

Children's Hospital Medical Center Best Evidence Statement (BESt)

Date: August 3, 2011

Hip Strengthening & Tibial Stress Fracture among Adolescent Runners¹

Clinical Question

P (population/problem) Among adolescent runners ages 12 to 19 with a diagnosis of tibial stress

fracture,

I (intervention) does hip strengthening as part of a treatment or injury prevention

protocol,

C (comparison) compared to no hip strengthening

O (outcome) affect the following outcomes:

1) injury recurrence rates

2) strength

3) running mechanics?

Target Population: Adolescent runners ages 12 to 19 with a diagnosis of tibial stress fracture

Recommendation (See Table of Recommendation Strength following references)

There is insufficient evidence and a lack of consensus to make a recommendation on the inclusion of hip strengthening as part of a treatment or injury prevention protocol for adolescent runners (ages 12 to 19) who have sustained, or are at risk of sustaining, a tibial stress fracture.

Discussion/summary of evidence

Following an in-depth literature review, no evidence was found regarding hip strength and injury recurrence rates amongst adolescent runners who have sustained a tibial stress fracture.

Primary limitations in the current research are that all of the cited studies were conducted on runners older than adolescents which may limit the generalizability of the findings (Heinert 2008 [3b], Milner 2010 [4a], Snyder 2009 [4a], Pohl 2008 [4a], Niemuth 2005 [4b]). Further, the majority of the subjects were female (Heinert 2008 [3b], Milner 2010 [4a], Snyder 2009 [4a], Pohl 2008 [4a]). Lastly, the studies by Snyder and Heinert included a heterogenous group of athletes and not exclusively runners (Heinert 2008 [3b], Snyder 2009 [4a]).

In terms of hip strengthening, there is limited evidence to suggest that hip strength alters running mechanics in a healthy population (Heinert 2008 [3b], Snyder 2009 [4a]). Snyder, using a within-subject, repeated measure design in a group of fifteen healthy females (mean age 21.9 years), demonstrated that performing hip abductor and hip external rotator strengthening using a cable column system leads to statistically significant improvements to both hip abductor and hip external rotator strength (hip abduction (p = 0.009) and external rotation strength (p < 0.0005)

http://www.cincinnatichildrens.org/svc/alpha/h/health-policy/best.htm, BESt103 pages 1 to 5, 8-3-2011.

¹ Please cite as Taylor-Haas, J., Paterno, M. Cincinnati Children's Hospital Medical Center: Best Evidence Statement for Hip Strengthening & Tibial Stress Fracture among Adolescent Runners,

increased by 13% and 23%, respectively) ($Snyder\ 2009\ [4a]$). Further, these strength changes were correlated with statistically significant changes to the subjects' running mechanics. Specifically, the runners demonstrated decreased rearfoot eversion range of motion, (p = 0.05), increased hip adduction range of motion (p = 0.05), and a trend of decreased hip internal rotation range of motion (p = 0.08). Rearfoot inversion moment (p = 0.02) and knee abduction moment (p = 0.05) decreased by 57% and 10%, respectively. Heinert measured hip abductor strength on a heterogeneous group of active, recreational, female college students a priori using a hand-held dynamometer. A post-hoc analysis demonstrated that the subject group with weaker hip abductors demonstrated significantly increased knee abduction angle (p = .008) at initial contact, maximum angle, and toe-off as compared to the stronger subject (*Heinert* 2008 [3b]).

There is limited evidence linking hip weakness with tibial stress fractures in runners. In a cross sectional study comparing a heterogeneous group of injured runners to a matched control group, Niemuth found that injured side hip abductors were significantly weaker, as were the hip flexors, compared with their uninjured-side paired muscles. Runners who had sustained either a tibial or fibular stress fracture accounted for 7% (2/30) of the injured subjects (Niemuth 2005 [4b]).

Two studies have demonstrated altered running mechanics in females who have sustained tibial stress fractures. In separate cross-sectional, retrospective studies comparing three-dimensional mechanics of female runners who had sustained a tibial stress fracture (TSF) to an uninjured cohort, Pohl and Milner found that the TSF groups demonstrated increased peak rearfoot eversion compared to controls (*Milner 2010 [4a]*, *Pohl 2008 [4a]*). Further, Milner reports that the TSF group also demonstrated significantly higher peak hip adduction while no significant differences were found for the variables peak tibial internal rotation, peak hip internal rotation, and peak knee angles (*Milner 2010 [4a]*). Pohl reports a logistic regression model containing the variables peak rearfoot eversion, peak hip adduction, and free moment correctly classified 83% (50/60) runners into TSF or control group (*Pohl 2008 [4a]*).

Three studies suggest further inquiry into the association between hip strength, foot pronation, and tibial stress fracture should be explored. Both Pohl and Milner found that females runners who have sustained a tibial stress fracture have higher peak rearfoot eversion, a component of foot pronation, compared to matched-controls (*Milner 2010 [4a], Pohl 2008 [4a]*). Further, Synder demonstrated that in healthy female subjects, increasing the hip abductor and external rotator strength lead to decreased peak rearfoot eversion (*Snyder 2009 [4a]*).

Additional limitations are that while the studies by Pohl and Milner demonstrated gait differences in runners who have sustained a tibial stress fracture compared to matched-controls, these case control studies are retrospective in nature and thus a cause and effect relationship cannot be established. Further, the authors did not include hip strength in their studies thus limiting the ability to infer potential reasons why the runners who had sustained a TSF demonstrated altered gait mechanics. It is possible the TSF runners adopted these gait differences once they resumed running post stress fracture recovery (*Milner 2010 [4a]*, *Pohl 2008 [4a]*).

Health Benefits, Side Effects and Risks

Because no recommendation for practice change is being made at this time, there are minimal health benefits, side effects, and risks to report.

Research Agenda

A major area for future inquiry may include relating hip strength and three-dimensional gait mechanics of both runners who have sustained a tibial stress fracture and those at risk for sustaining a tibial stress fracture.

References (evidence grade in []; see Table of Evidence Levels following references)

Note: When using the electronic version of this document, **⋄** indicates a hyperlink to the PubMed abstract. A hyperlink following this symbol goes to the article PDF when the user is within the CCHMC network.

- 1. **Bennell, K. L., and Brukner, P. D.:** Epidemiology and site specificity of stress fractures. *Clin Sports Med,* 16(2): 179-96, 1997, [4a] _________.
- 2. **Bennell, K. L.; Malcolm, S. A.; Thomas, S. A.; Reid, S. J.; Brukner, P. D.; Ebeling, P. R.; and Wark, J. D.:** Risk factors for stress fractures in track and field athletes. A twelve-month prospective study. *Am J Sports Med*, 24(6): 810-8, 1996, [4a] _____ .
- 4. **Hreljac, A.; Marshall, R. N.; and Hume, P. A.:** Evaluation of lower extremity overuse injury potential in runners. *Med Sci Sports Exerc*, 32(9): 1635-41, 2000, [4b] ________. ▼.
- 6. **Milner, C. E.; Hamill, J.; and Davis, I. S.:** Distinct hip and rearfoot kinematics in female runners with a history of tibial stress fracture. *J Orthop Sports Phys Ther*, 40(2): 59-66, 2010, [4a] _______. ❖.
- 7. **Niemuth, P. E.; Johnson, R. J.; Myers, M. J.; and Thieman, T. J.:** Hip muscle weakness and overuse injuries in recreational runners. *Clin J Sport Med*, 15(1): 14-21, 2005, [4b] ______.
- 8. **Pohl, M. B.; Mullineaux, D. R.; Milner, C. E.; Hamill, J.; and Davis, I. S.:** Biomechanical predictors of retrospective tibial stress fractures in runners. *J Biomech*, 41(6): 1160-5, 2008, [4a]

Note: Full tables of evidence grading system available in separate document:

- Table of Evidence Levels of Individual Studies by Domain, Study Design, & Quality (abbreviated table below)
- Grading a Body of Evidence to Answer a Clinical Question
- <u>Judging the Strength of a Recommendation</u> (abbreviated table below)

Table of Evidence Levels (see note above)

Quality level	Definition
1a† or 1b†	Systematic review, meta-analysis, or meta- synthesis of multiple studies
2a or 2b	Best study design for domain
3a or 3b	Fair study design for domain
4a or 4b	Weak study design for domain
5 or 5a or 5b	Other: General review, expert opinion, case report, consensus report, or guideline

 $\dagger a = good quality study; b = lesser quality study$

Table of Recommendation Strength (see note above)

Strength	Definition
"Strongly recommended"	There is consensus that benefits clearly outweigh risks and burdens (or visa-versa for negative recommendations).
"Recommended"	There is consensus that benefits are closely balanced with risks and burdens.
No recommendation made	There is lack of consensus to direct development of a recommendation.

Dimensions: In determining the strength of a recommendation, the development group makes a considered judgment in a consensus process that incorporates critically appraised evidence, clinical experience, and other dimensions as listed below.

- 1. Grade of the Body of Evidence (see note above)
- 2. Safety / Harm
- 3. Health benefit to patient (direct benefit)
- 4. Burden to patient of adherence to recommendation (cost, hassle, discomfort, pain, motivation, ability to adhere, time)
- 5. Cost-effectiveness to healthcare system (balance of cost / savings of resources, staff time, and supplies based on published studies or onsite analysis)
- 6. Directness (the extent to which the body of evidence directly answers the clinical question [population/problem, intervention, comparison, outcome])
- 7. Impact on morbidity/mortality or quality of life

Supporting information

Introductory/background information

Annually, 27-70% of runners will sustain an injury (Hreljac 2000 [4b]) with stress fractures accounting for between 6.0% and 15% of those injuries (Bennell 1997 [4a]). The tibia is the most common location for this injury, accounting for between 20% and 45% of all stress fractures (Bennell 1996 [4a]), and is a devastating injury requiring up to 12 weeks of rehabilitation (Matheson 1987 [4b]). Therefore, it is imperative that effective interventions are found that can both effectively treat and assist in preventing this injury from occurring.

BESt Development Team

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All Team Members have signed a conflict of interest declaration.

Search strategy

Search Dates: All dates up to May 3, 2011

Search Engines, Databases and Web Sources: A comprehensive search strategy was used and included searching the following databases: PubMed, Ovid, Medline, Cochrane Library, Cinahl, SPORTDiscus, Scopus, ACP Journal Club.

Search Terms: stress fracture, tibia, running, treatment, prevention, gait, kinematics, kinetics, strength, hip, hip strength, injury recurrence. The references of the studies meeting the search criteria were then hand-searched.

Copies of this Best Evidence Statement (BESt) are available online and may be distributed by any organization for the global purpose of improving child health outcomes. Website address: http://www.cincinnatichildrens.org/svc/alpha/h/health-policy/ev-based/default.htm Examples of approved uses of the BESt include the following:

- copies may be provided to anyone involved in the organization's process for developing and implementing evidence based care:
- hyperlinks to the CCHMC website may be placed on the organization's website;
- the BESt may be adopted or adapted for use within the organization, provided that CCHMC receives appropriate attribution on all written or electronic documents; and
- copies may be provided to patients and the clinicians who manage their care.

Notification of CCHMC at https://example.com/HPCEInfo@cchmc.org for any BESt adopted, adapted, implemented or hyperlinked by the organization is appreciated.

For more information about CCHMC Best Evidence Statements and the development process contact: Center for Professional Excellence/Research and Evidence-based Practice office at CPE-EBP-Group@cchmc.org.

Note

This Best Evidence Statement addresses only key points of care for the target population; it is not intended to be a comprehensive practice guideline. These recommendations result from review of literature and practices current at the time of their formulation. This Best Evidence Statement does not preclude using care modalities proven efficacious in studies published subsequent to the current revision of this document. This document is not intended to impose standards of care preventing selective variances from the recommendations to meet the specific and unique requirements of individual patients. Adherence to this Statement is voluntary. The clinician in light of the individual circumstances presented by the patient must make the ultimate judgment regarding the priority of any specific procedure.

Reviewed against quality criteria by 2 independent reviewers.