



**PASIG** **PERFORMING ARTS**  
SPECIAL INTEREST GROUP



**ORTHOPAEDIC SECTION**  
AMERICAN PHYSICAL THERAPY ASSOCIATION



**PASIG MONTHLY CITATION BLAST: No. 121**

**November 2016**

Dear Performing Arts SIG members:

**Upcoming Conferences!** CSM 2017 will be February 15-17 in San Antonio, TX. At CSM 2017, the PASIG will provide main session programming “A Guide to Upper Extremity Nerve Entrapment Syndromes in Musicians,” by Janice Ying, DPT, OCS, Adriaan Louw, PhD, PT, CSMT, and Erin M. Hayden, PT, DPT, OCS

The 2017 Orthopaedic Section Annual Conference will be San Diego Hyatt Regency Mission Bay April 20-22.

**Dancer Screening Update!** PASIG is attempting to collect relevant information and resources to share with our membership regarding screening the young dancer (adolescent, pre-pro, collegiate). If you are currently participating in research and/or utilizing young dancer screening tools, please contact our Dancer Screening Chair, Mandy Blackmon, at [mandydancePT@gmail.com](mailto:mandydancePT@gmail.com). We will be meeting at CSM 2017 in San Antonio, TX to discuss and collaborate on current resources. Please let Mandy know if you will be at CSM and are interested in attending that committee meeting, as we need to plan for meeting space. Time: 1:00 PM, Thursday, February 16<sup>th</sup>.

**Interested in a Performing Arts Fellowship? The American Board of Physical Therapy Residency and Fellowship Education (ABPTFRE) has approved the PASIG Description of Specialist Practice (DSP) for the Performing arts as an area of study.** We are now working with the ABPTFRE to turn the DSP into a Description of Fellowship Practice (DFP). We anticipate the DFP will be available online by June 2016. This means that sites can begin forming fellowships in dance medicine, music medicine, theater medicine, etc. The PASIG will provide the fellowship criteria for accreditation. We may have a meeting on creating a

performing arts fellowship at CSM 2017 on Saturday, February 18<sup>th</sup>, from 12:00pm to 1:30 PM. Please contact Mariah Nierman [Mariah.Nierman@osumc.edu](mailto:Mariah.Nierman@osumc.edu) or Laurel Abbruzzese [La110@cumc.columbia.edu](mailto:La110@cumc.columbia.edu) if interested.

**Looking for new committee members!** There is room for new committee members, and students are welcome to participate. Please refer to the list below for contact information.

Annette Karim, President	2014-2017	<a href="mailto:neoluvsonlyme@aol.com">neoluvsonlyme@aol.com</a>
Rosie Canizares, Vice President/Education Chair	2016-2019	<a href="mailto:Rcc4@duke.edu">Rcc4@duke.edu</a>
Janice Ying, Nominating Committee Chair	2016-2017	<a href="mailto:JaniceYingDPT@gmail.com">JaniceYingDPT@gmail.com</a>
Laura Reising, Research Chair	2016-2018	<a href="mailto:lbreising@gmail.com">lbreising@gmail.com</a>
Amanda Blackmon, Dancer Screen Chair	2016-2018	<a href="mailto:MandyDancePT@gmail.com">MandyDancePT@gmail.com</a>
Dawn Muci, Public Relations Chair	2016-2018	<a href="mailto:Dawnd76@hotmail.com">Dawnd76@hotmail.com</a>
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Anna Saunders, Secretary/Student Scholarship Chair	2015-2017	<a href="mailto:annarosemary@gmail.com">annarosemary@gmail.com</a>
Andrea N. Lasner, Nominating Committee	2015-2018	<a href="mailto:alasner1@jhmi.edu">alasner1@jhmi.edu</a>
Jessica Fulton, Nominating Committee	2016-2019	<a href="mailto:jessicafultonpt@gmail.com">jessicafultonpt@gmail.com</a>
Laurel Abbruzzese, Fellowship Chair Asst.	2016-2018	<a href="mailto:La110@cumc.columbia.edu">La110@cumc.columbia.edu</a>
Elizabeth Chesarek, Membership Chair	2016-2018	<a href="mailto:echesarek@gmail.com">echesarek@gmail.com</a>

**Membership:** Current PASIG members, please remember to update your membership:  
[https://www.orthopt.org/login.php?forward\\_url=/surveys/membership\\_directory.php](https://www.orthopt.org/login.php?forward_url=/surveys/membership_directory.php)

**Social Media:** For fun PT info and related performing artists info...

- 1) Facebook page: (closed) so, if you would like to be a part of the group, email me on Facebook: Dawn Doran and let me know you'd like to join.
- 2) follow PASIG on Twitter: @PT4PERFORMERS

**Call for case reports:** If you have a brief, clinically-focused case report on a performing arts PT patient, or a clinical commentary, please contact Annette Karim to submit your writing for the next Orthopaedic Physical Therapy Practice Magazine: [neoluvsonlyme@aol.com](mailto:neoluvsonlyme@aol.com)

**WE NEED MORE CONTRIBUTORS TO OUR MONTHLY CITATION BLASTS!!!!**  
 Past Monthly citation blasts are available, with citations and EndNote file, listed on the website:  
[http://www.orthopt.org/content/special\\_interest\\_groups/performing\\_arts/citations\\_endnotes](http://www.orthopt.org/content/special_interest_groups/performing_arts/citations_endnotes)

**TOPICS THAT HAVE BEEN COVERED RECENTLY INCLUDE:**

*2<sup>nd</sup> Tarsometatarsal Joint Injuries in Dancers (current)*  
*Screening Tools for the Young Dancer*  
*Thoracic Outlet Syndrome and Nerve Entrapment in Instrumental Musicians*  
*Plyometric Training in Dancers*  
*HVLAT for Lower Extremity Conditions*  
*Inguinal Disruption*  
*Femoroacetabular Impingement*  
*Hand and Wrist Conditions in Gymnasts*  
*Factors in Optimal Turnout*  
*Achilles Tendinopathy*  
*Biomechanics and Posture in Musicians*  
*Pilates*  
*ACL Injuries in Dancers*  
*Patellofemoral Pain and Dance*  
*Neural Entrapments Found Among Musicians*  
*Stress Fractures of the Foot and Ankle*  
*Dry Needling*  
*Dynamic Warm Up and Stretching*  
*Platelet Rich Plasma Injections*  
*Back Pain in Dancers*

**If you are interested in contributing by writing a citation blast or joining the research committee, contact me at [lbreising@gmail.com](mailto:lbreising@gmail.com).**

Sincerely,

*Laura*

Laura Reising, PT, DPT, MS, OCS  
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## **PERFORMING ARTS CONTINUING EDUCATION, CONFERENCES, AND RESOURCES**

Musician Health Series, Janice Ying, PT, DPT, OCS  
Glendale Adventist Therapy and Wellness Center, Los Angeles area (Eagle Rock), CA  
<http://www.musicianshealthcorner.com/>  
[Healthy Musician Series - Overuse](#)

Orthopaedic Section Independent Study Course. *20.3 Physical Therapy for the Performing Artist.*

Monographs are available for:

- Figure Skating (J. Flug, J. Schneider, E. Greenberg),
  - Artistic Gymnastics (A. Hunter-Giordano, Pongetti-Angeletti, S. Voelker, TJ Manal),
- and
- Instrumentalist Musicians (J. Dommerholt, B. Collier).

Contact: Orthopaedic Section at: [www.orthopt.org](http://www.orthopt.org)

Orthopaedic Section-American Physical Therapy Association,  
Performing Arts SIG

[http://www.orthopt.org/content/special\\_interest\\_groups/performing\\_arts](http://www.orthopt.org/content/special_interest_groups/performing_arts)

Performing Arts Citations and Endnotes

[http://www.orthopt.org/content/special\\_interest\\_groups/performing\\_arts/citations\\_endnotes](http://www.orthopt.org/content/special_interest_groups/performing_arts/citations_endnotes)

ADAM Center

<http://www.adamcenter.net/>

Publications:

<http://www.adamcenter.net/#!vstc0=publications>

Conference abstracts:

<http://www.adamcenter.net/#!vstc0=conferences>

Dance USA

<http://www.danceusa.org/>

Research resources:

<http://www.danceusa.org/researchresources>

Professional Dancer Annual Post-Hire Health Screen:

<http://www.danceusa.org/dancerhealth>

Dancer Wellness Project

<http://www.dancerwellnessproject.com/>

Becoming an affiliate:

<http://www.dancerwellnessproject.com/Information/BecomeAffiliate.aspx>

Harkness Center for Dance Injuries, Hospital for Joint Diseases

<http://hjd.med.nyu.edu/harkness/>

Continuing education:

<http://hjd.med.nyu.edu/harkness/education/healthcare-professionals/continuing-education-courses-cme-and-ceu>

Resource papers:

<http://hjd.med.nyu.edu/harkness/dance-medicine-resources/resource-papers-and-forms>

Links:

<http://hjd.med.nyu.edu/harkness/dance-medicine-resources/links>

Informative list of common dance injuries:

<http://hjd.med.nyu.edu/harkness/patients/common-dance-injuries>

Research publications:

<http://hjd.med.nyu.edu/harkness/research/research-publications>

International Association for Dance Medicine and Science (IADMS)

<http://www.iadms.org/>

Resource papers:

<http://www.iadms.org/displaycommon.cfm?an=1&subarticlenbr=186>

Links:

<http://www.iadms.org/displaycommon.cfm?an=5>

Medicine, arts medicine, and arts education organization links:

<http://www.iadms.org/displaycommon.cfm?an=1&subarticlenbr=5>

Publications:

<http://www.iadms.org/displaycommon.cfm?an=3>

Performing Arts Medicine Association (PAMA)

<http://www.artsmed.org/>

<http://www.artsmed.org/symposium.html>

Interactive bibliography site:

<http://www.artsmed.org/bibliography.html>

Related links:

<http://www.artsmed.org/relatedlinks.html>

Member publications:

<http://artsmed.org/publications.html>

***(Educators, researchers, and clinicians, please continue to email your conference and continuing education information to include in future blasts.***




## **2<sup>nd</sup> Tarsometatarsal Joint Injuries in Dancers**

Metatarsal stress fractures affected 12.6% of skeletally immature ballet dancers in a study by O'Malley et al. (1996). This report looks at acute and overuse injuries to the 2<sup>nd</sup> tarsometatarsal joint. One common overuse injury in ballet dancers is the stress reaction or fracture to the base of the 2<sup>nd</sup> metatarsal, but can also occur in other idioms like Highland dance. Risk factors for stress fractures were delayed menarche, low body weight, recent increase in activity and history of prior stress fracture. Symptoms tend to be of insidious onset and increased pain with ambulation; as well as, with performing and balancing on relevé (both demi pointe and pointe). Studies presented state that radiographical imaging is preferred to tuning fork and ultrasound diagnostic tests for diagnosing stress fractures, especially a posterior-anterior view to eliminate overlap at the Lisfranc joint. Tong et al. (2013) reported that there is only a low relationship between pes cavus and pes planus foot types and lower extremity injuries. O'Malley (1996) also suggests that leg length discrepancies, hard surfaces, hip external rotation greater than 65 degrees, forefoot varus and poor ankle joint dorsiflexion maybe risk factors as well. It is also suggested that an "overpointed" foot can potentially lead to a stress fracture of the 2<sup>nd</sup> metatarsal due to the stress placed at the tarsometatarsal joint. Conservative treatment is usually successful and sometimes require rocker bottom walking boot, crutches and relative rest. Rehabilitation should include restoring prior level of motion, strength, endurance, and proprioception, as well as; correcting faulty technique, appropriately supportive pointe shoes and graded pain-free return to dance. Modalities reported in the research to be beneficial are taping, shockwave therapy, and padding.

Less common is the acute disruption of the Lisfranc joint in the dance world. Imaging that is recommended in the research is as follows: oblique radiographs, radiographs in weightbearing, MRI, tomograms, and bone scan to help diagnose disruption of the Lisfranc joint. Conservative care recommends immobilization and modified training. For more severe injuries, surgical intervention may be needed. Delayed recognition and treating this injury promptly may result in poor prognosis. However, Charlton et al. (2015) reported that 7 professional dancers and high level athletes were able to return to dance/sport 6 months s/p suture-button devices vs. the more common screw fixation.

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**Albisetti W, Perugia D, De Bartolomeo O, Tagliabue L, Camerucci E, Calori GM. Stress fractures of the base of the metatarsal bones in young trainee ballet dancers. *Int Orthop*. 2010;34(1):51-55.**

ABSTRACT: Classical ballet is an art form requiring extraordinary physical activity, characterised by rigorous training. These can lead to many overuse injuries arising from repetitive minor trauma. The purpose of this paper is to report our experience in the diagnosis and treatment of stress fractures at the base of the second and third metatarsal bones in young ballet dancers. We considered 150 trainee ballet dancers from the Ballet Schools of "Teatro Alla Scala" of Milan from 2005 to 2007. Nineteen of them presented with stress fractures of the base of the metatarsal bones. We treated 18 dancers with external shockwave therapy (ESWT) and one with pulsed electromagnetic fields (EMF) and low-intensity ultrasound (US); all patients were recommended rest. In all cases good results were obtained. The best approach to metatarsal stress fractures is to diagnose them early through clinical examination and then through X-ray and MRI. ESWT gave good results, with a relatively short time of rest from the patients' activities and a return to dancing without pain.

**Charlton T, Boe C, THordarson DB. Suture button fixation treatment of chronic lisfranc injury in professional dancers and high-level athletes. *J Dance Med Sci*. 2015;19(4):135-139.**

ABSTRACT: Chronic Lisfranc injury is a subtle and severe injury in high-level athletes, including dancers. This patient population is generally intolerant of intra-articular screw fixation and can develop significant post-traumatic arthritis with potentially career ending complications. Flexible fixation with suture-button devices provides potential restoration of physiologic motion at the joint, with appropriate support for healing that may facilitate return to en pointe activities for dancers. We hypothesized that the suture-button device would restore motion at the Lisfranc joint and allow for return to activities in this particular population without the limitations and complications of rigid fixation. We operated on seven dancers and high-level athletes with diagnosed Lisfranc injuries by installing a suture-button device. All patients had failed conservative management after late presentation. They were allowed to return to sport in 6 months, preoperative and postoperative American Orthopaedic Foot and Ankle Score (AOFAS) foot scores were obtained, and patients were followed for a minimum of 15 months. All seven returned to full activities in 6 months, with radiographic evidence of fixation and no complications to date. AOFAS foot scores improved from an average of 65 preoperatively to an average of 97 postoperatively at latest follow-up. It is concluded that flexible fixation with suture-button type device represents a viable alternative to screw fixation or fusion that may allow dancers and athletes to return to previous levels of activity after Lisfranc injury. This case series represents to our knowledge the first application of

this device to a unique population that requires flexibility at the Lisfranc joint for performance.

**Davidson G, Pizzari T, Mayes S. The influence of second toe and metatarsal length on stress fractures at the base of the second metatarsal in classical dancers. *Foot Ankle Int.* 2007;28(10):1082-1086.**

**BACKGROUND:** Stress fractures at the base of the second metatarsal frequently occur in female classical dancers. There is a strong belief that a foot shape in which the first metatarsal or toe is shorter than the second metatarsal or toe increases the risk of this injury in dancers. However, there is a lack of empirical evidence to support this theory. The objective of this study was to examine the influence of the relative length difference between the first and second metatarsals and first and second toes on the frequency of stress fractures at the base of the second metatarsal in elite, female classical dancers.

**METHODS:** Both feet of 50 elite female classical dancers were measured for length differences between the first and second toes and first and second metatarsals. Retrospective analysis of dancers' medical histories revealed 17 feet with stress injury and 83 without. The mean of the difference between the metatarsal and toe length for the stress-injury group was compared to that of the control group.

**RESULTS:** No difference between the groups was identified for first and second toe length difference ( $p = 0.865$ ) and the relative difference between the ends of the first two metatarsals ( $p = 0.815$ ).

**CONCLUSIONS:** Dancers who had a stress injury at the base of the second metatarsal displayed similar variances in the two independent variables as dancers who had not had such an injury.

**Della Valle CJ, Su E, Nihal A, Rosenberg AS, Trepman E. Acute disruption of the tarsometatarsal joints in a ballet dancer. *J Dance Med Sci.* 2000;4(4):128-131(4).**

**ABSTRACT:** A 15-year-old female ballet dancer suffered acute midfoot pain when landing from a jump. Physical examination and imaging studies revealed acute disruption of the tarsometatarsal (Lisfranc's) joints with rupture of Lisfranc's ligament. Fluoroscopic examination under anesthesia confirmed instability of the first, second, and third tarsometatarsal joints. Treatment included operative open reduction and rigid internal fixation to re-establish stable alignment, and postoperative protection (non-weightbearing) in a bivalved cast. The screws were removed 14 weeks after fixation, and weightbearing and physiotherapy were advanced. Follow-up evaluation at 10 months after initial treatment showed maintenance of stable alignment. The patient had no pain at the tarsometatarsal joints, but there was pain at the metatarsal heads after dance activity. She was able to pli , tendu, and work on demi-pointe, and had achieved her age level of dance, but had not resumed pointe work because of limitation in plantar flexion. Acute tarsometatarsal



disruption is rare in young dancers and may be difficult to diagnose. Recognition of this type of injury is important because delay in the diagnosis and treatment may be associated with residual instability and poor prognosis.

**Gillespie P, Robertson A, George B, Nihal A. Acute Lisfranc joint disruption in a ballet dancer. *Foot Ankle Surg.* 2005;11(2):105-108.**

ABSTRACT: We present the case of a 16-year-old female ballet dancer who sustained an acute disruption of the Lisfranc joint while dancing. We discuss the diagnostic pitfalls of this unusual injury, its surgical management and outcome.

**Gotha HE, Lareau CR, Fellars TA. Diagnosis and management of lisfranc injuries and metatarsal fractures. *RI Med J.* 2013;96(5):33-36.**

ABSTRACT: Forefoot and midfoot injuries are relatively common and can lead to chronic disability, especially if they are not promptly diagnosed and appropriately treated. A focused history and physical examination must be coupled with a thorough review of imaging studies to identify the correct diagnosis. Subtle radiographic changes can represent significant ligamentous Lisfranc injury. Midfoot swelling in the presence of plantar ecchymosis should be considered to be a Lisfranc injury until proven otherwise. While most metatarsal fractures can be treated with some form of immobilization and protected weight-bearing, this article will distinguish these more common injuries from those requiring surgical intervention. We will review relevant anatomy and biomechanics, mechanisms of injury, clinical presentation, imaging studies, and diagnostic techniques and treatment.

**Greenberg ET, Queller HR. Tarsometatarsal (Lisfranc) joint injury in an athlete with persistent foot pain. *J Orthop Sports Phys Ther.* 2016;46(6):494. Doi: 10.2519/jospt.2016.0408**

ABSTRACT: The patient was a 20-year-old female ultimate frisbee player who felt a "pop" in her left foot with resultant pain and bruising along the plantar aspect of her midfoot. She was seen by an orthopaedic physician, who ordered standard radiographs that were found to be unremarkable. Although initial non-weight-bearing films were normal, these findings do not rule out tarsometatarsal joint injury. Following presentation to physical therapy 4 months after the initial injury, the patient was referred to a sports medicine physician. Weight-bearing radiographs and magnetic resonance imaging were ordered and confirmed a high-grade Lisfranc ligament tear.

**Harrington T, Crichton KJ, Anderson IF. Overuse ballet injury of the base of the second metatarsal: a diagnostic problem. *Am J Sports Med.* 1993;21(4):591-598.**

ABSTRACT: Performing classical ballet may cause major stress to the feet of the dancer. A variety of foot injuries have been described, with one such injury being an overuse syndrome involving the base of the second metatarsal and adjacent Lisfranc's joint. The diagnosis for this syndrome usually requires differentiating synovitis of Lisfranc's joint from a stress reaction of the base of the second metatarsal. Prompt diagnosis is important since the treatment for these two conditions differs significantly and, in the case of bone stress reaction, delay can cause progression of the lesion. We report good clinical results in a group of eight ballerinas for whom we obtained early diagnosis and treatment of their injuries. This is in contrast to poor results reported in the literature if the diagnosis and management of these types of injuries are delayed. We developed a simple diagnostic protocol to enable diagnosis at presentation. When a bone stress reaction had progressed to a fracture line, a characteristic appearance was found on magnetic resonance imaging, suggesting a specific mechanism of injury. A possible mechanism for this injury is discussed.

**Kadel N. Foot and ankle problems in dancers. *Phys Med Rehabil Clin N Am.* 2014 Nov;25(4):829-44. doi: 10.1016/j.pmr.2014.06.003. Epub 2014 Aug 2.**

ABSTRACT: The dancer's foot and ankle are subjected to high forces and unusual stresses in training and performance. Injuries are common in dancers, and the foot and ankle are particularly vulnerable. Ankle sprains, ankle impingement syndromes, flexor hallucis longus tendonitis, cuboid subluxation, stress fractures, midfoot injuries, heel pain, and first metatarsophalangeal joint problems including hallux valgus, hallux rigidus, and sesamoid injuries will be reviewed. This article will discuss these common foot and ankle problems in dancers and give typical clinical presentation and diagnostic and treatment recommendations.

**Kadel N, Boenisch M, Teitz C, Trepman E. Stability of Lisfranc joints in ballet pointe position. *Foot Ankle Int.* 2005;26(5):394-400.**

BACKGROUND: Ballerinas develop stress fractures at the second metatarsal base associated with dancing en pointe. The purpose of this study was to evaluate the relative importance of the pointe shoe and the tarsometatarsal ligaments in Lisfranc joint stability en pointe.

METHODS: Eleven cadaver feet were dressed with pointe shoes, loaded in foot flat with ligaments intact, and loaded en pointe before and after sequential sectioning of the dorsal, interosseous, and plantar ligaments between the first and second metatarsals and cuneiforms. Relative motion between the first and second metatarsals and cuneiforms was determined radiographically.

RESULTS: No significant displacement of the Lisfranc joints occurred when the shod foot with intact ligaments was loaded in the foot flat or en pointe positions. Serial sectioning of the ligaments from dorsal to plantar in the shod foot en pointe demonstrated no change in alignment after the dorsal and interosseous ligaments were cut, but a significant change in alignment between the second metatarsal and second cuneiform was noted after the plantar ligament was cut ( $p < 0.0001$ ). Removal of the pointe shoe after cutting the ligaments and applying a minimal (1 to 2 kg) load resulted in complete subluxation and diastasis through the first-second intermetatarsal and intercuneiform region. Replacing the shoe improved alignment en pointe with similar loading.

CONCLUSIONS: Both the pointe shoe and Lisfranc ligaments are important for Lisfranc region stability in feet en pointe. The plantar ligaments are major stabilizers of the Lisfranc region in the loaded, shod foot en pointe. Selection of a pointe shoe with adequate support may limit susceptibility to stress fracture of the second metatarsal base in ballerinas.

**Kriz P, Rafferty J, Evangelista P, Van Valenburg S, DiGiovanni C. Stress fracture of the second metatarsal and sprain of lisfranc joint in a pre-professional ballet dancer. *J Dance Med Sci.* 2015;19(2):80-85. doi: 10.12678/1089-313X.19.2.80.**

ABSTRACT: We present the case of a 14-year-old pre-professional ballerina that demonstrates common features of two conditions affecting the midfoot that are often missed or subject to delay in diagnosis in such young athletes: 1. stress fractures at the base of the second metatarsal, and 2. sprain of the Lisfranc joint complex. While these represent potentially career-altering injuries in the professional dancer, this case demonstrates that a high index of clinical suspicion, careful physical exam, appropriate radiographic assessment, and prompt treatment are essential to achieving the best possible outcome.

**Malone TR, Hardaker WT. Rehabilitation of foot and ankle injuries in ballet dancers. *J Orthop Sports Phys Ther.* 1990;11(8):355-361.**

ABSTRACT: Classical ballet is an exacting art form with roots dating to the Italian Renaissance. The physical demands of dance class, rehearsal, and performance can predispose the dancer to injury. The foot and ankle are common sites of injury. Most injuries are caused by overuse rather than acute injuries. The purpose of this clinical report is to describe the initial treatment, as well as a structured program directed to the restoration of motion, strength, endurance, and proprioception essential for the successful return to dance. Additionally, specific rehabilitation techniques will be presented to assist the physical therapist in reducing those risk factors that may predispose a dancer to future injury.

**Micheli LJ, Sohn RS, Solomon R. Stress fractures of the second metatarsal involving Lisfranc's joint in ballet dancers: a new overuse injury of the foot. *J Bone Joint Surg Am.* 1985;67(9):1372-1375.**

ABSTRACT: We reviewed the cases of four female ballet dancers with a stress fracture of a type that has not been reported previously. This fracture occurs in the proximal portion of the second metatarsal and involves the volar and medial aspects of Lisfranc's joint. A differential diagnosis of pain in the middle part of the foot in a dancer should include a consideration of this entity, which can be very difficult to diagnose on initial assessment. Oblique radiographs, tomograms, and a bone scan may be necessary to confirm the diagnosis. With early recognition and diagnosis, in three of the four patients the fracture healed with immobilization and modified training. One patient required surgical resection because of persistent non-union of the necrotic fracture fragment.

**Muscolo L, Miguez A, Slullitel G, Costa-Paz M. Stress fracture nonunion at the base of the second metatarsal in a ballet dancer: a case report. *Am J Sports Med.* 2004;32(6):1535-1537.**

**O'Malley MJ, Hamilton WG, Munyak J, DeFranco MJ. Stress Fractures at the base of the second metatarsal in ballet dancers. *Foot Ankle Int.* 1996 Feb;17(2):89-94.**

ABSTRACT: Stress fractures are a frequent injury in ballet companies and the most common location is at the base of the second metatarsal. While previous reports have focused on risk factors for this injury (overtraining, delayed menarche, poor nutrition), there is no published series describing the natural history and outcome following this fracture. We reviewed the office records of the senior author and identified 51 professional dancers (64 fractures) who sustained a stress fracture at the base of the second metatarsal. History of a previous stress fracture in the lower extremity was seen in 19 patients and delayed menarche in the women was common. The clinical presentation was insidious onset of midfoot pain an average of 2.5 weeks prior to seeking medical care. The initial radiographs of the foot were positive in 19 patients, questionable in 3 patients, and negative in 42 patients. The usual location of the fracture was at the proximal metaphyseal-diaphyseal junction (three fractures extended into the tarsometatarsal joint). Treatment consisted of a short leg walking cast for 6 patients, and a wooden shoe and symptomatic treatment for the remainder. At follow-up, 14% of patients still had occasional pain or stiffness in the midfoot with dancing. The patients returned to performance at an average of 6.2 weeks following diagnosis. No patients required bone grafting for persistent symptoms. There were eight refractures (at the same site) occurring an average of 4.3 years, all of which healed with conservative care. Stress fractures at the base of the second metatarsal are common in ballet dancers and can usually be treated with symptomatically. The results of this study are discussed in terms of risk factors, the use of a

posterior-anterior view of the foot to eliminate overlap at Lisfranc's joint, and our present treatment regimen.

**Onofeitmimi S, Bronner S, Becica L. Conservative management of second metatarsophalangeal joint instability in a professional dancer: a case report. *J Orthop Sports Phys Ther.* 2016;46(2):114-123. doi: 10.2519/jospt.2016.5824.**

STUDY DESIGN: Case report.

BACKGROUND: Professional ballet and modern dancers spend an inordinate amount of time on demi pointe (rising onto their forefeet), placing excessive force on the metatarsophalangeal joints and putting them at risk of instability. Surgical treatment of this condition is well described in the literature.

However, studies describing conservative management, particularly in dance populations, are lacking.

CASE DESCRIPTION: A 33-year-old dancer presented with insidious onset of medial arch and second and third metatarsophalangeal joint pain. Functional deficits included the inability to walk barefoot, perform demi relevé, or balance on demi pointe. Imaging studies revealed osteoarthritis of the first metatarsophalangeal joint, second metatarsophalangeal joint calcification, capsulitis, and plantar plate rupture, leading to a diagnosis of instability. The dancer underwent a treatment program that included taping, padding, physical therapy, a series of prolotherapy injections, and activity modification.

OUTCOMES: The dancer was seen for a total of 37 physical therapy sessions over the 16-week rehabilitation period. At the time of discharge, the patient had returned to full duty and performed all choreography with taping and padding. Repeated single-leg jumps and turns on the right foot, however, still caused discomfort. At her 6-month follow-up, the dancer's total Dance Functional Outcome Survey (DFOS) score had improved from 16% to 86%, and her Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) physical scores improved from 24 to 47. One year after discharge, the dancer reported pain-free dancing with no taping or padding.

DISCUSSION: This case report describes early diagnosis and a multimodal treatment approach in a professional dancer with significant disability secondary to metatarsophalangeal joint instability.

LEVEL OF EVIDENCE: Therapy, level 4.

**Rhim B, Hunt JC. Lisfranc injury and Jones fractures in sports. *Clin Podiatr Med Surg.* 2011;28(1):69-86. doi: 10.1016/j.cpm.2010.09.003**

ABSTRACT: This article provides an update and overview of Lisfranc injury and Jones fracture in the athletic population. Sports-related Lisfranc sprains or fractures are subtle injuries that can be easily missed. Now, there is greater understanding of midfoot sprains that represent a spectrum of injury to the Lisfranc ligament complex. Most types of fifth metatarsal fractures have a favorable prognosis and can be treated conservatively. The treatment options for Jones fractures in athletes have been much debated. This article discusses

issues related to anatomy, mechanism of injury, clinical presentation, imaging, and diagnosis, which are necessary to appropriately treat these injuries.

**Schneiders AG, Sullivan SJ, Hendrick PA, Hones BDGM, McMaster AR, Sugden BA, Tomlinson C. The ability of clinical tests to diagnose stress fractures: a systematic review and meta-analysis. *J Orthop Sports Phys Ther.* 2012;42(9):760-771. doi:10.2519/jospt.2012.4000**

**STUDY DESIGN:** Systematic literature review and meta-analysis. Objectives: To evaluate the diagnostic accuracy of clinical tests to identify stress fractures in the lower limb.

**BACKGROUND:** Stress fractures are a bone-related overuse injury primarily occurring in the lower limb and commonly affecting running athletes and military personnel. Physical examination procedures and clinical tests are suggested for diagnosing stress fractures; however, data on the diagnostic accuracy of these tests have not been investigated through a systematic review of the literature.

**METHODS:** A systematic review was conducted in 8 electronic databases to identify diagnostic accuracy studies, published between January 1950 and June 2011 that evaluated clinical tests against a radiological diagnosis of lower-limb stress fracture. Retrieved articles were evaluated using the Quality Assessment of Diagnostic Accuracy Studies tool, and a meta-analysis was performed where appropriate.

**RESULTS:** Nine articles investigating 2 clinical procedures, therapeutic ultrasound (n = 7) and tuning fork testing (n = 2), met the study inclusion criteria. Meta-analysis was used to statistically analyze the data extracted from the ultrasound articles and demonstrated a pooled sensitivity of 64% (95% confidence interval [CI]: 55%, 73%), specificity of 63% (95% CI: 54%, 71%), positive likelihood ratio of 2.1 (95% CI: 1.1, 3.5), and negative likelihood ratio of 0.3 (95% CI: 0.1, 0.9). Tuning fork test data could not be pooled; however, sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio ranged from 35% to 92%, 19% to 83%, 0.6 to 3.0, and 0.4 to 1.6, respectively.

**CONCLUSION:** The results of this systematic review do not support the specific use of ultrasound or tuning forks as standalone diagnostic tests for lower-limb stress fractures. As the overall diagnostic accuracy of the tests investigated is not strong, based on the calculated likelihood ratios, it is recommended that radiological imaging should continue to be used for the confirmation and diagnosis of stress fractures of the lower limb.

**LEVEL OF EVIDENCE:** Diagnosis, level 1a

**Tong JWK, Kong PW. Associate between foot type and lower extremity injuries: systematic literature review with meta-analysis. *J Orthop Sports Phys Ther.* 2013;43(10):700-714, A1-A8. Epub 30 Aug 2013. doi:10.2519/jospt.2013.4225**

**STUDY DESIGN:** Systematic literature review with meta-analysis. Objectives: To investigate the association between nonneutral foot types (high arch and flatfoot) and lower extremity and low back injuries, and to identify the most appropriate methods to use for foot classification.

**METHODS:** A search of 5 electronic databases (PubMed, Embase, CINAHL, SPORTDiscus, and ProQuest Dissertations and Theses), Google Scholar, and the reference lists of included studies was conducted to identify relevant articles. The review included comparative cross-sectional, case-control, and prospective studies that reported qualitative/quantitative associations between foot types and lower extremity and back injuries. Quality of the selected studies was evaluated, and data synthesis for the level of association between foot types and injuries was conducted. A random-effects model was used to pool odds ratio (OR) and standardized mean difference (SMD) results for meta-analysis.

**RESULTS:** Twenty-nine studies were included for meta-analysis. A significant association between nonneutral foot types and lower extremity injuries was determined (OR = 1.23; 95% confidence interval [CI]: 1.11, 1.37;  $P < .001$ ). Foot posture index (OR = 2.58; 95% CI: 1.33, 5.02;  $P < .01$ ) and visual/physical examination (OR = 1.17; 95% CI: 1.06, 1.28;  $P < .01$ ) were 2 assessment methods using distinct foot-type categories that showed a significant association with lower extremity injuries. For foot-assessment methods using a continuous scale, measurements of lateral calcaneal pitch angle (SMD, 1.92; 95% CI: 1.44, 2.39;  $P < .00001$ ), lateral talocalcaneal angle (SMD, 1.36; 95% CI: 0.93, 1.80;  $P < .00001$ ), and navicular height (SMD, 0.34; 95% CI: 0.16, 0.52;  $P < .001$ ) showed significant effect sizes in identifying high-arch foot, whereas the navicular drop test (SMD, 0.45; 95% CI: 0.03, 0.87;  $P < .05$ ) and relaxed calcaneal stance position (SMD, 0.49; 95% CI: 0.01, 0.97;  $P < .05$ ) displayed significant effect sizes in identifying flatfoot. Subgroup analyses revealed no significant associations for children with flatfoot, cross-sectional studies, or prospective studies on high arch.

**CONCLUSIONS:** High-arch and flatfoot foot types are associated with lower extremity injuries, but the strength of this relationship is low. Although the foot posture index and visual/physical examination showed significance, they are qualitative measures. Radiographic and navicular height measurements can delineate high-arch foot effectively, with only anthropometric measures accurately classifying flatfoot.

**LEVEL OF EVIDENCE:** Prognosis, level 2a.

**Wadsworth DJ, Eadie NT. Conservative management of subtle Lisfranc joint injury: a case report. *J Orthop Sports Phys Ther.* 2005; 35: 154– 164.**  
<http://dx.doi.org/10.2519/jospt.2005.35.3.154>

STUDY DESIGN: Case report.

BACKGROUND: Athletic Lisfranc injuries are characterized by disruption of the soft tissues about the tarsometatarsal joint complex. They are frequently missed on initial consultation due to a paucity of demonstrable physical signs, yet often result in significant disability. This case illustrates the 2 great challenges in managing these injuries: firstly, arriving at an accurate diagnosis and, secondly, determining whether the injury is stable and, therefore, appropriate for conservative management.

CASE DESCRIPTION: The athlete was a 21-year-old professional basketball player with a recurrent ligamentous injury of the Lisfranc joint. A global approach to evaluation and treatment of the entire lower extremity and pelvis in managing this injury is emphasized.

OUTCOMES: The athlete in this case report made a successful return to his previous level of competition 12 weeks postinjury. At 2-year follow-up he continues to play professionally without any symptoms.

DISCUSSION: In selected cases for which patients have no osseous displacement and the ability to run on the toes soon after injury, conservative management of Lisfranc injury may be appropriate. Key features of a conservative approach include recognition of a prolonged recovery time, adequate rest for soft tissue healing, restoration of a normal gait pattern to prevent chronic overstress of injured tissues, appropriate orthotic prescription, and proprioceptive retraining.

**Watson HI, O'Donnell B, Hopper GP, Chang W. Proximal base stress fracture of the second metatarsal in a Highland dancer. *BMJ Case Rep.* 2013. Published online 2013 Jun 26. doi: [10.1136/bcr-2013-010284](https://doi.org/10.1136/bcr-2013-010284)**

ABSTRACT: A 15-year-old female Highland dancer presented to the accident and emergency department with an ankle inversion injury on a background of several weeks of pain in the right foot. A radiograph of the right foot demonstrated a stress fracture at the base of the second metatarsal. She was treated conservatively with a below knee removable supportive walking boot with a rocker bottom sole. She re-presented to the accident and emergency department 3 weeks later with pins and needles in the right foot; she was given crutches to use along side the supportive walking boot. Radiographs 12 weeks after the first presentation showed healing of the stress fracture. The patient was now asymptomatic of the injury. She was unable to fully train for 12 weeks due to the injury. Conservative management was successful in this patient.