**PASIG MONTHLY CITATION BLAST: No.21** **June 2007**

Dear PASIG members:

Last Call!!!! CSM abstract submissions close this week on June 15th at 11:59 PM EST. Go to http://www.apta.org/csm for more information and to connect to Scholar One Abstract Central for electronic submission. Even if you're not submitting, we hope you will join us at the PASIG programming and PASIG abstract platform presentations on Feb 6 – 10 in Nashville, TN.

If you missed planning an abstract for this year, plan ahead for next year and mentor a student on a PA-topic. Don't forget, the PASIG sponsors an annual student research scholarship to recognize students, who have had an abstract accepted to CSM, for their contribution to performing arts medicine and research. For more information on the research award please check our webpage (www.orthopt.org/sig_pa.php). Students with additional questions can contact PASIG Treasurer Leigh Roberts (lar@brventures.com). And clinicians, if you accept students for a performing arts clinical affiliation, please contact me so that we can update our webpage. The PASIG is an important clearinghouse for this information.

Our topic this month is '*Stress Fractures of the Foot and Ankle in Dancers*', contributed by Cora Maglaya. The format is an annotated bibliography of articles on the selected topic from 1996 – 2006. Each month's citations will be added to EndNote libraries available on the PASIG webpage for our members to access and download. (Information about EndNote referencing software can be found at http://www.endnote.com, including a 30-day free trial). If you'd like to suggest a topic or create one, please let me know. As always, your comments and entry contributions to these Citation Blasts or other PA research ideas are always welcome. Please drop me an e-mail anytime.

Regards,

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**Stress Fractures of the Foot and Ankle in Dancers**

The etiology of stress fractures is multifactorial. It is difficult to study in dancers as they have different variables of training regimens, menstrual abnormalities, and disordered eating. Early detection is critical. The first step is identifying common risk factors. For treatment to be successful, it is essential to address underlying causes such as dynamic biomechanical faults. This will help reduce the incidence of further injury. The following articles collected were designed to give the clinician a diverse overview of the pathophysiology, evaluation, diagnosis, and treatment of stress fractures as it relates to dancers.

Cora L. Maglaya PT, ATC, LAT, CSCS

Brown TD, Micheli L (2004). Foot and ankle injuries in dance. Am J Orthop **33**(6): 303-9.
This review focuses on many of the foot and ankle injuries commonly seen among dancers. These unique athletes place extreme demands on their musculoskeletal system and thereby face a variety of acute and overuse injuries. Conservative treatment is successful in the majority of cases, but these patients often continue to dance while healing--commonly prolonging and at times complicating treatment. When surgery is being contemplated, the dancer's performance level and expectations about returning to dance after surgery should be thoroughly explored. Foot and ankle surgeries that routinely yield good to excellent results in the general population can prematurely end a dancer's otherwise promising career. The physician must consider all these factors when designing an appropriate treatment plan for a dancer.

Dixon SJ, Creaby MW, et al. (2006). Comparison of static and dynamic biomechanical measures in military recruits with and without a history of third metatarsal stress fracture. Clin Biomech (Bristol, Avon) **21**(4): 412-9.
BACKGROUND: For Royal Marine recruits in training, the third metatarsal is the most common site for stress fracture. Previous evidence regarding biomechanical factors contributing to metatarsal stress fracture development is conflicting, possibly due to the lack of differentiation between the metatarsals. The present retrospective study compares static anatomical characteristics and dynamic biomechanical variables for Royal Marine recruits with and without a history of third metatarsal stress fracture. METHODS: Ten Royal Marine recruits with a history of third metatarsal stress fracture were compared with control

subjects with no previous stress fracture occurrence. Selected static anatomical variables were measured to describe the ankle and subtalar joints. Peak ankle dorsi-flexion and rearfoot eversion were measured during running. In addition, peak vertical and horizontal ground reaction force variables were compared for the two study groups. FINDINGS: No significant differences in static anatomical variables were identified between study groups. During running, peak rearfoot eversion was found to occur significantly earlier for the stress fracture group than for their matched controls, suggesting an increase in time spent loading the forefoot. The peak applied resultant horizontal force during the braking phase was directed significantly more laterally for the stress fracture group. In addition, the peak magnitude of resultant horizontal force applied during the propulsion phase was significantly lower for the stress fracture subjects. INTERPRETATION: The findings of this study highlight the importance of including dynamic biomechanical data when exploring variables associated with the development of third metatarsal stress fracture and indicate that successful interventions to reduce the incidence of this injury are likely to focus on forefoot function during braking and propulsion.

Garrick JG, Lewis SL (2001). Career hazards for the dancer. Occup Med **16**(4): 609-18, iv.

Most dance injuries are of the overuse variety. Their gradual onset, coupled with the intense competition for professional positions, often results in injuries being ignored and thus seen late in their course. While treatment of the specific injury is of paramount concern, maintenance of the extremes of flexibility, strength, and conditioning necessary to dance professionally is an equally important treatment element.

Gellman R, Burns S (1996). Walking aches and running pains. Injuries of the foot and ankle. Prim Care **23**(2): 263-80.

Running is enjoyed by approximately 30 million people in the United States, 10 million on a regular basis. It is common to encounter a patient who runs and expects his or her primary physician to have a degree of expertise in injuries caused by running. The primary care clinician also may experience the frustration of motivating a patient to exercise, only to have him or her return with complaints of foot or ankle pain. Running injuries occur from an overload on the muscles, tendons, bones, or joints. The knee, foot, and ankle are the most common sites of injury.

Heaslet MW, Kanda-Mehtani SL (2007). Return-to-activity levels in 96 athletes with stress fractures of the foot, ankle, and leg: a retrospective analysis. J Am Podiatr Med Assoc **97**(1): 81-4.

Stress fractures of the foot and ankle are common in the athletic population. Because this population is especially eager to return to activity, such fractures can be challenging to treat. If the biomechanical faults are not addressed or gradual return to activity is not monitored appropriately, fractures occasionally recur. A retrospective analysis was conducted of 96 athletes who presented to a

podiatric sports medicine practice over the course of 10 years with stress fractures confirmed by radiograph or bone scan. The most common type of fracture sustained by this population was tibial stress fracture, followed by second metatarsal fracture. Marathon training was the most common pre-injury activity overall, although fitness walking was the most common activity among those with metatarsal fractures. This study relates the most common types of stress fractures of the foot, ankle, and leg to certain athletic activities and correlates duration of symptoms before presentation with return-to-activity time.

Kadel NJ (2006). Foot and ankle injuries in dance. Phys Med Rehabil Clin N Am **17**(4): 813-26, vii.

Although dancers develop overuse injuries common in other athletes, they are also susceptible to unique injuries. This article reviews common foot and ankle problems seen in dancers and provides some basic diagnosis and treatment strategies.

Kaufman KR, Brodine SK, et al. (1999). The effect of foot structure and range of motion on musculoskeletal overuse injuries. Am J Sports Med **27**(5): 585-93.

The purpose of this prospective study was to determine whether an association exists between foot structure and the development of musculoskeletal overuse injuries. The study group was a well-defined cohort of 449 trainees at the Naval Special Warfare Training Center in Coronado, California. Before beginning training, measurements were made of ankle motion, subtalar motion, and the static (standing) and dynamic (walking) characteristics of the foot arch. The subjects were tracked prospectively for injuries throughout training. We identified risk factors that predispose people to lower extremity overuse injuries. These risk factors include dynamic pes planus, pes cavus, restricted ankle dorsiflexion, and increased hindfoot inversion, all of which are subject to intervention and possible correction.

Khan K, Brown J, et al. (1995). Overuse injuries in classical ballet. Sports Med **19**(5): 341-57.

Successful management of classical ballet dancers with overuse injuries requires an understanding of the art form, precise knowledge of anatomy and awareness of certain conditions. Turnout is the single most fundamental physical attribute in classical ballet and 'forcing turnout' frequently contributes to overuse injuries. Common presenting conditions arising from the foot and ankle include problems at the first metatarsophalangeal joint, second metatarsal stress fractures, flexor hallucis longus tendinitis and anterior and posterior ankle impingement syndromes. Persistent shin pain in dancers is often due to chronic compartment syndrome, stress fracture of the posteromedial or anterior tibia. Knee pain can arise from patellofemoral syndrome, patellar tendon insertional pathologies, or a combination of both. Hip and back problems are also prevalent in dancers. To speed injury recovery of dancers, it is important for the sports medicine team to cooperate fully. This permits the dancer to benefit from accurate diagnosis, technique correction where necessary, the full range of manual therapies to joint

and soft tissue, appropriate strengthening programmes and maintenance of dance fitness during any time out of class with Pilates-based exercises and nutrition advice. Most overuse ballet conditions respond well to a combination of conservative therapies. Those dancers that do require surgical management still depend heavily on ballet-specific rehabilitation for a complete recovery.

Korpelainen R, Orava S, et al. (2001). Risk factors for recurrent stress fractures in athletes. Am J Sports Med **29**(3): 304-10.

Our aim was to identify factors predisposing athletes to multiple stress fractures, with the emphasis on biomechanical factors. Our hypothesis was that certain anatomic factors of the ankle are associated with risk of multiple stress fractures of the lower extremities in athletes. Thirty-one athletes (19 men and 12 women) with at least three separate stress fractures each, and a control group of 15 athletes without fractures completed a questionnaire focusing on putative risk factors for stress fractures, such as nutrition, training history, and hormonal history in women. Bone mineral density was measured by dual-energy x-ray absorptiometry in the lumbar spine and proximal femur. Biomechanical features such as foot structure, pronation and supination of the ankle, dorsiflexion of the ankle, forefoot varus and valgus, leg-length inequality, range of hip rotation, simple and choice reaction times, and balance in standing were measured. There was an average of 3.7 (range, 3 to 6) fractures in each athlete, totaling 114 fractures. The fracture site was the tibia or fibula in 70% of the fractures in men and the foot and ankle in 50% of the fractures in women. Most of the patients were runners (61%); the mean weekly running mileage was 117 km. Biomechanical factors associated with multiple stress fractures were high longitudinal arch of the foot, leg-length inequality, and excessive forefoot varus. Nearly half of the female patients (40%) reported menstrual irregularities. Runners with high weekly training mileage were found to be at risk of recurrent stress fractures of the lower extremities.

Masala S, Fiori R, et al. (2003). Imaging the ankle and foot and using magnetic resonance imaging. Int J Low Extrem Wounds **2**(4): 217-32.

Magnetic resonance (MR) imaging has improved the possibility of evaluating musculoskeletal structures thus gaining an important role in the diagnosis and treatment of foot and ankle pathologies. In this review, the normal and pathological images of the ankle and foot obtained using MR techniques are presented and discussed. The high soft-tissue contrast resolution and the multiplanar sections of MRI allow the imaging of contiguous tissues where small contrast differences exist, such as ligamentous and tendinous injuries or impingement syndromes. The spatial resolution with high sensitivity for bone signal changes offers an early detection of osseous abnormalities such as stress fractures or osteonecrosis. Here it is specified possibilities and limitations of MRI in the diabetic foot: this technique is superior to nuclear medicine and computed tomography (CT), however it is unable to distinguish between neuro arthropathy and infection.

Nilsson C, Leanderson J, et al. (2001). The injury panorama in a Swedish professional ballet company. Knee Surg Sports Traumatol Arthrosc **9**(4): 242-6.

We performed a combined retro- and prospective study of injuries in a Swedish professional, classical ballet company during 5 consecutive years. There were 390 injuries incurred by 98 dancers over a 5-year period, i.e., 0.6 injuries/1000 dance hours. Most injuries were considered to be due to overuse. The median sick leave was 2.3 weeks per injury. The foot and ankle region is vulnerable in classical ballet dancers, and overuse injuries can result in long periods of sick leave. Of the dancers employed for more than 1 year 95% were suffered injuries during the study period. We found considerable differences in the injury profile between male and female and between younger and older dancers. Male dancers suffered more frequently from acute injuries to the knee joint. Traumatic injuries were seen most frequently in male soloists. Female dancers more often suffered overuse injuries, especially to the foot and ankle region. The younger dancers more often suffered traumatic injuries, for example, ankle sprain, and also stress fractures.

Quirk R (1994). Common foot and ankle injuries in dance. Orthop Clin North Am **25**(1): 123-33.

Classical ballet is a popular but physically demanding activity. Minor injuries become increasingly common as the dancer encounters the greater workload of professional dancing. The doctor must have a basic knowledge of ballet technique and an understanding of the mental approach of dancers to accurately diagnose and effectively treat their injuries. The practice of dancing on the toes, the exaggerated turn out of the feet, and the extreme flexibility of the hips and spine all lead to unusual injuries. With informed conservative treatment, most ballet injuries will heal, but surgery is occasionally required.

Rossi F, Dragoni S (2005). Talar body fatigue stress fractures: three cases observed in elite female gymnasts. Skeletal Radiol **34**(7): 389-94.

OBJECTIVE: To introduce and emphasize the clinical and radiological findings of three talar body fatigue stress fractures in competitive athletes. DESIGN AND PATIENTS: Clinical and radiographic skeletal records of 24,562 athletes taken between 1962 and 2002 were retrospectively reviewed. Among these, 6851 files related to acute foot and ankle injuries or chronic post-traumatic sequelae were found. RESULTS: There were 925 (3.76%) stress fatigue fractures selected from the whole collection. Among these there were three cases (0.32%) of talar body stress fractures diagnosed in elite female gymnasts 15-17 years old. The negative first radiograph become positive 4-6 weeks later. Scintigraphy was positive at an early stage and consistent for the diagnosis. CT and MRI gave positive results 1-2 weeks after the beginning of symptoms which were always greatly diagnostic. CONCLUSIONS: The sports medicine literature lacks reports of talar body fatigue stress fractures. The poor initial sensitivity of radiography makes it problematic to establish an early diagnosis. A wise combination of scintigraphy, CT and MRI has therefore to be relied upon. Familiarity with this

rare location for a stress fracture may prevent delayed diagnosis and long-lasting damage, both of which are important factors in competitive athletes.

Sormaala MJ, Niva MH, et al. (2006). Bone stress injuries of the talus in military recruits. Bone **39**(1): 199-204.

The purpose of the present study was to assess the incidence, anatomic distribution, and nature of fatigue bone stress injuries of the talus in military recruits based on magnetic resonance imaging (MRI). Military recruits referred to MRI examination due to exercise-induced ankle and/or foot pain were identified from the MRI archives. MR images of cases with bone stress injury findings in the talus were retrospectively re-evaluated concerning the anatomic location and type of the bone stress injury. During 96 months, fifty-one consecutive recruits displayed bone stress injuries of the talus in the population base of 117,149 person-years, yielding an incidence of 4.4 (3.2-5.5)/10,000 person-years. Bilateral injuries were seen in five of the patients. Of the 56 bone stress injuries, 40 occurred in the head, 15 in the body, and 5 in the posterior part of the talus. In four cases, both the head and the body were affected. Solitary, the talus was affected in 12 cases. In 44 cases, a stress injury was also present in other tarsal bones. Assessing the severity of the bone stress injury, a grade I-III injury was found in 46 and a grade IV injury with a fracture line in 10 of the cases. Injuries of the upper part of the body were associated with calcaneal stress injuries in 78% of the cases (P=0.03), and injuries of the head of the talus were associated with stress injuries in the naviculare in 60% of the cases (P=0.04). Age, sex, height, weight, body mass index, or physical fitness failed to reach statistical significance as risk factors for fatigue bone stress injuries of the talus. On MRI, the majority of the bone stress injuries of the talus were revealed in the head. A grade IV injury was discovered in 18% of the cases; in the remaining 82%, only grade I-III injuries were ascertained. In all locations, the lower grade bone stress injuries dominated. This study established the incidence of fatigue bone stress injury of the talus and indicated that these injuries are rare but not unseen in military recruits.

Weishaupt D, Schweitzer ME (2002). MR imaging of the foot and ankle: patterns of bone marrow signal abnormalities. Eur Radiol **12**(2): 416-26.

Diagnosis of marrow disorders of the foot and ankle is among the more challenging aspects of MR interpretation. Evaluation of normal and abnormal bone marrow with regard to pattern, distribution, and signal characteristics on different sequences often allows a specific diagnosis. This pictorial review illustrates MR imaging findings of normal variants of bone marrow of the foot and ankle, and the varied responses of bone marrow to trauma, stress, or disease.