Introductory Remarks

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“Injuries to Runners”
James et al., 1978

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- et: Barry Bates, Ph.D.
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Accommodating Strategies for Preventing Chronic Lower Extremity Injuries

Barry T. Bates, Ph.D.
MOVEMENT

FORCES

BIOMECHANICS

WHY?

INJURY: PREVENT

INJURY: REHABILITATION

PERFORMANCE: ENHANCE
RUNNING is “VIOLENT”

400-600 IMPACTS / FOOT / MILE
At 1.5-3.5 BW’s Each
Equal To 100 TONS / FOOT
Is There a Difference?

Stride vs Injury
INJURY STATISTICS: RUNNING

KOPLAN et al, 1982 35%
LYSHOLM et al, 1987 65%
MARTI et al, 1988 46%
WALTER et al, 1989 48%
van MECHELEN, 1992 50%
ASPLUND, TANNER, 2004 50%

Ten Common Injuries
(AOSSM, 2008; Others)

- Plantar Fasciitis
- Stress Fractures (Foot & Leg)
- Achilles Tendonitis
- Shin Splints
- Iliotibial Band Syndrome
- Patellofemoral Pain Syndrome
- Ankle Sprains
- Muscle Pulls
- Blisters

Foot
Leg
Knee
Other
JAMES et al, 1978
Training Errors (60%)
Shoes and Surfaces
Anatomic Factors

AOSSM, 2008
Training Errors
Shoes, Surfaces, Weather
Anatomic Abnormalities
Stop!

Why Is This The Case?

Why Haven’t We Seen More Change Across Time?

STATISTICS

BIOMECHANICS RESEARCH

TYPICALLY IGNORE
“Average” Person

Individual

SHOE RESEARCH RESULTS

vs

SHOES CAUSE INJURIES?
JAMES et al, 1978
Training Errors (60%)
→ Shoes and Surfaces
→ Anatomic Factors

AOSSM, 2008
Training Errors
→ Shoes, Surfaces, Weather
→ Anatomic Abnormalities

Max PF Torque: Running

Reinschmidt & Nigg, 1995
Final Comment

“... propositions about people cannot necessarily be derived from propositions about the mean of people ...”

Bouffard, 1993, p.371

HOW HAS BIOMECHANICS CONTRIBUTED?
Progression

SCIENCE

KNOWLEDGE

ART

TREATMENT

HOW HAS BIOMECHANICS CONTRIBUTED?

FEWER MISTAKES

SCIENCE ← ART
(of “CHANGE”)
MOVEMENT FORCES

BIOMECHANICS

FIRST STEP TO GAINING UNDERSTANDING / INSIGHT
PREDICT
MODEL
UNDERSTAND
DESCRIBE

RELATIONSHIPS
IMPACT / LOADING
ANATOMICAL CONSTRAINTS
METABOLIC COST
INJURY
PERFORMANCE
INJURY

CAUSE: FORCE / STRESS
HOW: CHANGE

CURE: FORCE / STRESS REDUCTION
HOW: CHANGE

INJURY

CAUSE: FORCE / STRESS
HOW: CHANGE

PREVENT: FORCE / STRESS
HOW: CHANGE FORCE
HOW: MAGNITUDE, DIRECTION
**Insights on Injury**

\[
\text{Injury} = f(\text{Change}) \quad \left\{\begin{array}{l}
\text{Too Much} \\
\text{Too Fast}
\end{array}\right.
\]

\[
\text{Prevention} \quad \text{Rehabilitation} = f(\text{Patience})
\]

\[
\text{Patience} = f(\text{Controlled Change})
\]

“The human system is functionally pliable in that changes (e.g. volition, perception, learning, growth and development, etc.) are possible within the bounds of imposed constraints.”

James & Bates, 1996
How Individuals Differ

- Anatomical Structure
- Functional Capabilities
- Experiences
- Goals

Diagram:
- Structure
  - Knee Flex/Ext
  - Running
  - Chronic Injury
  - Stress

Accommodation
Stress “Modifies” Structures

Positively = “Accommodation”
or
Negatively = “Injury”
Load sufficiently to get the physiological response / accommodation for specific activity (increase acute threshold)

Vary load enough to avoid cumulative stress / injury (increase chronic threshold)

Remember: Training Errors (60%) (James et al., 1978)
Too fast a change in too short a period of time

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Physiological Response
(at any instant in time)

- Age
- Gender
- Loading Rate
- Load Duration, Magnitude
- History
  - Experience
  - Use
  - Disuse
"We are all creatures of **experience** turning into **memory**" (mentally and physically)
**Movement Constraints**

- Morphological
- Environmental
- Bio/Mechanical

★ Task

---

**Movement**

A Tool for problem solving, i.e. accomplishing a Task  
(time, space & n-m-s system)

**Constrained by:**
- Morphology
- Environment
- Bio/Mechanics
Strategy

Selected
Neuro-Musculo-Skeletal Solution
For the Performance of a Motor Task

Response Strategies
(to an Applied Load)

IGNORE ➔ Newtonian

ACCOMMODATE ➔ Neuro-muscular

ACKNOWLEDGE ➔ Combination (Biomechanical)
INJURY

CAUSE: FORCE / STRESS
HOW: CHANGE FORCE

PREVENT: FORCE / STRESS
HOW: CHANGE FORCE
HOW: MAGNITUDE, DIRECTION
How do we change the force factor (magnitude and/or direction)?

Variations within activity (changing shoes, terrain, footstrike, knee angle, etc.)

Variations by changing activity (cross training)

How do we change the force factor (magnitude and/or direction)?

Change the environment, i.e. shoes, surface, terrain, etc.

Change performance characteristics, i.e. footstrike, knee angle, etc.

Change the activity, i.e. running, cycling, crosstraining, etc.
Shoes

Running Surface
How do we change the force factor (magnitude and/or direction)?

Change the environment, i.e. shoes, surface, terrain, etc.

Change performance characteristics, i.e. footstrike, knee angle, etc.

Change the activity, i.e. running, cycling, crosstraining, etc.

Footstrike Pattern

Forefoot

Heel
Performance Characteristics

Distribute Forces

Injury?

How do we change the force factor (magnitude and/or direction)?

Change the environment, i.e. shoes, surface, terrain, etc.

Change performance characteristics, i.e. footstrike, knee angle, etc.

Change the activity, i.e. running, cycling, crosstraining, etc.
Greater Variation

Cross Training

Greater Variation

Single Activity
Chronic Injury Risk

Skill Development?
SUMMARY

Accommodation vs Injury

[Diagrams illustrating the comparison between accommodation and injury in terms of force thresholds and time/repetition]
Strategies vs Injury

Activity vs Injury
Chronic Injury Risk

Skill Development?

Activity with Variation

Variability / Variation

Specificity

Risk

Specificity (100 m)

Single Activity

Chronic Injury Risk

Cross-Training

Dilemma

Skill Performance vs Injury Risk

Take Home Lesson 1

Choice

Winning vs Wellness
Take Home Lesson 2

Injury = f (Change) \[
\begin{align*}
\begin{cases}
\text{Too Much} \\
\text{Too Fast}
\end{cases}
\end{align*}
\]

Prevention
Rehabilitation = f (Patience)

Patience = f (Controlled Change)

Some Final Suggestions

- Have Appropriate Goals
- Train/Exercise Smart
- Get Adequate Rest
- Don’t Ignore Pain
- Think Prevention
- Have Fun
It’s Your Choice!

Choose Wisely

Wellness

Injury Risk

Goals

Injury Risk

Age

Winning

Thank You!