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ORTHOPAEDIC SECTION
AMERICAN PHYSICAL THERAPY ASSOCIATION

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PASIG MONTHLY CITATION BLAST: No.45 **October 2009**

Dear PASIG members:

Please don't forget, the PASIG sponsors an annual student research scholarship. This award is to recognize students, who have had an abstract accepted to CSM, for their contribution to performing arts research. For more information on the research award please check our webpage (www.orthopt.org/sig_pa.php). **The deadline for application is November 15, 2009**. For more information, contact Scholarship Chairperson, Amy Humphrey, at Phone: 703-527-9557, e-mail: ahumphrey@bodydynamicsinc.com, Fax: 703-526-0438.

Soon the PASIG website will provide more information for members. First of all, the PASIG membership directory will provide more detailed information. We will be soliciting that information from members in the near future. Often performing artists travel to other cities, so this directory is important to help find performing arts PTs in those cities.

Also, the PASIG plans to provide more performing arts specific information that can be downloaded from our website. It will be free to members, and we will charge non-members to access the information. **We will need volunteers to contribute so that the information provided can be across a broad spectrum of performing arts**. **Your contributions are important, so please consider volunteering in your specific area of specialty.** If you haven't seen the PASIG website recently, please click on http://www.orthopt.org/sig_pa.php.

The PASIG and Orthopaedic Section connect on Facebook! If you are already a Facebook member, please join the APTA Orthopaedic Section at the following website http://www.facebook.com/group.php?gid=129461320453. The PASIG would like to have performing arts discussions on the Orthopaedic Section Facebook discussion board. Please contact Amy Humphrey, PT, DPT, OCS, MTC at ahumphrey@Bodydynamicsinc.com if you have any questions, discussion topics, or would like more information on how to become a member of Facebook.

For this October Citation BLAST, I've selected the topic: *Lisfranc Sprains.* The format is an annotated bibliography of articles on the selected topic from 1998 – 2008. The BLASTS and updated libraries are posted 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 are interested in contributing a special topic citation blast, please contact me. As always, your comments and suggestions are welcome. Drop me an e-mail anytime. If you're seeking a research mentor, looking for a sounding board about a research idea, want some editorial suggestions on a manuscript, let me know and I'll try to connect you with the right researcher.

Regards,
Shaw

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Lisfranc Joint Sprains

The Lisfranc joint, or tarsometatarsal articulation of the foot, is named for Jacques Lisfranc de St. Martin, a field surgeon in Napoleon's army. Lisfranc described an amputation performed through this joint due to the development of gangrene in a soldier's foot after falling off a horse with his foot caught in the stirrup. The 2 major causes of Lisfranc fracture-dislocations and sprains are low-energy, sports-related injuries and high-energy motor vehicle and industrial accidents. In low-energy settings, Lisfranc injuries are caused by a direct blow to the joint or by axial loading with medially or laterally directed rotational forces as in a twisting fall.

The Lisfranc ligament connects the first ray (first metatarsal-medial cuneiform articulation) to the middle and lateral columns of the foot. Injury to this ligament can result in functional instability with loss of longitudinal and transverse arches. Because of its limited mobility, the Lisfranc joint provides a stable axis for rotation, acting as a keystone for plantar flexion and dorsiflexion.

Low-energy Lisfranc injuries are seen more commonly in football players, gymnasts, ballet dancers, and track-and-field athletes. The mechanism of injury for most athletes is axial loading on a hyper-plantarflexed midfoot. These injuries carry a high risk of chronic disability, therefore health professionals should consider the Lisfranc area in patients with foot injuries characterized by marked swelling, tarsometatarsal joint tenderness, midfoot instability, plantar surface ecchymosis, and the inability to bear weight particularly with the foot plantarflexed.

Dancers and gymnasts may sustain an ankle sprain when landing poorly from a jump with a concurrent Lisfranc injury that is overlooked. Delay in the diagnosis and treatment may be associated with residual instability and poor prognosis. However, surgical treatment, despite restoration of anatomical alignment, may result in limitations in functional movement such as plantar flexion.

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Bulut G, Yasmin D, et al. (2009). A complex variant of Lisfranc joint complex injury. J Am Podiatr Med Assoc **99**(4): 359-63.

We report an unusual case of a variant of Lisfranc injury, plantar dislocation of the medial cuneiform with plantar fracture-dislocation of the intermediate cuneiform and dorsal fracture-dislocation of the lateral cuneiform, which has never been reported, to our knowledge. The entire pathologic abnormality was treated by open reduction and fixation with Kirschner wires, which were removed 8 weeks postoperatively because of pin-tract infection. Complex regional pain syndrome, which was a problem early in the recovery process, is now in remission, and at the 25-month follow-up examination, the patient was almost symptom free.

Burroughs KE, Reimer CD, et al. (1998). Lisfranc injury of the foot: a commonly missed diagnosis. Am Fam Physician **58**(1): 118-24.

Lisfranc joint injuries are rare, complex and often misdiagnosed. Typical signs and symptoms include pain, swelling and the inability to bear weight. Clinically, these injuries vary from mild sprains to fracture-dislocations. On physical examination, swelling is found primarily over the midfoot region. Pain is elicited with palpation along the tarsometatarsal articulations, and force applied to this area may elicit medial or lateral pain. Radiographs showing diastasis of the normal architecture confirm the presence of a severe sprain and possible dislocation. Negative standard and weight-bearing radiographs do not rule out a mild (grade I) or moderate (grade II) sprain. Reevaluation may be necessary if pain and swelling continue for 10 days after the injury. Proper treatment of a mild to moderate Lisfranc injury improves the chance of successful healing and reduces the likelihood of complications. Patients with fractures and fracture-dislocations should be referred for surgical management.

Chilvers M, Donahue M, et al. (2007). Foot and ankle injuries in elite female gymnasts. Foot Ankle Int **28**(2): 214-8.

BACKGROUND: Gymnastics is a competitive and popular sport that is started at an early age, and elite female gymnasts reach their prime in mid-teenage years. The level of intensity of practice and competition, the number of events, and the degree of difficulty of the maneuvers make gymnastics one of the most injury-producing sports. METHODS: Over a 3-year period, 14 elite, female gymnasts were seen in one foot and ankle center. The mean age was 17 (range 14 to 21) years. All gymnasts sustained acute or sub-acute injuries to the foot or ankle requiring surgery. The mechanism of injury, the type of injury, operative repair, and followup were recorded. RESULTS: There were five Lisfranc fracture-dislocations, and five talocalcaneal, two multiple metatarsal, one medial malleolar, one phalangeal, and one sesamoid fracture. All injuries had operative repair. One gymnast with a Lisfranc injury was able to return to full competition; all others with a Lisfranc injury retired from gymnastics, were lost to followup, or graduated from college. One gymnast with a talar

osteochondral injury was not able to return to competition but all other injured gymnasts were able to return to gymnastics at the same level or higher. CONCLUSION: Elite female gymnasts can sustain significant injury to the foot and ankle region. In our study, Lisfranc injuries were most likely career-ending.

Coetzee JC (2008). Making sense of Lisfranc injuries. Foot Ankle Clin **13**(4): 695-704, ix.
Management of Lisfranc injuries has evoked significant debate and controversy over the years, and there is no indication that the controversy is nearing an end. Probably the main reason for the controversy is because a "Lisfranc injury" is part of a very wide and poorly defined spectrum of injuries. Not all Lisfranc injuries are created equal, and there will never be a single treatment option for all these injuries. Lisfranc injuries are relatively uncommon, but if undetected, untreated or under-treated can cause morbidity and disability. The objective of this article is to provide guidelines for treatment of the spectrum of Lisfranc injuries.

Coetzee JC, Ly TV (2007). Treatment of primarily ligamentous Lisfranc joint injuries: primary arthrodesis compared with open reduction and internal fixation. Surgical technique. J Bone Joint Surg Am **89 Suppl 2 Pt.1**: 122-7.
BACKGROUND: Open reduction and internal fixation is currently the accepted treatment for displaced Lisfranc joint injuries. However, even with anatomic reduction and stable internal fixation, treatment of these injuries does not have uniformly excellent outcomes. The objective of this study was to compare primary arthrodesis with open reduction and internal fixation for the treatment of primarily ligamentous Lisfranc joint injuries. METHODS: Forty-one patients with an isolated acute or subacute primarily ligamentous Lisfranc joint injury were enrolled in a prospective, randomized clinical trial comparing primary arthrodesis with traditional open reduction and internal fixation. The patients were followed for an average of 42.5 months. Evaluation was performed with clinical examination, radiography, the American Orthopaedic Foot and Ankle Society (AOFAS) Midfoot Scale, a visual analog pain scale, and a clinical questionnaire. RESULTS: Twenty patients were treated with open reduction and screw fixation, and twenty-one patients were treated with primary arthrodesis of the medial two or three rays. Anatomic initial reduction was obtained in eighteen of the twenty patients in the open-reduction group and twenty of the twenty-one in the arthrodesis group. At two years postoperatively, the mean AOFAS Midfoot score was 68.6 points in the open-reduction group and 88 points in the arthrodesis group ($p < 0.005$). Five patients in the open-reduction group had persistent pain with the development of deformity or osteoarthrosis, and they were eventually treated with arthrodesis. The patients who had been treated with a primary arthrodesis estimated that their postoperative level of activities was 92% of their preinjury level, whereas the open-reduction group estimated that their postoperative level was only 65% of their preoperative level ($p < 0.005$). CONCLUSIONS: A primary stable arthrodesis of the medial two or three rays appears to have a better short and medium-term outcome than open reduction and internal fixation of ligamentous Lisfranc joint injuries.

Crim J (2008). MR imaging evaluation of subtle Lisfranc injuries: the midfoot sprain. Magn Reson Imaging Clin N Am **16**(1): 19-27, v.
MR imaging offers the great advantage over other imaging modalities by demonstrating ligament injuries directly rather than relying on secondary signs of bony abnormalities. Based on the literature at present, it has been shown that MR imaging can demonstrate tears of the Lisfranc ligament complex. There is, however, limited information on diagnostic accuracy.

Delfaut EM, Rosenberg ZS, et al. (2002). Malalignment at the Lisfranc joint: MR features in asymptomatic patients and cadaveric specimens. Skeletal Radiol **31**(9): 499-504.
OBJECTIVE: To assess the frequency of malalignment in the 1st, 2nd and 3rd tarso-metatarsal joints (Lisfranc joint) in cadaveric specimen and asymptomatic individuals utilizing oblique axial MR images. DESIGN AND PATIENTS: Four fresh frozen cadaveric feet were dissected in the oblique axial plane at 5 mm slice thickness. Thirty MR studies in 29 patients who had no history of pain, trauma or surgery at the tarso-metatarsal area were included in our study. The 1st to 3rd tarso-metatarsal joints were evaluated on the MR studies and cadaveric slices by two musculoskeletal radiologists for (1) the presence of a medial and/or lateral step-off and (2) articular surface divergence. RESULTS: In the cadaveric dissections there were lateral step-offs in the 1st (n=3) and in the 2nd ray (n=3) respectively. No joint incongruity was evidenced. The MR studies in the patients population depicted 28 step-offs (9 medial, 19 lateral) in the 1st ray, 16 (2 medial, 14 lateral) in the 2nd ray and two in the 3rd ray. Joint incongruity was present in the 2nd ray (n=6) and in the 3rd ray (n=12). All the above findings were limited to a few images. CONCLUSIONS: Isolated joint malalignment with otherwise normal findings (no ligamentous injury, no fracture and no bone marrow edema) might reflect normal anatomic features at the tarso-metatarsal joints and must be interpreted carefully.

Della Valle CJ, Su E, et al. (2000). Acute disruption of the tarsometatarsal (Lisfranc's) joints in a ballet dancer. J Dance Med Sci **4**(4): 128-131.
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 plie, 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.

DeOrio M, Erickson M, et al. (2009). Lisfranc injuries in sport. Foot Ankle Clin **14**(2): 169-86.
Injuries to the Lisfranc ligament complex have traditionally been associated with high energy trauma such as motor vehicle collisions and industrial accidents. Recently, there has been a greater appreciation of mid-foot sprains that represent a spectrum of injury to the Lisfranc ligament complex. As a result, there has been an increased incidence of such injury resulting from low-energy trauma in activities ranging from recreational activity to elite athletic activity. This article discusses issues related to anatomy, clinical presentation, mechanism of injury, and diagnosis that are necessary to provide appropriate treatment for these injuries. There should be a high index of suspicion of this injury, and prompt diagnosis is important to allow athletes to return to sport with the best possible outcome.

Harrington T, Crichton KJ, et al. (1993). Overuse ballet injury of the base of the second metatarsal: A diagnostic problem. Am J Sports Med **21**(4): 591-598.
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, Boenisch M, et al. (2005). Stability of Lisfranc joints in ballet pointe position. Foot Ankle Int **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.

Kadel NJ, Donaldson-Fletcher EA (2004). Lisfranc fracture-dislocation in a male ballet dancer during take-off of a jump: A case report. J Dance Med Sci **8**(2): 56-58.

While initiating a jump, a male professional ballet dancer (28 years old) sustained an acute injury to his midfoot. Radiographs revealed a fracture-dislocation of the first and second tarsometatarsal joints, with dorsal dislocation of the proximal second metatarsal. Surgical treatment included open reduction and internal fixation of the first and second tarsometatarsal joints and the intercuneiform joints. This injury caused the dancer to retire prematurely from professional ballet dancing, despite restoration of anatomical alignment and reacquisition of full mobility in the foot and ankle. Follow-up radiographs at three years post-injury indicated maintenance of the reduction and signs of mild arthritis in the midfoot. The dancer resumed ballet dancing at a non-professional level. It is important for dancers to realize that acute Lisfranc injuries can end dance careers despite immediate treatment. Proper footwear and floor-surface maintenance are important for prevention of this injury.

Kuo RS, Tejwani NC, et al. (2000). Outcome after open reduction and internal fixation of Lisfranc joint injuries. J Bone Joint Surg Am **82-A**(11): 1609-18.

BACKGROUND: Open reduction and internal fixation has been recommended as the treatment for most unstable injuries of the Lisfranc (tarsometatarsal) joint. It has been thought that purely ligamentous injuries have a poor outcome despite such surgical management. METHODS: We performed a retrospective study of patients who underwent open reduction and screw fixation of a Lisfranc injury in a seven-year period. Among ninety-two adults treated for that injury, forty-eight patients with forty-eight injuries were followed for an average of fifty-two months (range, thirteen to 114 months). Fifteen injuries were purely ligamentous, and thirty-three were combined ligamentous and osseous. Patient outcome was assessed with use of the American Orthopaedic Foot and Ankle Society (AOFAS) midfoot score and the long-form Musculoskeletal Function Assessment (MFA) score. RESULTS: The average AOFAS midfoot score was 77 points (on a scale of 0 to 100 points, with 100 points indicating an excellent outcome), with patients losing points for mild pain, decreased recreational function, and orthotic requirements. The average MFA score was 19 points (on a scale of 0 to 100 points, with 0 points indicating an excellent outcome), with patients losing points because of problems with "leisure activities" and difficulties with "life changes and feelings due to the injury." Twelve patients (25 percent) had posttraumatic osteoarthritis of the tarsometatarsal joints, and six of them required arthrodesis. The major determinant of a good result was anatomical reduction ($p = 0.05$). The subgroup of patients with purely ligamentous injury showed a trend toward poorer outcomes despite anatomical reduction and screw fixation. CONCLUSIONS: Our results support the concept that stable anatomical reduction of fracture-dislocations of the Lisfranc joint leads to the best long-term outcomes as patients so treated have less arthritis as well as better AOFAS midfoot scores.

Lattermann C, Goldstein JL, et al. (2007). Practical management of Lisfranc injuries in athletes. Clin J Sport Med **17**(4): 311-5.

Foot injuries are common in athletes. Injuries to the midfoot and, particularly, the Lisfranc joint are less common, but they have a high risk of ending the athlete's season or even career. Lisfranc injuries can be difficult to diagnose, and they often lead to a disastrous outcome when missed. Weight-bearing radiographs of the foot are recommended to confirm the diagnosis, although advanced imaging also may be required. Lisfranc injuries with less than 2 mm of diastasis on weight-bearing radiographs can be treated without weight bearing in a short leg cast or a walking boot for 6 weeks. Lisfranc injuries with more significant displacement or instability require operative intervention. Physicians who evaluate athletic injuries should be vigilant not to miss these injuries. Familiarity with the subtle clinical signs of a Lisfranc injury and knowledge of the basic treatment algorithm will help clinicians manage these injuries successfully.

Macmahon PJ, Dheer S, et al. (2009). MRI of injuries to the first interosseous cuneometatarsal (Lisfranc) ligament. Skeletal Radiol **38**(3): 255-60.

OBJECTIVE: The objective of this study was to assess the utility of MRI in diagnosing injury to the first interosseous cuneometatarsal (Lisfranc) ligament and to additionally determine the associated patterns of traumatic soft tissue and osseous injury. MATERIALS AND METHODS: Fifteen patients (16 feet) who were referred for MRI evaluation of the Lisfranc ligament, and had operative exploration or examination under anesthesia, were included for analysis. Standard non-contrast MRI foot imaging was performed in all cases. Evaluation of the following components was performed: the dorsal and plantar bundles of the Lisfranc ligament, the plantar tarsal metatarsal ligaments, soft tissue edema and fluid, and bone marrow edema and fractures. Surgical reports were regarded as the reference standard in all cases. RESULTS: Seven of 10 cases of grade 3 Lisfranc ligament injuries at surgery were correctly graded at MRI. No cases of surgically proven complete Lisfranc ligament tears (grade 3) were interpreted as normal at MRI. All Lisfranc ligament sprains (grade 2 or

3) at surgery were detected at MRI. Two of six cases reported as grade 1 injuries at MRI were normal at surgery. No cases of surgically proven normal or sprained Lisfranc ligaments were interpreted as grade 3 tears on MRI. Four of six of our cases of normal or sprained Lisfranc ligaments demonstrated fractures; while the minority of complete Lisfranc ligament tears (3/10) contained fractures. CONCLUSION: MRI is reasonably accurate at detecting traumatic injury to the Lisfranc ligament. However, in clinically suspected cases of traumatic Lisfranc ligament injury, true positive rate for sprain is low.

Micheli LJ, Sohn RS, et al. (1985). 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 **67**(9): 1372-1375.
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.

Nunley JA, Vertullo CJ. (2002). Classification, investigation, and management of midfoot sprains: Lisfranc injuries in the athlete. Am J Sports Med **30**(6): 871-878.
Background: Midfoot sprains in athletes represent a spectrum of injuries to the Lisfranc ligament complex, from partial sprains with no displacement to complete tears with frank diastasis. Treatment of these injuries varies from the treatment of high-velocity injuries seen in nonathletes. Purpose: We wanted to report the outcome of treatment in athletes with Lisfranc injuries classified according to our system. Study Design: Retrospective cohort study. Methods: Weightbearing radiographs and bone scintigrams were used to diagnose midfoot sprains in 15 athletes who were treated surgically or nonoperatively according to the following classification: nonoperative management for stage I injuries (undisplaced) and anatomic reduction with fixation for stage II (diastasis with no arch height loss) and stage III (diastasis with arch height loss) injuries. Results: We achieved an excellent outcome in 93% of 15 athletes with midfoot sprains at an average follow-up of 27 months (range, 9 to 72). Conclusions: Weightbearing radiographs and bone scintigrams are sensitive, reproducible, and relatively inexpensive methods of investigation of these injuries. Restoration and maintenance of the anatomic alignment of the Lisfranc joint is the key to appropriate treatment of injury to the midfoot.

O'Malley MJ, Hamilton WG, et al. (1996). Stress fractures at the base of the second metatarsal in ballet dancers. Foot & Ankle Int **17**(2): 89-94.

Pease J, Miller M, et al. (2009). An easily overlooked injury: Lisfranc fracture. Mil Med **174**(6): 645-6.
We report a case of a 16-year-old male who sustained a Lisfranc (tarsal metatarsal joint) fracture after a minor fall. His emergency department (ED) presentation, clinical course, and operative repair are presented as well as a discussion of Lisfranc fractures to include historical significance. Even after minor trauma, an emergency department physician must consider the often elusive diagnosis of a Lisfranc fracture in any patient with foot pain.

Raikin SM, Elias I, et al. (2009). Prediction of midfoot instability in the subtle Lisfranc injury. Comparison of magnetic resonance imaging with intraoperative findings. J Bone Joint Surg Am **91**(4): 892-9.

BACKGROUND: The objective of the present study was to assess the utility of magnetic resonance imaging for the diagnosis of an injury to the Lisfranc and adjacent ligaments and to determine whether conventional magnetic resonance imaging is a reliable diagnostic tool, with manual stress radiographic evaluation with the patient under anesthesia and surgical findings being used as a reference standard. METHODS: Magnetic resonance images of twenty-one feet in twenty patients (ten women and ten men with a mean age of 33.6 years [range, twenty to fifty-six years]) were evaluated with regard to the integrity of the dorsal and plantar bundles of the Lisfranc ligament, the plantar tarsal-metatarsal ligaments, and the medial-middle cuneiform ligament. Furthermore, the presence of fluid along the first metatarsal base and the presence of fractures also were evaluated. Radiographic observations were compared with intraoperative findings with respect to the stability of the Lisfranc joint, and logistic regression was used to find the best predictors of Lisfranc joint instability. RESULTS: Intraoperatively, seventeen unstable and four stable Lisfranc joints were identified. The strongest predictor of instability was disruption of the plantar ligament between the first cuneiform and the bases of the second and third metatarsals (the pC1-M2M3 ligament), with a sensitivity, specificity, and positive predictive value of 94%, 75%, and 94%, respectively. Nineteen (90%) of the twenty-one Lisfranc joint complexes were correctly classified on magnetic resonance imaging; in one case an intraoperatively stable Lisfranc joint complex was interpreted as unstable on magnetic resonance imaging, and in another case an intraoperatively unstable Lisfranc joint complex was interpreted as stable on magnetic resonance imaging. The majority (eighteen) of the twenty-one feet demonstrated disruption of the second plantar tarsal-metatarsal ligament, which had little clinical correlation with instability. CONCLUSIONS: Magnetic resonance imaging is accurate for detecting traumatic injury of the Lisfranc ligament and for predicting Lisfranc joint complex instability when the plantar Lisfranc ligament bundle is used as a predictor. Rupture or grade-2 sprain of the plantar ligament between the first cuneiform and the bases of the second and third metatarsals is highly suggestive of an unstable midfoot, for which surgical stabilization has been recommended. The appearance of a normal ligament is suggestive of a stable midfoot, and documentation of its integrity may obviate the need for a manual stress radiographic evaluation under anesthesia for a patient with equivocal clinical and radiographic examinations.

Teng AL, Pinzur MS, et al. (2002). Functional outcome following anatomic restoration of tarsal-metatarsal fracture dislocation. Foot Ankle Int **23**(10): 922-6.

Anatomic restoration of displaced fracture-dislocation of the tarsometatarsal junction of the foot is essential, as even "minor" disruptions of this joint complex leads to poor clinical results. In order to determine a "key" element associated with good or poor functional outcomes, 11 patients with excellent radiographic results following surgical treatment of unilateral closed Lisfranc fracture-dislocation of the tarsometatarsal joint of the foot were evaluated at an average of 41.2 (range, 14 to 53) months following their injury and surgery. Their average age was 40.6 (range, 21 to 58) years. AOFAS midfoot scores averaged 71.0 (range, 30 to 95). Radiographic analysis at follow-up revealed anatomic reduction in 10 of 11. Eight of 11 had evidence of arthritis of the tarsometatarsal joints. Clinical alignment was normal in all subjects, with nine of 11 clinically exhibiting decreased relative range of motion. Gait analysis was performed with the F-Scan (Tekscan, Boston, MA) in-shoe pressure-monitoring system. Vertical ground reaction force was recorded under the hallux, first metatarsal head, lateral metatarsals, and heel. Stance phase duration, rate of loading, rate of unloading, peak loading, and total loading were recorded at each of the named regions.

There was no statistical difference in the parameters measured between the injured and normal control feet. The results of this study reveal that when anatomic reduction is accomplished in tarsometatarsal fracture dislocation of the foot, objective measures of gait analysis are returned to normal. In spite of excellent radiographic results and return to normal dynamic walking patterns, subjective patient outcomes were less than satisfactory. It is presently well accepted that fracture-dislocations of the tarsometatarsal junction of the foot are best treated with anatomic restoration by closed, percutaneous or open methods. Many individuals achieve poor functional results. It is well accepted that patients are likely to develop late joint deformity at the tarsometatarsal junction, joint separation, and radiographic and clinical evidence of post-traumatic arthritis when anatomic reduction is not obtained. (1-7) The goal of this study was to determine if clinical results and subjective patient outcomes are assured with anatomic reduction. It appears that the major function of the tarsometatarsal joint complex is the regulation and redirecting of loading forces during weightbearing. There is very limited motion of the tarsometatarsal joint during walking. (8) This knowledge has prompted support for anatomic restoration following injury. Even with seemingly anatomic restoration of normal alignment, many patients fare poorly. The goal of this study was to objectively analyze the components of vertical ground reaction force during walking in patients who had evidence of excellent surgical reduction measured on follow-up weightbearing radiographs following isolated injury to the tarsometatarsal joint complex. We hoped to detect some key element of gait altered by the injury, and responsible for why patients fare poorly following this injury. By dissecting out the components of mechanical loading and unloading of the foot during walking, we wished to determine if there was a "key" factor associated with either favorable or unfavorable subjective clinical outcomes.

Wadsworth DJS, Eadie NY (2005). Conservative management of subtle Lisfranc joint injury: A case report. JOSPT **35**(3): 154-164.

Woodward S, Jacobson JA, et al. (2009). "Sonographic evaluation of Lisfranc ligament injuries." J Ultrasound Med **28**(3): 351-7.

OBJECTIVE: This study characterized the sonographic appearances of Lisfranc injuries. METHODS: Sonography reports (2000-2007) were searched for "Lisfranc," resulting in 10 patients. Sonographic images of affected and asymptomatic contralateral feet were reviewed, recording the thickness of the dorsal ligament between the first (medial) cuneiform (C1) and second metatarsal (M2) ligaments, distance between C1 and M2, and change in this distance with weight bearing, hyperemia, and fractures. Correlations were made to clinical, surgical, and other imaging findings. RESULTS: In 5 asymptomatic feet, the dorsal C1-M2 ligament was 0.9 to 1.2 mm thick, and the C1-M2 distance was 0.5 to 1 mm. Of the symptomatic feet, 1 group (n=3) had normal sonographic findings (thickness, 0.9-1.1 mm; distance, 0.6-0.7 mm; all had normal radiographic findings and follow-up, and 1 had normal magnetic resonance imaging [MRI] findings). Another group (n=3) had abnormal hypoechogenicity and thickening of the dorsal C1-M2 ligament (1.4-2.3 mm), a normal C1-M2 distance (0.6-0.7 mm), and no widening with weight bearing (1 of 1), consistent with a ligament sprain (1 had normal computed tomographic [CT] findings, and all had uneventful follow-up). The third group (n=4) had nonvisualization of the dorsal C1-M2 ligament, an increased C1-M2 distance of 2.5 to 3.1 mm, and further widening with weight bearing (3 of 4) from Lisfranc ligament disruption (shown at surgery in 2, MRI in 1, and CT in 1). CONCLUSIONS: Nonvisualization of the dorsal C1-M2 ligament and a C1-M2 distance of 2.5 mm or greater were indirect signs of a Lisfranc ligament tear. Dynamic evaluation with weight bearing showed widening of the space between C1 and M2.