



855-UOA-DOCS UOANJ.com

Outline

- Case presentation
- Diagnosis
- Management
- Conclusion





• 17 y/o male w throbbing pain in the anterior lower leg, worse w activity





History

What happened?

• The pain developed gradual pain while running. Pain worsened with increased activity, and persisted a short while after cessation

• Location?

• Anterior mid-distal right lower leg

• When?

Symptoms began 3 months prior to presentation, have worsened in intensity and frequency over the last month

• Current symptoms?

Persistent dull pain during activity, mild swelling; worse on hard surfaces

• Other pertinent history?

• Pt is a cross country runner x 3 years; prior to onset, pt was running 40-50 miles/wk

• Treatment?

Stretching, compression sleeve, ice



Physical Exam

- Pain? Focal tenderness at anterior tibia
- Swelling?
 - Mild diffuse swelling in lower leg
- Gait, ROM, NV exam, laxity?
 - WNL



Imaging

• X-rays, MRI













Diagnosis

• 17 y/o male w right tibia bone stress injury







- Case presentation
- Diagnosis
- Management
- Conclusion



What are Bone Stress Injuries (BSI)?



Pathophysiology

- BSI describes a spectrum of injury, including tibial periostitis, medial tibial, stress syndrome, stress, reaction, and stress fracture.
- Occurs from an imbalance in bone remodeling in which microtrauma outpaces the capacity of the bone to heal



Mechanism of Injury

- In competitive athletics and military training, abnormal cyclic loading can induce these injuries in normal bone
- The threshold of loading activity resulting in BSI can be even lower for those with nutritional, hormonal or anatomic variances







AKA

- "Stress fracture"
- "Bone Marrow Edema"
- "Insufficiency Fracture"
- "Bone contusion"
- "Impaction fracture"



Epidemiology

- Females > Males (1.8-2.3x)
- Extremes of body weight (low/high BMI)
- Caucasians
- Most BSIs occur in the lower leg (24%) and foot (23%)

Epidemiology of Bone-Stress Injuries and Health Care Use in Pac-12 Cross-Country Athletes

Robert Aaron Wayner, PT, DPT*; Cathleen N. Brown Crowell, PhD, ATC†; Viktor Bovbjerg, PhD, MPH†; Michael Federicson, MD‡; Michael Soucy, MS†; SeokJae Choe, MA, ATC†; Janet E. Simon, PhD, ATC§

*Division of Physical Therapy, School of Rehabilitation and Communication Sciences and §Division of Athletic Training, School of Applied Health Sciences & Wellness, Ohio University, Athens; †College of Public Health and Human Sciences, Oregon State University, Corvallis; ‡Department of Orthopaedic Surgery, Stanford University, Redwood City, CA



Epidemiology

- Retrospective three year injury surveillance of multiple sports shows BSI as 0.15% of all injuries
- Track and field is the sport with the highest injury rates, w BSI up to 20% of MS injuries
- Also high in military recruits, with avg incidence of 20/1000 stress fxs in the first 6 months
- Female recruits have a 4x greater hazard of BSI in the first 6 months

Evidence-Based Treatment and Outcomes of Tibial Bone Stress Injuries

Naveen M. Jasty, BS¹; Paige Dyrek, MD²; Japsimran Kaur, BS^{2,3}; Kathryn E. Ackerman, MD, MPH¹; Emily Kraus, MD²; Benton E. Heyworth, MD¹

¹Division of Sports Medicine, Department of Orthopedic Surgery, Boston Children's Hospital, Boston, MA; ²Division of Physical Medicine and Rehabilitation, Department of Orthopedic Surgery, Stanford University, Redwood City, CA; ³University of Rochester School of Medicine and Dentistry, Rochester, NY

Review

Risk Factors, Diagnosis and Management of Bone Stress Injuries in Adolescent Athletes: A Narrative Review

Belinda Beck ^{1,2,*} and Louise Drysdale ^{1,3}

¹ School of Health Sciences and Social Work, Griffith University, Gold Coast, QLD 4222, Australia; louise.drysdale2@griffithuni.edu.au

UOA

- ² The Bone Clinic, Brisbane, QLD 4151, Australia
- Queensland Ballet, Brisbane, QLD 4101, Australia
- Correspondence: b.beck@griffith.edu.au

Nutritional Factors

- <u>RED-S</u> (Relative Energy Deficiency in Sport)
 - Can cause disruptions in immuno, GI, CV, psych, developmental, metabolic, and endocrine systems
 - Evidence based rvw suggests optimal energy availability (EA) in women of 45 kcal/kg FFM/day, w EA <30 kcal/kg threshold for low EA
- <u>Female Athlete Triad</u> (Eating disorder, menstrual dysfxn, low BMD)

Ŕvw shows 29% collegiate female athletes were placed as mod-high risk for Triad, w moderate risk 2x and high risk 4x as likely to have BSI Operative Techniques in Sports Medicine Volume 31, Issue 3, September 2023, 151025

UOAY

Relative Energy Deficiency in Sport (RED-S) and Bone Stress Injuries

Daniel R. Kim, Kathleen Weber 온 🛛

Midwest Orthopaedics at Rush, Chicago, IL

Association of the Female Athlete Triad Risk Assessment Stratification to the Development of Bone Stress Injuries in Collegiate Athletes

Adam S. Tenforde,^{*} MD, Jennifer L. Carlson,[†] MD, Audrey Chang,[‡] BA, Kristin L. Sainani,[§] PhD, Rebecca Shultz,^{||} PhD, Jae Hyung Kim,[¶] MD, Phil Cutti,^{||} MS, Neville H. Golden,[†] MD, and Michael Fredericson^{¶#} Investigation performed at Boswell Human Performance Laboratory, Department of Orthopaedic Surgery, Stanford University, Stanford, California, USA

Nutritional Factors

- Vitamin D, calcium deficiency
- Recommended Daily intake for adults:
 - 1000 IU Vit D, 1200mg Calcium
 - Consider supplementing
- Therapeutic bone health levels:
 50-100 nmol/mL (20-40ng/mL)
- Sys rvw of >2000 athletes showed 56% Vit D deficient (<32 ng/mL)
- In NCAA D1 athletes, rate of stress fx 12% higher in athletes w Vit D <40 ng/mL (100 nmol/mL)

Association of Serum Vitamin D Levels and Stress Fractures in Collegiate Athletes

David Millward,^{*†} MD, MS, CAQ-SM, Allison D. Root,[†] MS, RDN, Jeremy Dubois,[†] MPH, Randall P. Cohen,[†] DPT, ATC, Luis Valdivia,[†] Bruce Helming,[†] MD, Justin Kokoskie,[†] MA, ATC, Anna L. Waterbrook,[†] MD, CAQ-SM, and Stephen Paul,[†] MD *Investigation performed at University of Arizona, Tucson, Arizona, USA*

VITAMIN D IN ORTHOPAEDICS

Elaine Y. Tran, MD Richard L. Uhl, MD Andrew J. Rosenbaum, MD

Investigation performed at the Division

Medical College, Albany, New York

of Orthopaedic Surgery, Albany

Abstract

» Defining vitamin D deficiency or in remains controversial because of the on each individual.

» A variety of orthopaedic population insufficient vitamin D levels, includi Football League (NFL) athletes, and shoulder arthroplasty and foot and a reflection of the overall prevalence



Metabolic / Anatomic conditions

- Prior BSI is strongest risk factor for future BSI
- Celiac disease
- IBS/IBD
- Hyperparathyroidism
- Osteogenesis Imperfecta
- Pes plants/cavus, hip IR, Increased Q angle, limb length discrepancies, trauma

Factors Associated With High-Risk and Low-Risk Bone Stress Injury in Female Runners

Implications for Risk Factor Stratification and Management

Adam S. Tenforde,*[†] MD, Kathryn E. Ackerman,^{‡§} MD, MPH, Mary L. Bouxsein,^{§||} PhD, Logan Gaudette,[†] MS, Lauren McCall,[‡] BA, Sara E. Rudolph,[§] MD, MPH, Sarah Gehman,[§] BS, Margaret Garrahan,[§] BS, Julie M. Hughes,[¶] PhD, Jereme Outerleys,[†] MS, Irene S. Davis,[#] PhD, and Kristin L. Popp,^{§¶**} PhD

Investigation performed at Massachusetts General Hospital, Boston, Massachusetts, USA

Prevalence of metabolic bone disorders in patients with bony stress injuries - implications for endocrine services

Christopher Speers ¹, Charlotte Cadge ², Neil Gittoes ², Kim Gregory ¹& Zaki Hassan-Smith ²,



Other Risk Factors

- Running/Jumping sports
- Rapid increase in training
- Poor pre participation conditioning
- Extremes of body size/composition
- Running on irregular/angled surfaces
- Inappropriate footwear
- Poor flexibility/muscle strength
- Early sports specialization
- Year-round sports training
- Type A behavior





Location



- Fibula
- Navicular
- Metatarsal
- Femoral Neck
- Calcaneus
- Pelvis
- Lumbar spine





Location

- Most commonly occur in the tibia and metatarsals
- March fracture MT fx in military
- Dancers (en pointe) 2nd-4th MT fxs
- Sprint, jump, hurdle athletes BSI foot (Navicular, Calcaneus)
- Middle/long distance runners BSI tibia, femoral neck, sacrum











Signs and Symptoms

- Dull pain worsens w WB or activity, not trauma
- Localized swelling
- TTP at injury site
- Periosteal pain may seem like BSI (e.g. shin splints)





Imaging

- <u>Xrays</u> usually negative, may show stress fx or bone remodeling later on
- <u>MRI</u> Sens 72-88%, Spec 86-100%
- <u>Bone scan</u> Lower sens/spec than MRI, uses radiation
- <u>CT/US</u> not used, lower sens/spec

Retrospective Review of Radiographic Imaging of Tibial Bony Stress Injuries in Adolescent Athletes With Positive MRI Findings: A Comparative Study

Eric D. Nussbaum, MEd, LAT, ATC,*[†] Catherine King, MD,[‡] Robert Epstein, MD,[‡] Jaynie Bjornaraa, PhD, MPH, PT, ATC,[§] Patrick S. Buckley, MD,[†] and Charles J. Gatt, Jr, MD[†]

Does Magnetic Resonance Imaging Grading Correlate With Return to Sports After Bone Stress Injuries?

A Systematic Review and Meta-analysis

Tim Hoenig,^{*†} MD, Adam S. Tenforde,[‡] MD, André Strahl,[†] PhD, Tim Rolvien,[†] MD, PhD, MBA, and Karsten Hollander,^{‡§} MD, PhD Investigation performed at the University of Hamburg, Hamburg, Germany



Fredericson classification

Grade 1 – Periosteal edema

Grade 2 – Periosteal edema w mild bone marrow chgs T2

Grade 3 – Periosteal edema w extensive marrow chgs T1 and T2

Grade 4a – Grade 3 + focal cortical signal chgs

Grade 4b – Grade 3 + fracture line

 MRI grading system used initially for medial tibial stress syndrome but also applied elsewhere



UOA



- Case presentation
- Diagnosis
- Management
- Conclusion



Management

• Nonoperative

• Operative





Non operative

- Tx is usually non op
- Modified WB
 - Crutches
 - Walking boot, cast, hard soled shoe
- Gradual increase in physical activity
- Gradual return to sport progression





Non operative

- Posteromedial Tibia Protected WB x 2-4 wks
- Tibial Plateau Protected WB x 2-4 wks
- Femoral neck (compression side)- Protected WB x 2-4 wks
- Navicular short leg cast or boot immobilization, NWB x 6 wks
- MT (2nd-4th) Hard soled shoe, protected WB x 2-4 wks
- Pelvis
- LS spine

Low-risk and high-risk classification of bone stress injuries. Injuries to highrisk bone sites are associated with an increased risk of treatment complications such as delayed union or non-union.

LOW-RISK	HIGH-RISK
Humerus	Lumbar vertebral arch
Hand	Femoral neck
Rib	Patella
Sacrum	Anterior tibia
Pubic bone	Medial malleolus
Femoral shaft	2nd metatarsal base
Posteromedial tibia	5th metatarsal base
Fibula	Great toe sesamoids
1st – 4th metatarsal shaft	
Calcaneus	

UOA

Non operative

<u>Timeline</u>:

- Complete cessation of athletic activity for 2-6 wks (~4 wks)
- May require protected WB x 2-4 wks
- May progress starting at 50% of normal pace
- Activity frequency, duration and intensity may increase by 10% each wk w 1-2 days rest/wk
- If pain noted, halt progression and go back to previous pain free level

Treatment and Rehabilitation Approaches for Stress Fractures in Long-Distance Runners: A Literature Review

Spyridon Hadjispyrou ¹ , Argyris C. Hadjimichael ² , Angelos Kaspiris ³ , Petros Leptos ^{2, 4} , Jim D. Georgoulis

STUART J. WARDEN, PT, PhD, FACSM12 • IRENE S. DAVIS, PT, PhD, FACSM, FAPTA, FASB34 • MICHAEL FREDERICS ON, MD

Management and Prevention of Bone Stress Injuries in Long-Distance Runners



Operative

- Operative tx when higher risk for delayed union or nonunion based on anatomic location and fracture line
- Tibia Anterior tibia, "Dreaded Black Line"
- Femoral neck Tension side (superior)
- Navicular Elite athletes for quicker RTS
- 5th MT, medial malleolus high risk for nonunion
- Any fracture showing delayed/nonunion after non op tx can be considered for surgical intervention







Other Treatment Options

Limited evidence for:

- Extracorporeal Shockwave Therapy
- Orthobiologics







Rehabilitation

- Physical Therapy
- Cross training aerobic fitness
- Vitamin D, calcium, iron suppl
- Eval for Red-S, nutrition
- DEXA scan









Prevention

- Educating athletes on BSI
- Educating parents, coaches, training staff on risk factors and BSI signs/symptoms
- Appropriate and gradual loading of activity
- Optimize nutrition
- Facilitate bone recovery



Outline

- Case presentation
- Diagnosis
- Management
- Conclusion









- MRI revealed grade 3 Fredericson changes in right tibia with no cortical involvement
- WBAT
- Cessation of athletic activity x 1 month, with progression to 50% intensity and frequency x 1 month, then slow progression to full activity as tolerated
- Physical therapy for stretching, strengthening and cross training
- Involvement of pt's ATC to develop long term plan
- Education of pt and mother regarding diagnosis and tips for prevention



- Pain improved significantly after the first month
- Pain-free and back to full participation in cross country after 3 months of conservative tx





Key Diagnostic Tips

- Suspect BSI when skeletal pain develops after recent increases in training load, especially in target areas
- Palpate painful area to localize
- Request MRI too confirm presence of BSI and grade severity
- MRI grading and anatomic location of BSI should guide treatment and time for RTS



Conclusion

- BSI is a spectrum of disease and usually presents as dull pain worse with activity
- High suspicion for BSI w Track and Field sports, recent changes to training regimen, female, extremes of BMI
- BSI can account for ~20% of musculoskeletal injuries in track and field sports
- Establish a multidisciplinary network early (ATC, PT, MD/DO) to agree on rehab and RTS



Thank You

