Overuse Injuries in Endurance Athletes

Chad Asplund, MD
Primary Care Sports Medicine
Team Physician
The Ohio State University

Learning Objectives

- 1. Describe etiology of common injuries of endurance athletes.
- 2. Use a pathoanatomic approach in the diagnosis and treatment of injuries in the endurance athlete.
- 3. Use the best available evidence to guide treatment decisions for injuries in the endurance athlete.

Disclosure

- I have no commercial, financial or research relationships that affect my ability to provide a fair and balanced presentation for this CME activity

Overuse

- Main injury type in endurance athletes is overuse!!

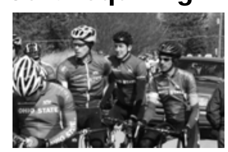
Overuse Injuries - Triathletes

- 95 competitors (75 men, 20 women) in the 1986 Hawaii Ironman Triathlon
- At least 91% sustained at least one soft tissue, overuse injury during the previous year's training

'Overuse Injuries in Ultraendurance Triathletes,' American Journal of Sports Medicine, Vol. 17, pp. 514-518, 1989

Overuse Injuries - Bicyclists

- 294 male, 224 female recreational cyclists responded to mail in questionnaire
- Overall, 85% of the cyclists reported one or more overuse injury, with 36% requiring medical treatment.
- Most common sites: Neck, knee, back
- Female cyclists 1.5 – 2.0 times more likely to be injured



Wilber, et al. Int J Sports Med. 1995 Apr;16(3):201-6

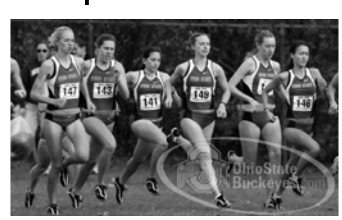
Overuse Injuries - Running

- Marathon Runners
- Yearly incidence rate of injury about 90% [Satterthwaite]
- Risk of injury increases over 40mpw RR 2.88
- Knee injuries (PFPS) most common

Satterthwaite, et al. Br J Sports Med 1996; 30: 324-6
Fredericson, et al. Sports Med 2007; 37: 4-5.

Overuse Injuries – Summary

- Common in all endurance athletes at all levels of competition.



Overuse Injuries

- Common injuries:
  - ✓ Tendinopathies
  - ✓ Patellofemoral Pain Syndrome
  - ✓ IT Band Syndrome
  - ✓ Stress Injury/Fracture

Intrinsic Factors

- Malalignment
- Leg length discrepancy
- Muscle weakness
- Inflexibility
- Body size
- Body composition

Overuse Injuries

- Generally multifactorial in origin
- Interaction between intrinsic and extrinsic factors
- Intrinsic factors account for up to 2/3 of all achilles tendon disorders in athletes [Kvist]

Kvist M. Achilles tendon injuries in athletes. Sports Med 1994; 18: 173-201.

Extrinsic Factors

- Training Errors
- Surfaces
- Shoes
- Equipment
- Environmental Conditions
- Outside Stressors
- Inadequate Nutrition

Tendinopathy

- Tendons connect muscle to bone – allow transmission of force from muscle to bone
- Overuse tendon injuries account for 30% of all running related injuries [James]

Tendinopathy

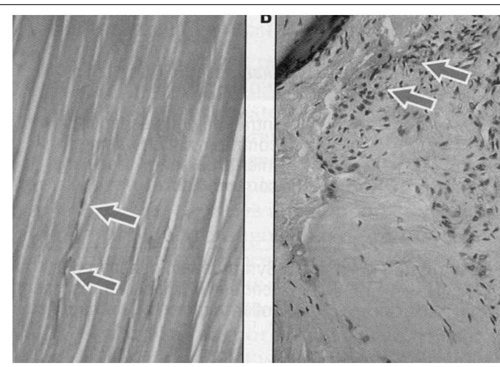
- Increased mucoid ground substance
- Increase in myofibroblastic cells
- Discontinuity of collagen fibers
- Abrubt discontinuity of vascularity with myofibroblastic proliferation adjacent to abnormal area
- Absence of inflammatory cells

Tendinopathy

- Etiology unclear
- Many causes theorized:
- Ischemia/reperfusion leading to free radicals [Astrom]
- Hypoxia alone may lead to degeneration [Birch]
- Stress activated proteins within the tendon [Yuan]

Astrom [Thesis] University of Lund 1997
Birch, et al. Res Vet Sci 1997; 62: 93-7.
Yuan, et al. Clin Sports Med 2003; 22: 693-701.

Normal Tendon and Tendinosis

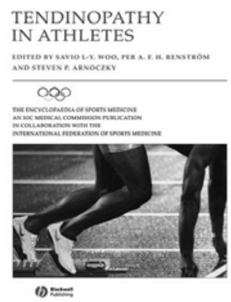


Tendinopathy

- Common sites of tendinosis in endurance athletes:
- Patellar tendon
- Achilles tendon
- Medial tibia
- IT Band
- Hamstring

Treatments for Tendinopathy - Evidence

- Eccentric muscle training
- Topical glyceryl nitrate
- ESWT
- Steroid injection
- Other injectable agents



Treatments for Tendinopathy

Table 1 Conservative treatments for chronic tendinopathy.[a]

Treatment	Putative target or mode of action
Rest or modification of activity	Removal of precipitating factors and prevention of reinjury
Orthotics (e.g. heel inserts)	As above
Cryotherapy (e.g. ice packs and baths)	Reduction of acute inflammation and decrease in cell metabolism
Heat treatment	Stimulation of cell activity and increase in blood flow
Physiotherapy (including massage and controlled motion)	As above
Electrical stimulation	Reduction of pain perception, stimulation of blood flow and increase in cell activity
Laser treatment (pulsed or continuous)	Possible analgesic effects and unspecified (unknown) effects on cell activity
Pulsed electromagnetic fields	As above
Ultrasound (0.75–3.0 MHz; pulsed or continuous)	Thermal effects on tissue, stimulation of cell activity and increased blood flow
Extracorporeal shock-wave therapy	As above, with possible stimulatory effects on neovascularization and inhibition of nociception
NSAIDs	Reduction of inflammation through inhibition of prostaglandin synthesis
Corticosteroid injection (peritendinous)	Reduction of inflammation and other unknown effects (generally inhibitory of protein synthesis)
Low-dose heparin	Effect on tendon blood flow; possibly results in improved healing
Actovegin (deproteinized extract of calf's blood)	Unknown (suggested to promote glucose uptake and other effects on tendon cell metabolism that promote repair and resolution)
Glycosaminoglycan polysulfate	Inhibition of inflammation, possibly also acting to inhibit metalloproteinase enzyme activity
Eccentric exercise therapy	Thought to promote restoration of normal tissue structure, possibly through an effect on cell activity and matrix remodeling
Sclerosant injection (ultrasound-guided)	Blocks tendon blood flow (targets neovascularization and associated nerve in-growth)
Platelet-rich plasma injection	Contains growth factors (e.g. transforming growth factor β and platelet-derived growth factor) that promote matrix synthesis and tissue repair

[a]Few treatments for chronic tendinopathy are targeted against specific molecular processes. In most cases, there is little or no evidence of therapeutic effectiveness, especially in the long term. Large, appropriately controlled clinical trials with extended follow-up are required.

Eccentric loading exercises

- Curwin and Stanish in 1984 first showed effectiveness of eccentric load in achilles tendinopathy with 6 week program. (no pain)
- Alfredson then adapted this program to 12 weeks (pain to tolerance)
- Shalibi showed immediate change on MR to achilles with eccentric exercises

Curwin, et al. Tendinitis: its etiology and treatment 1984.
Alfredson, et al. AJSM 1998; 26: 360-6.
Shalibi, et al. AJSM 2004; 32: 1286-96.

Eccentric exercises for tendinopathy

- Systematic review of 9 clinical trials:
- The effects of eccentric exercise training in patients with chronic Achilles tendinopathy on pain are promising [Kingma] but quality evidence not sufficient
- However, Woodley, et al. in a systematic review of 20 trials found that there was not sufficient evidence to recommend EE

Kingma, et al. Eccentric overload training in patients with chronic Achilles tendinopathy: a systematic review. *British Journal of Sports Medicine* 2007;41:e3
Woodley BL *et al.* (2007) Chronic tendinopathy: effectiveness of eccentric exercise. *Br J Sports Med* 41: 188–198

Eccentric Exercises - Summary

- Success:
- Right injury – no partial tear
- Right patient – off season/low load
- Certain tendons respond better – achilles, patella
- ?? Need inflammatory mediator before eccentric activities (under study)

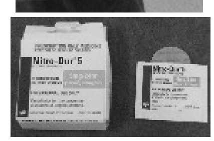
Why do eccentric exercises fail?

- (1) Ongoing overload (i.e. players in season, but also those who overload in ADLs)
- (2) Pathological changes so severe that reversal is not possible with first line treatment.

✓(a) partial rupture – unrepaired
✓(b) calcific changes
✓(c) neovascularisation

Topical glyceryl nitrate

- NO is important to healing
- Paoloni, et al. looked at application of patch daily x 6 months vs. placebo
- Decreased pain at 12 and 24 weeks with improved outcomes at 6 months
- Studies also positive in lateral epicondylosis and supraspinatous tendinosis [Murrell]



Paoloni, et al. JBJS 2004; 86A: 916-21.
Murrell. BJSM 2007; 41: 227-31.

Nitrates

- Kane, et al. found that there was no benefit when using NO patches for achille's tendinopathy
- Overall, the evidence is contradictory, but they may be helpful in some athletes

Kane TP, et al. AJSM 2008; 36: 1160-1163.

Other Injection Therapies

- Sclerosant injections have been shown to give at least short term benefit [Alfredson]
- May provide a rational basis for targeting neovascularization in painful tendinopathy, which might be triggered initially by hypoxia and regulated by levels of endostatin and vascular endothelial growth factor.[Pufe]

Alfredson H Knee Surg Sports Traumatol Arthrosc 2005 13: 338–344
Pufe T et al. Virchows Arch 2001 439: 579–585
Pufe T et al. J Orthop Res 2003 21: 610–616

ESWT

- Shock-wave therapy, which is thought to function on the tenocytes to stimulate repair, might be effective in a carefully selected group of patients [Rompe]
- In animal model may induce tissue regeneration [Wang]
- Other studies, however, have reported no significant effect.[Speed][D'Vaz]

Rompe JD et al. Am J Sports Med 2007 35: 374–383
Wang CJ, et al. J Orth Res 2006; 21(6): 984-989
Speed CA J Bone Joint Surg Br 2004 86: 165–171
D'Vaz AP et al. Rheumatology (Oxford) 2006 45: 566–570

Other Injection Therapies

- Systematic review of four injection therapies (PrT, polidocanol, whole blood and platelet rich plasma) for refractory lateral epicondylosis
- Eight studies (five prospective case series, three controlled trials) included
- There is strong pilot-level evidence supporting the use of prolotherapy, polidocanol, autologous whole blood and platelet-rich plasma injections in the treatment of LE.

Rabago, et al. A systematic review of four injection therapies for lateral epicondylosis: prolotherapy, polidocanol, whole blood and platelet rich plasma. BJSM Published Online First: 21 November 2008. doi:10.1136/bjsm.2008.052761

Cortisone Injections

- Used for decades
- Very few RCTs
- Give short-term pain relief
- Weaken the tendon
- Anti-inflammatory but may not be mechanism of action (symptom relief)
- Relieve impingement
- Associated with rupture

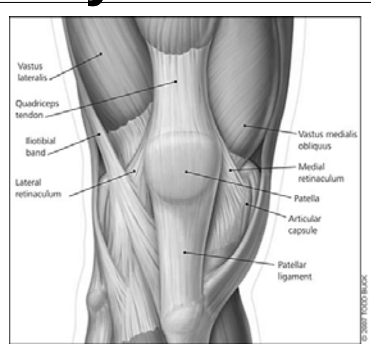
Tendinopathy - Summary

- Currently more evidence in support of eccentric exercises than the other interventions
- Low cost and low risk makes these exercises ideal first-line therapy.
- Alternative treatment should be considered in patients who are unable or unwilling to perform or have failed treatment with these exercises.
- ESWT, injections of sclerosing agents, and topical glyceryl nitrate application show promise in early studies without known complications to date, but additional study is needed.

Does surgery work for tendinopathy?

- Previous paradigm of rest, NSAID tablet, cortisone injection and then surgery is no longer valid
- Surgery helpful for shoulder tendinopathy, adductor tendinopathy and probably tennis elbow, plantar fasciitis.
- Seems to be minimally helpful for patellar tendinopathy and insertional Achilles tendinopathy
- No agreement on surgical technique

Patellofemoral Pain Syndrome



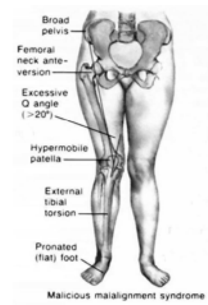
Patellofemoral Pain Syndrome

- Loosely defined as retro or peripatellar pain secondary to physical and biochemical changes to the patellofemoral joint
- Patella moves in multiple directions (up/down, tilts, rotates) causing various points of contact between patella and femur
- Multifactorial in nature

Etiology of PFPS

- Q angle often increased
- Normal:

  Male <15-20º;
  Female <20-25º
- The value of this measurement for predicting PFS has been questioned



Etiology of PFPS

- Overload and overuse
- Pes planus: “miserable malalignment” syndrome
- Pes cavus: high arched foot causes decreased cushioning with more stress on the patellofemoral mechanism

Etiology of PFPS

- One study found similar Q angles in those with and without PFS. Another found similar Q angles in affected and non-affected legs
- Similar results have been seen in studies regarding sulcus and congruence angles of the PF articulation

History: Clues to Diagnosis

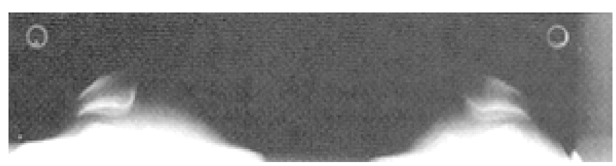
- Anterior knee pain activity related
- Pain worsens with stairs and hills
- Pain worsens with prolonged knee flexion especially with sitting (“theater sign”)
- Giving way or buckling of knee because of quad reflex inhibition secondary to pain
- May have popping or snapping

Imaging

- In general needed to rule out other possible diagnoses, not needed to confirm PFS
- Standard views would include a standing AP, lateral in 20 degrees of flexion, tunnel view and a sunrise or merchants view

Examination Signs

- Abnormal patellar tracking with extension
- Positive patellar grind and/or inhibition testing
- May have small effusion
- VMO atrophy or weakness
- Various muscle group tightness



Axial view showing bliateral patellar subluxation

Hip and PFPS

- Prospective cohort study of 35 runners with PFPS followed in a 6 week treatment program
- Improvements in hip flexion strength combined with increased iliotibial band and iliopsoas flexibility were associated with excellent results in patients with patellofemoral pain syndrome. [Tyler]

Tyler, et al. The Role of Hip Muscle Function in the Treatment of Patellofemoral Pain Syndrome Am J Sports Med April 2006 vol. 34 no. 4 630-636

Treatment of PFS

- PRICEMM
- Quad strengthening (VMO) and PT
- Hip abductor/external rotator strength
- Knee sleeves, PF braces and taping
- Footwear and arch supports
- Surgery – only after a prolonged aggressive rehabilitation process

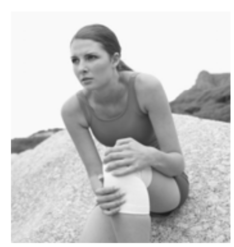
Hip and PFPS

- Systematic review of 5 cross sectional studies
- Females with patellofemoral pain syndrome demonstrate a decrease in abduction, external rotation and extension strength of the affected side compared with healthy controls. [Prins]

Prins, et al. Females with patellofemoral pain syndrome have weak hip muscles: a systematic review. Aust J Physiother. 2009;55(1):9-15.

PFPS - Summary

- Common problem
- Combination of anatomy and muscular imbalance
- Treatment focuses on quad strength and hip girdle strength

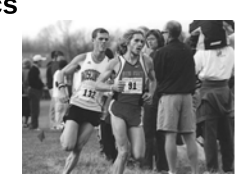


Iliotibial Band Syndrome

- Very common cause of lateral knee pain in peds especially runners
- Due to recurrent friction of the iliotibial band across the lateral femoral epicondyle
- Acts to abduct the thigh (decelerate or control adduction) and anterolateral stabilizer of the knee

Hip and PFPS/ITBS

- Large and growing body of literature suggests that weakness of hip-stabilizing muscles leads to atypical lower extremity mechanics and increased forces within the lower extremity while running. [Ferber]



Ferber, et al. Suspected Mechanisms in the Cause of Overuse Running Injuries: A Clinical Review. Sports Health 2009;1(3): 242-246.

ITBS: Why?

- ITB is free from bony attachment from superior portion of lateral femoral epicondyle to lateral tibia (Gerdy's tubercle)
- ITB slides anteriorly in knee extension and posteriorly in knee flexion - tense in both positions
- Multiple biomechanical influences can increase friction and inflammation

Hip and PFPS/ITBS

- There is a strong association between hip abductor, adductor, and flexor muscle group strength imbalance and lower extremity overuse injuries in runners. [Niemuth]
- The addition of strengthening exercises to specifically identified weak hip muscles may offer better treatment results in patients with running injuries.

Niemuth, et al. Hip Muscle Weakness and Overuse Injuries in Recreational Runners. CJSM 2005; 15(1): 14-21.

ITBS: History and Physical

- Lateral knee sharp pain or burning, initially with activity then persistent
- Localized lateral knee tenderness, occasionally pain along the course of the iliotibial band
- Assess strength and flexibility of other muscle groups

ITBS - Summary

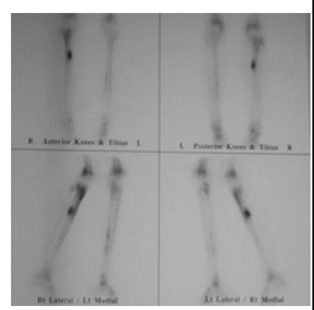
- Common problem
- Combination of anatomy and muscular imbalance
- Treatment focuses on quad strength and hip girdle strength

ITBS: Treatment

- Acute phase: ice and phonophoresis, activity modification, NSAIDs. If grossly visible swelling persists for longer than 3 days corticosteroid injection is warranted
- Subacute phase: stretching and strengthening, gradual resumption of regular activity

Stress Injury

- Common in endurance athletes
- Spectrum of diseases
- In tibia ranges from:
- Shin splints
- MTSS
- Stress Rxn
- Stress Fx
- FX



Stress Fracture

- Microfracture of bone that results from repetitive physical loading
- Localized pain and tenderness at fracture site
- Recent change in training
- Worse with impact, increases with exercise
- Initial radiographs often negative
- May need further imaging

Physical Exam

- Local bone tenderness
- – ++ Metatarsal, tarsal navicular, tibia, forearm
- – +/- Pelvis, lumbar spine, rib, proximal humerus
- – ? Femoral neck, femoral shaft
- –
- Other helpful tests
- –Lumbar spine- pain with extension, single leg extension
- –Femoral neck- internal rotation, log roll
- –Tibia, femur- hop test
- –Long bones- fulcrum test

Pain Continuum

- 1 Mild Stress Reaction
  - ✓ Local pain toward end of activity
- 2 Moderate Stress Reaction
  - ✓ Local pain earlier during activity
- 3 Severe Stress Reaction
  - ✓ Significant pain throughout activity, persists
- 4 Stress Fracture
  - ✓ Pain with daily activities and rest

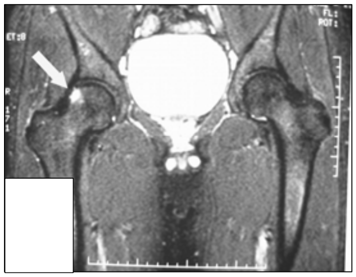
[Jones ESSR 1989]

Risk Factors for Stress Fx

- Repeated loading of the bone
- Menstrual disturbances, caloric restriction, lower bone density, muscle weakness and leg length differences [Bennell]
- Previous stress fractures, lower bone mass, and possibly menstrual irregularity [Kelsey]
- Female gender and low aerobic fitness measured by run times are risk factors [Jones]

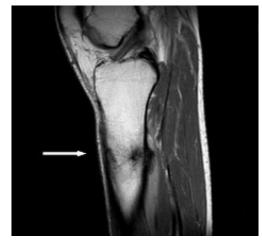
Stress Fx – High Risk

- High Risk
- Femoral neck
- Tibia anterior cortex
- Medial malleolus
- Talus
- Navicular
- 5th metatarsal
- Great toe sesamoids
- Spine- bilateral pars (spondy)



Stress Fx - CT

- Very good for imaging bones
- One particularly useful application of CT is for the evaluation of stress injuries of the spine
- Limited in demonstrating the activity of the lesion
- May need bone scan



Imaging Stress Fracture

- Start with high resolution radiographs
- radiographic findings can sometimes lag behind the clinical presentation
- May need advanced imaging
  - ✓ CT
  - ✓ MR
  - ✓ Bone Scan

Stress Fx – Bone Scan

- Scintigraphy is sensitive for diagnosing early stress remodeling and stress fractures
- Although nuclear medicine scintigraphy is quite sensitive for the evaluation of bone turnover and therefore can detect very early development of stress reactions or stress fractures, this method is not specific for fractures
- Nuclear medicine examinations must be interpreted with close correlation of conventional radiographs as well as the patient's clinical history

Stress Fx - MR

- MRI can provide detailed information regarding the presence of a stress fracture or stress reaction, especially in cases in which the radiographic findings are inconclusive
- MRI provides a comprehensive evaluation of the area in question, providing morphologic as well as functional information
- MRI as a routine diagnostic imaging modality was superior to radionuclide bone scan [Shin]

Shin A.Y., et al. *Am J Sports Med* (1996) 24 : pp 168-176.

Stress Fx - Treatment

- Stress fractures are best managed by prevention.
- Training errors, such as an excessive increase in intensity, are the most frequent culprit and should be corrected. [Boden]
- Athletes, coaches, military personnel, and parents should be educated about the deleterious effects of overtraining and the importance of periodic rest days.
- In addition, female athletes and their coaches need to be alerted to the adverse effects of eating disorders and hormonal abnormalities.

Stress Fx - MR

- MR imaging is the single best technique in assessment of patients with suspected tibial stress injuries [Gaeta]
- Sensitivity 88%, Specificity 100% compared to Sens 40-70% and Spec 62-92%

Gaeta, et al. Radiology 2005: 235, 553-561.

Stress Fx - Management

- Stress fracture management should take into consideration the injury site (low versus high risk), the grade (extent of microdamage accumulation), and the individual's competitive situation.
- Low-risk stress fractures usually respond well to nonoperative management, and treatment is largely guided by the patient's symptoms.
- High-risk stress fractures should be treated more aggressively with absolute rest or surgical fixation, with the goal of fracture healing and minimizing risk of complete fracture or refracture.

Stress Fx - RTP

- Graduated Load Program
- Stage 0 pre-entry walking aids
- Stage 1 walk jog 2d on 1d off
- Stage 2 jog every other
- Stage 3 4 jog loads per week
- Stage 4 5 running loads per week
- Stage 5 sport activity
- Pain guides the level

Summary

- Overuse injuries are common
- Prevention is the best treatment

Stress Fx – RTP

- May use pneumatic braces, sleeves
- Ultrasound
- Meds?
- Cyclic or cross training for athlete and body part
- Swimming, cycling, weight training, stretching
- 6 to 8 week recovery is usual