• **Physiological Stress**
  **Overtraining**

• **Mechanical Stress**
  **Injuries**

Running > cross-country skiing > biking > aqua-jogging
### Monthly Periodisation

- One microcycle of “relative rest” is important to ensure proper
  - Physiological (endurance) and
  - Neuro-hormonal (speed) recovery

Adaptations of the musculoskeletal system directly related to mechanical stress are less malleable. It is therefore preferable to always progress slowly without reducing the mechanical stress for an extended period.
Progression


• **Changes**
  – Seasons, hills, surfaces

• **Volume**
  – Max 10% more / week
  – Long run: max 10 min more / week (5’ to 15’)

• **Intensity** (>70-85% max HR)
  – 10 to 20% / week, max 3% more / week
  – Mechanical stress more important than volume

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Cross Training

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Cross Training

- Physical activity that allows aerobic exercise without contributing to the exacerbation of an existing pathology.
- Goal: Maintain the athlete’s physiological capacities while being as specific as possible to the original activity. Accelerate the healing process (increased vascularization and metabolism of the injured tissue).

Mechanical Stress Types

| Load                  | Speed, plio, running up hills  
|                      | (sprinter, quality, ...)       |
| Repetition            | Volume, same surface          
|                      | (Long distances, quantity, ...) |
| Range                | Speed, running down hills      
|                      | (specific, ...)                |
Cross Training
According to the Cause of Injury

Load
- MTSS (Shin Splints)
- Stress # (distal)
- Plantar Fasciopathy
- Tendonopathy
- Muscle Strain
- PFS

✓ Pool Running
✓ Start with volume

Cross Training
According to the Cause of Injury

✓ Biking
✓ Avoid speed and hills

- Muscle Strain
  - LBP
  - Tendonopathy (IP)
Cross Training
According to the Cause of Injury

✓ Intervals
✓ Variety of movements

- PFS
- Stress # (proximal)
- Pes Anserinus
- ITBS

Repetition

Training
Flexibility
Flexibility

- Stretching does not increase muscle temperature
- Stretching does **not prevent DOMS**
- Stretching does not improve post-workout recovery

Flexibility - Performance

- Four reviews conclude that muscle stretching during warm-up has a negative influence on:
  - **Speed**, **Strength**, **Jumping**
  - **Endurance**

  But one review states that this effect is minimal if stretching duration is shorter than 60 sec.
Flexibility - Performance

- One review concludes that regular stretching has a positive effect on performance for:
  - Speed, Strength, Jumping
- An unknown influence (or opposite?) on:
  - Endurance

Flexibility - Injuries

- Regular stretching has a positive influence on the prevention of injuries if performed at other times than in your trainings.
Flexibility – Injuries

- Stretching **before** an activity does **not decrease** the risk of injury and might even increase it.

  Stretching a muscle in excessive range temporarily increases its tolerance to pain and in so doing alters its protection mechanisms against elongation.


« However » #1

- Experimental and clinical data suggest that a « U curve » would properly represent the relation between flexibility and injuries (?)

  ![Graph showing the risk of injury vs. flexibility with a U-shaped curve](TheRunningClinic.com)
• Muscle imbalances are unique to each individual

• Functional demands are different from one sport to the other (ROM, speed, repetition)

**Evaluating Flexibility**

*flexibility vs stiffness*

- **Thomas**
  - IP: 0 to -10°
  - ITB: < 15 to 20°
  - RF: > 50 to 70°

- **SLR**
  - Hamstrings: > 70°

- **Quadrant**
  - Glutes: -

- **Wall Dorsiflexion**
  - Calf muscles: (10°) 20° to 45°

- **Ober**
  - TFL (RL): 0° to -10°

- **Modified Ober**
  - TFL (CP): 0° to -10°

- **Prone Hip Ext.**
  - IP: 20 to 40°

- **Ely**
  - RF: -

- **Fabere**
  - Add: -
Types of stretching

- Static
- Ballistic
- Functional

Should I Stretch?

- **YES**
  - To normalize MY muscle stiffness/length
  - After my workouts (Pre-workout only if my stiffness negatively influences an existing pathology)
  - Proximal muscles

- **NO**
  - If I am hyper-flexible
  - Before workouts (see above)
  - Calf muscles (?)
Training

Warm-up

Treatment

Plantar orthoses
Orthoses built to correct “abnormal” biomechanics with the intent of preventing or treating a musculoskeletal pathology of the lower extremity.

- There is generally no relationship between a “longstanding” anatomical or biomechanical peculiarity and pathologies of the lower extremity.
The kinematic changes brought upon by corrective plantar orthoses are slight and non-systematic, sometimes opposite to the expected results.

(Some authors suggest a theory of neuromodulation effect.)

- The lack of quality studies does not allow us to know the real effect of plantar orthoses in the treatment of running injuries

Tendency: little or no effect!
Considerable placebo effect
Orthoses for Support

• Pain
• Foot (overload pathology)
• Short-term

Metatarsalgia, sesamoiditis, plantar fasciopathy, fat pad, metatarsal stress fracture, …

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Treatment

Exercises

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Strengthening IMF
Intrinsic Muscles of the Foot

WB on both legs, holding balance with hands, slight triple flexion

✓ Inversion
✓ Regain ground contact with the head of the first metatarsal
✓ Keep the arch supported
✓ Do not grip the toes
✓ Keep proper distribution of pressure

Step down

• Active correction

✓ Foot alignment
✓ Active arch support
✓ Knee alignment (2nd toe?)
✓ No pelvic drop

Visual, tactile feedback
Core Exercises

2012-Jamison, 2009-Sato

Exercises on Swiss Ball

2010-Escamilla

Core and hip proprioception

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Step Down and Progression

Triple flexion control / Hip strengthening

Functional Exercises

(Field A, B, C, D’s)

Specific motor control (speed and function)
Barefoot Running

- Control of the intrinsic muscles of foot
- Adaptation and increased capacity of supporting structures
- Neuro-physiological training
Summary

✓ Be cautious with surface changes

Adaptation

✓ Choose cross-country running and avoid very level, repetitive surfaces

Variety

✓ Choose the surface according to the pathology

Specificity
**Therapeutic relationship**

**Voltaire**

*The art of medicine consists in amusing the patient while nature cures the disease.*

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**Proximal hamstring tendinopathy**

**T**: ↓ speed, avoid uphill and plyometrics

**P**: “doughnut” cushion for sitting (avoid compression)

**E**: Eccentric strengthening for hamstrings, stretching (PRN)

**MSQ… 180, minimalist**
T:  ↓ volume, speed, avoid downhill gait retraining  

P:  Neuro-proprioceptive taping  

E:  Hip strengthening, Quadriceps strengthening, Core strengthening, Lower limb control  

**MSQ… 180, minimalist**
The addition of exercises or gait retraining provided no additional benefits compared with education alone.

- Training errors often contribute to the onset of running injuries → Treatment should focus on Education regarding training loads.
- Increases in isometric strength is potentially not a moderator of clinical improvement.
- Limitations: absence of a ‘no intervention’ group; no long-term follow-up.

**KEY MESSAGES FROM RCT**

Clinical interventions in runners with PFP should include appropriate education on symptoms and management of training loads as a primary component of treatment.

These results should not discourage clinicians from prescribing gait retraining and exercises if judged necessary.

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**ITBS**

**T:** ↓ volume, avoid downhill
↑ intensity, 1’walk, uneven surface

**P:** Neuro-proprioceptive taping, massage, NSAID (per os, gel, corticosteroids)

**E:** Hip strengthening (Abductors)
Step down (increase demand on control / increase loading)

**MSQ… 180, minimalist**
**Patellar Tendinopathy**

**T:** ↓ intensity, volume, avoid downhill

**P:** “Levy” strap

**E:** Eccentric quadriceps strengthening (step down → increase loading)

**MSQ… 180, minimalist**

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**Achilles Tendinopathy**

**T:** ↓ speed, avoid uphill

**P:** Neuro-proprioceptive taping (?)
Desensitization (calf massage)

**E:** Heel drop program (adaptation)
Calf stretch (PRN)

**MSQ… 180**
**Tib post Tendinopathy**

- **T:** ↓ speed, avoid hills
- **P:** Neuro-proprioceptive taping (?)
  Plantar orthoses
- **E:** Heel drops with elastic pulling medially (adaptation)
  Strengthening foot intrinsics (dynamic support)
  Calf stretch (PRN)

**MTSS & Stress fracture**

- **T:** ↓ speed, avoid hills and plyometrics
- **P:** Taping (circular or butterfly)
  Desensitization (myofascial release)
  US for stress fracture (0.05w/cm², 20’, 4x/week)
- **E:** Calf stretch (PRN)
  Heel drop program (adaptation)

**MSQ… 180, minimalist**
Ant. compartment syndrome

2015-Helmhout, 2013-Waterman, 2012-Diebal

T: Avoid downhill
P: 180, forefoot, low drop shoes
E: Skipping

180, minimalist

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Plantar Fasciopathy

2015-Rathleff, 2008-Neufeld, 2003-DiGiovanni

T: ↓ speed, avoid uphill and plyometrics
P: Neuro-proprioceptive taping
   Orthoses (?)
   Desensitization (massage)
E: Strengthening foot intrinsics (dynamic support)
   Heel drop program (adaptation)
   Calf stretch (PRN)

MSQ… 180

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**Fat pad syndrome**  (heel)

**T:** ↓ downhill  
**P:** 180, forefoot,  
Taping, gel pad (?), plantar orthoses  
Shoes with lower drop  
**E:** Heel drop program (adaptation)

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**Metatarsalgia**

**T:** ↓ speed, avoid uphill and plyometrics  
**P:** Metatarsal support, cushioned insole,  
plantar orthoses  
**E:** Strengthening foot intrinsics
Metatarsal stress fracture

T: ↓ speed, avoid uphill and plyometrics
P: Taping, rigid sole, high drop shoes
E: Strengthening foot intrinsics

MSQ

Treatment

Tendon
Treating Tendon "itis"

- Rest
- Protection
- Ice
- NO NSAIDs
- Patience...

3 days... 1 week?

Treatment Advice

TheRunningClinic.com
Advice #1

Surround Yourself With the Right People

Medical – Training – Shoes

(never accept final recommendations from a professional that is not a runner himself OR not specialized in running injuries)

Advice #2

Keep It Simple Back to nature

(Medicalisation – Orthotics – Shoes)
Advice #3

The Body Adapts!
Be gradual

(Every new stimulus must be integrated gradually)

Advice #4

Cadence

170 to 190

(To minimize ground reaction forces, energy loss and injuries while maximizing stride efficiency)
Advice #5

Natural Surface Variety

(Less repetitive movements, share loads between structures)

Advice #6

Warm-up: Gradual and Specific

(Increase your body temperature followed by gradual functional ballistic stretches)
Advice #7

Stretching: YES and NO

(Stiff—after—proximal / Flexible—before—distal)

Advice #8

Strengthening Barefoot

(Also: Specific stabilization, proprioception and strengthening programs)
Advice #9

> 4 x / week
(Often – Short)

(Increase the number of easy trainings)

Advice #10

Nutrition & Psychology

(Quality, variety and balance)
(Having fun, positive attitude, healthy life habits)
• **Progression for the Resumption of a Running Program**
  - Level I (30 min. in 8 weeks)
  - Level II (30 min. in 3 weeks)
  - Level III (Resumption after off-season)

- Interval training to maximize physiological stress while minimizing mechanical stress
- According to symptoms and comfort, accelerate or slow down the proposed progression.
- Frequent stimuli in order to create soft tissue adaptations by running minimum 4 x / week
- Ensure proper biomechanical preparation by walking 5 minutes.

- Complete your workout schedule with a cross-training activity that produces less mechanical stress while providing positive vascular and metabolic effects on soft tissue repair.
Hyponatremia

An imbalance between plasma $[\text{Na}^{2+}]$ and total water volume under 130 mmol/L.

Can be symptomatic or not.

Runners = water intoxication.
EAH (Exercise-Associated Hyponatremia)

- **Risk factors:** Overdrinking
- **Signs and symptoms:** Puffiness, increased body weight
- **Treatment:** Restrict hypotonic and isotonic fluids until urinating freely. Administration of oral HTS (hypertonic saline (concentrated bouillon))
- **Prevention:** Drink to thirst (before, during, after)

**Hyponatremia (EAH)**

**Statement of the 3rd International EAH Consensus 2019**


- **Recommended prevention for EAH**
  - Using the innate thirst mechanism to guide fluid consumption

**Drink to thirst**

**Before**  **During**  **After**

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Compression Garments

- Psychological > Physiological effects
- Low quality studies with high risk of bias
- More recent and better quality studies show no benefits of using CG

No Conclusion

Try it?
Cold-Water Immersion (CWI)

- Psychological > Physiological effects
- Low quality studies with high risk of bias
- More recent and better quality studies show no benefits of using CWI

No Conclusion

Try it?
of what we said is FALSE, but we don’t know what …yet!