Is eccentric strength training effective in the prevention of hamstring strains in otherwise healthy individuals?

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Outline

- Introduction
- Methods
- Results
- Discussion
  - Limitations
- Future Research
- Conclusion

"It appears to be a hamstring problem."
INTRODUCTION
Hamstring Strains: Prevalence

- 1\textsuperscript{o} soft-tissue injury in recreation & sports (Arnason, 2007)
  - 29% of injuries in sprinting
  - 16-23% of injuries in Australian Rules football

- Activities: sprinting, jumping and kicking

- High recurrence rates: 12-31% (Petersen, 2005)
Hamstring Strains: Concerns

- High recurrence rate
- Loss of function
- Long period of recovery

Petersen et al. (2005)
Hamstring Strains: Anatomy

- Posterior thigh triad
- Bi-articular arrangement: Hip & Knee
- Common site:
  Biceps femoris musculotendinous junction

Petersen et al. (2005) & Thelen et al. (2006)
Hamstring Strains: Risk Factors

Intrinsic:
- Age
- Sex
- Ethnicity
- Previous injury
- Lumbopelvic instability
- Hamstring flexibility
- Hamstring strength
- Muscle imbalance

Extrinsic:
- Fatigue
- Lack of warm-up
- Inadequate preseason training

Most significant predictor of strain

Petersen et al. (2005)
Proposed mechanism for hamstring strains:
- Rapid phase change eccentric to concentric
- Hamstrings = maximally loaded & lengthened
  (Hoskins et al., 2005)

E.g. Hamstring muscle action during gait:
- Late swing: eccentric contraction
- Heel strike: concentric contraction
  (Proske et al., 2004)
Eccentric Training

Subsequent bouts of training:
- Shift in the length-tension curve
- Peak tension generated at longer muscle lengths
- Protective effect against exercise-induced damage (Clarkson et al., 1988)

Proposed mechanism:
- Sarcomeres added in series
- Optimize angle of peak torque
- Reduce risk of potential injury (Brockett et al., 2001)
Rationale

- Lack of consensus with respect to the appropriate management of hamstring strains

- Role of eccentric training in 1° & 2° prevention of hamstring strains not clearly defined
Research Question

Is eccentric strength training effective in the prevention of hamstring strains in otherwise healthy individuals?
METHODS
Electronic Databases

- MEDLINE
- PubMed
- EMBASE
- CINAHL
- Cochrane Central Register of Controlled Trials
- Cochrane Database of Systematic Reviews
- SPORTDiscus
- PEDro
- Web of Science
Hand Searching

- Reference lists
- Articles published by leading authors
- Pertinent academic journals
- Grey literature
  - CIRRIE
  - NARIC’S REHABDATA
  - CATs
Search Terms

‘athletic injuries’ OR ‘sprains and strains’ OR ‘leg injuries’

AND

‘hamstring’ OR ‘semimembranosus’ OR ‘semitendinosus’ OR ‘biceps femoris’

AND

‘eccentric’
Inclusion Criteria

**Population**
Otherwise healthy individuals

**Intervention**
Eccentric strength training

**Comparison**
Eccentric vs. other or no training

**Outcome**
Incidence or recurrence of hamstring strain
Data Extraction

- Two independent reviewers
- Custom form

Consensus?
- Yes: accept or decline
- No: 3rd reviewer made final decision
Quality Assessment

- Two independent reviewers
- PEDro Scale
- Oxford Levels of Evidence
The Search

Electronic databases (N=508)

Duplicates removed (N=354)

Title screening (N=95)

Abstract screening (N=21)

Full text screening (N=5)

Hand searching (N=2)

Total Studies (N=7)
RESULTS
Results

- 7 studies met inclusion criteria
- PEDro: ranged from 2 to 7
- Oxford Levels: ranged from 2b to 4
- Grouped into 3 eccentric protocols:
  1. “Hamstring lowers” (n=3)
  2. Isokinetic strengthening (n=2)
  3. Other strengthening (n=2)
Effect of Eccentric Exercise

“Hamstring Lowers”
Arnason et al. (2007)

- Oxford Level = 4 (cohort study)
- PEDro = 2
- 1° & 2° prevention
- Elite male soccer players (n=17 teams)

Interventions:
A. Warm-up Stretching & Flexibility
B. Warm-up Stretching & “Hamstring Lowers”
C. Warm-up Stretching, Flexibility & “Hamstring Lowers”
D. Controls
Arnason et al. (2007)

A. Warm-up Stretching & Flexibility
B. Warm-up Stretching & “Hamstring Lowers”
C. Warm-up Stretching, Flexibility & “Hamstring Lowers”
D. Controls
Arnason et al. (2007)

Outcomes:

*Incidence* = # of hamstring strains per 1000 player hrs
*Severity* = duration of absence from play

Results:

*Incidence*
- “Hamstring Lowers” < baseline amongst all interventions
- “Hamstring Lowers” 65% < controls

*Severity*
- No sig. difference in injury & re-injury severity rates
  - All interventions vs. baseline
  - “Hamstring lowers” vs. controls
Brooks et al. (2006)

- Oxford Level = 4 (cohort study)
- PEDro = 5
- 1° & 2° prevention
- Elite male rugby players (n=546)

Interventions:
A. Strengthening
B. Strengthening & Stretching
C. Strengthening, Stretching & “Hamstring Lowers”
Outcomes:

Incidence = # of injuries per 1000 player hours
Severity = # of days lost per injury

Results:

Incidence
- “Hamstring lowers” sig. < strengthening
- “Hamstring lowers” sig. < strengthening & stretching

Severity
- No sig. difference across groups
Gabbe et al. (2006)

- Oxford Level = 2b (RCT)
- PEDro = 7
- 1° & 2° prevention
- Competitive male football players (n=220)
- Interventions:
  A. “Hamstring Lowers”
  B. Stretching & ROM
Gabbe et al. (2006)

Outcomes:

\[ \text{Incidence} = \# \text{ of hamstring strains} \]

Results:

\[ \text{Incidence} \]

- “Hamstring Lowers” group not at decreased risk for strains
- Players who completed at least 2 training sessions:
  - “Hamstring Lowers” < Strengthening & Stretching
    - (4%) < (13.2%)
- +++ drop out rate
Effect of Eccentric Exercise

Isokinetic Strengthening
Croisier et al. (2002)

- Oxford Level = 4 (cohort study)
- PEDro = 2
- 2° prevention
- Elite male athletes (n=26)
  - Soccer, track & field, martial arts
- Intervention:
  - Individualized rehab program
  - Kintrex 500® dynamometer
Outcomes:

- **Incidence** = # of hamstring strains
- **Pain** (VAS)

Results:

- **Incidence**
  - No recurrent hamstring strains @ 12 months

- **Pain**
  - VAS sig. decreased
  - Remained constant for 12 months
Queiros Da Silva et al. (2005)

- Oxford Level = 4 (cohort study)
- PEDro = 2
- 2° prevention
- Male athletes (n=8)

- Intervention:
  - Cybex® isokinetic dynamometer
  - “Classical kinesitherapy”
Queiros Da Silva et al. (2005)

Outcome:

\[ Incidence = \# \text{ of hamstring strains} \]

Results:

\[ Incidence \]
- No recurrent hamstring strains @ 8-months
Effect of Eccentric Exercise

Other Strengthening
Askling et al. (2003)

- Oxford Level = 2b (RCT)
- PEDro = 6
- 1° & 2° prevention
- Elite male soccer players (n=30)

Intervention:
A. General training & YoYo™ Flywheel ergometer (Trained)
B. General training (Control)
Askling et al. (2003)

Outcomes:

\[ \text{Incidence} = \# \text{ of hamstring strains} \]

Results:

\[ \text{Incidence} \]

- Trained (n=3) < control (n=10)

  - 6 in Trained had previous hamstring injury
  - 4 in Controls had previous hamstring injury

  - 2/6 in Trained sustained recurrent strain
  - 4/4 in Controls sustained recurrent strain
Sherry & Best (2004)

- Oxford Level = 2b (RCT)
- PEDro = 7
- 2° prevention
- Male & female athletes (n=24)

Interventions:
- A. Stretching & Strengthening (STST): “Standing foot catches”
- B. Progressive Agility & Trunk Stability (PATS)
Sherry & Best (2004)

Outcomes:

*Incidence* = # of hamstring strains

Results:

*Incidence*

- PATS (n=0) sig. < STST (n=6) @ 16 days after return to sport
- 1+ hamstring strain in each group @ 12-month follow-up
## Summary of Results

<table>
<thead>
<tr>
<th>AUTHOR (YEAR)</th>
<th>PREVENTION</th>
<th>INCIDENCE</th>
<th>SEVERITY</th>
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<tbody>
<tr>
<td><strong>“Hamstring Lowers”</strong></td>
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DISCUSSION
Discussion

- Protective effect of eccentric training
- No apparent relationship between study quality & findings
- No apparent relationship between eccentric exercise protocols & findings
Limitations

- Small # of studies
- Lack of high level research
- Poor study design
- Small sample size
Limitations

- Heterogeneous diagnosis of hamstring strains
- Heterogeneous eccentric interventions
  - Prescription
  - Not in isolation
  - Concurrent training
- Heterogeneous operational definitions
  - Incidence
  - Severity
Limitations

- Participants
  - Sex
  - Level of competition
- Adverse effects: DOMS
- Dropouts
FUTURE RESEARCH
Future Research

- Additional high level research
- Larger sample sizes
- Better controls
  - Eccentric strengthening in isolation
  - Avoid concurrent training
Future Research

Suggestions:

■ Comparison of eccentric protocols (e.g. type, prescription)

■ Comparison between athletic levels of competition

■ Male vs. female response to eccentric training
CONCLUSION
Conclusion

- Numerous studies suggest a protective effect. However, generalization of findings is limited due to a lack of high level trials.

- Until more evidence becomes available, concrete recommendations to support or counter the application of eccentric training protocols for the 1° & 2° prevention of hamstring strains cannot be made.
Acknowledgements

We would like to thank:

Dr. Darlene Redenbach
Dr. Donna MacIntyre
Ms. Charlotte Beck
Dr. Angela Busch
Dr. Susan Harris

… for their mentorship during the preparation of this systematic review


References


http://www.bu.edu/athletics/news/photos/Lee_Story31.jpg
http://www.yamakai.org/profile/side-kick-face.jpg
http://www.zonkbonk.com/media/hamstring.gif
http://bigchase.files.wordpress.com/2007/02/soccer.jpg
http://www.tacoma.k12.wa.us/schools/es/sherman/teamwork%20pic.jpg
QUESTIONS?