



PASIG MONTHLY CITATION BLAST: No.44

September 2009

Dear PASIG members:

Many of us have been busy conducting our annual pre-season screening of both professional and student dancers. Dance/USA now has over 30 professional dance companies participating and using their uniform screen. With more and more dance screenings occurring throughout the country, to all of you out there I continue to pose this question: **How can we move forward in this area with musicians and orchestras?** I got no response last year, but I'll keep trying!

By this time, CSM abstract acceptance notices have gone out. 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](http://www.orthopt.org/sig_pa.php)). The deadline for application is November 15, 2006. For more information, contact Scholarship Chairperson, Amy Humphrey, at Phone: 703-527-9557, e-mail: [ahumphrey@bodydynamicsinc.com](mailto:ahumphrey@bodydynamicsinc.com), Fax: 703-526-0438.

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Performing Arts continuing education, courses, and related conferences.

Orthopaedic Section Independent Study Course  
Dance Medicine: Strategies for the Prevention and Care of Injuries to Dancers. This is a 6-monograph course and includes many PASIG members as authors. This home study course can be purchased at <http://www.orthopt.org/independent2.php>.

American College of Sports Medicine Greater NY Regional Chapter  
Dance Medicine and Science: What's New and Relevant to You?  
October 17, 2009  
Contact: Harkness Center

International Association for Dance Medicine and Science (IADMS) 19th Annual Meeting  
October 29- November 1, 2009  
The Hague, The Netherlands  
Contact: [www.iadms.org](http://www.iadms.org)

Combined Sections Meeting San Diego  
PASIG Programming to be announced.  
February 17 – 20, 2010  
Contact: [www.apta.org](http://www.apta.org)

If you know of other courses of interest to our membership, please send the information to: Amy Humphrey PT, DPT, OCS, MTC  
e-mail: [ahumphrey@bodydynamicsinc.com](mailto:ahumphrey@bodydynamicsinc.com)

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For this September Citation BLAST, I've selected the topic: *Plantar Plate Disruption*. 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 step up! As always, your comments and suggestions are welcome. Please 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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### **Plantar Plate Disruption of the Lesser Toes (2 through 5)**

The plantar plate of the foot is formed by the plantar aponeurosis and plantar capsule. The plantar plate supports the undersurface of the metatarsal head and resists hyperextension of the metatarsophalangeal joint (MTPJ), withstanding considerable compressive and tensile forces. Plantar plate disruption or rupture most commonly occurs at the second MTPJ, with subsequent instability of the MTPJ and dorsal subluxation of the proximal phalanx. This "cock-up" deformity, also termed "overriding toe deformity", at the MTPJ shortens and compromises the action of the extensor digitorum longus tendon and contributes over time to a flexion deformity at the interphalangeal joints. This condition is particularly painful to the dancer in relevé. While surgery is an option, primary repair may result in painful scarring and the frequently used flexor tendon transfer comprises other structures.

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Blitz NM, Ford LA, et al. (2004). Second metatarsophalangeal joint arthrography: a cadaveric correlation study. J Foot Ankle Surg **43**(4): 231-40.

Arthrography of the second metatarsophalangeal joint is an important diagnostic tool to evaluate the integrity of the plantar plate and to aid in the decision process for surgical intervention. A variety of filling patterns have been identified with lesser metatarsophalangeal joint arthrography and their significance with soft-tissue pathology remains to be completely understood. The purpose of this cadaveric study was to evaluate dye patterns in a series of arthrograms of the second metatarsophalangeal joint and to correlate them with identifiable anatomic lesions or structural variants. Thirty-nine cadaveric specimens (including 28 matched pairs) underwent second metatarsophalangeal joint arthrography with a colored radiopaque dye. Arthrographic findings were observed and recorded. Specimens exhibiting dye extravasation outside of the capsular constraints of the joint were dissected to discover any soft-tissue abnormalities. Twenty-one percent of specimens exhibited abnormal extravasation of dye outside of the joint capsule. A plantar plate tear was identified in 2 of these specimens. Filling of the first intermetatarsophalangeal bursa occurred in 6 specimens. However, because this finding was identified in 2 matched pairs, an anatomic variance is suggested rather than a pathologic entity. This cadaveric study shows that anatomic variances exist concerning the second metatarsophalangeal capsule and that arthrography should be correlated with the clinical scenario.

Bouche RT, Heit EJ (2008). Combined plantar plate and hammertoe repair with flexor digitorum longus tendon transfer for chronic, severe sagittal plane instability of the lesser metatarsophalangeal joints: preliminary observations. J Foot Ankle Surg **47**(2): 125-37.

The plantar plate provides a substantial static support for the lesser metatarsophalangeal joints. Insufficiency involving tear, attenuation, or absence of this structure can result in significant sagittal plane instability and deformity. When a plantar plate tear is established and is unresponsive to conservative treatment, plantar plate repair is indicated to address symptoms and reestablish static joint stability. The authors hypothesized that combined plantar plate and hammertoe repair with flexor digitorum longus tendon transfer provides a viable surgical option to address chronic plantar plate tears with secondary joint instability and digital deformity. The authors retrospectively evaluated a case series of 18 consecutive patients (20 feet) who underwent this combined surgical strategy as the primary procedure to address severe, chronic sagittal plane instability of the lesser metatarsophalangeal joints. Other procedures were performed concurrently in all cases to address predisposing factors and concomitant deformities. Method of evaluation included a subjective, objective, and radiologic evaluation performed at least 1 year after their surgical procedure. Two rating systems were used: the Lesser Metatarsophalangeal-Interphalangeal Scale from the American Orthopedic Foot and Ankle Society, and another designed by the authors. The average postoperative American Orthopedic Foot and Ankle Society score was 83.2/100 and the average postoperative score with the authors' rating system was 87.7/100. All patients were satisfied with their postoperative result. Study results suggest combined plantar plate and hammertoe repair with flexor digitorum longus tendon transfer to be a viable option to address severe, chronic sagittal plane instability of the internal lesser metatarsophalangeal joints. ACFAS Level of Clinical Evidence: 4.

Co AY, Ruch JA, et al. (2006). Radiographic analysis of transverse plane digital alignment after surgical repair of the second metatarsophalangeal joint. J Foot Ankle Surg **45**(6): 380-99.

We undertook a retrospective cohort study of 51 feet in 49 patients with surgically managed second metatarsophalangeal joint instability, including repair of the crossover second toe deformity. The fundamental intervention consisted of proximal interphalangeal joint arthrodesis combined with second metatarsophalangeal joint relocation and Kirschner-wire

transfixation, and this was performed alone or in combination with one of the following additional surgical maneuvers: flexor tendon transfer or flexor set release, flexor plate repair, placement of a plantar-lateral retention suture, extensor tendon transfer, metatarsophalangeal arthroplasty, metatarsal osteotomy, or second-to-third syndactyly. The outcome of interest was the presence of a transverse plane second metatarsophalangeal joint angle of 0 degrees to 15 degrees measured on the late postoperative follow-up radiograph. Overall, the median angular correction for all second metatarsophalangeal joint interventions was 8 degrees, and second-to-third syndactyly yielded the most long-term correction followed by, in descending order of the amount of angular correction, use of the fundamental intervention in combination with metatarsophalangeal joint arthroplasty, placement of a plantar-lateral anchor suture in the flexor plate, metatarsal osteotomy, flexor tendon transfer, flexor plate repair, extensor tendon transfer, and the fundamental intervention as a solitary procedure. A sensitivity analysis indicated that our results were resistant to the influence that an unmeasured variable would impart on the data. The results of this investigation should aid surgeons treating patients with unstable second metatarsophalangeal joints, and can be used in the development of future clinical trials and observational studies that focus on the management of this common deformity.

Coughlin MJ (1987). Crossover second toe deformity. Foot Ankle **8**(1): 29-39.

The crossover second toe deformity occurs when the lateral collateral ligament and joint capsule of the second metatarsophalangeal joint deteriorate. The second toe initially deviates in a medial direction but with time deviates dorsally and crosses up and over the great toe. A total of 17 patients (22 toes) were evaluated and 11 patients (15 toes) underwent surgical correction. A 90 deg satisfactory rate was noted at 42 months follow-up.

Coughlin MJ (1989). Subluxation and dislocation of the second metatarsophalangeal joint. Orthop Clin North Am **20**(4): 535-51.

This article discusses the causes of subluxation and dislocation of the second metatarsophalangeal joint. Determination of the pathology and magnitude of the deformity is reviewed and methods for conservative care are included. Surgical procedures presented include soft-tissue release and repair and excisional arthroplasty with consideration given to hammertoe repair.

Coughlin MJ (1993). Second metatarsophalangeal joint instability in the athlete. Foot Ankle **14**(6): 309-19.

In a group of athletically active patients, second metatarsophalangeal joint instability was diagnosed in nine patients (11 toes). A positive drawer sign was pathognomonic of early second metatarsophalangeal joint instability. A soft tissue realignment procedure was used to stabilize the second metatarsophalangeal joint in seven toes. In five of seven cases (71%), good to excellent results were noted at an average follow-up of 20.4 months.

Coughlin MJ, Schenck RC, et al. (2002). Concurrent interdigital neuroma and MTP joint instability: long-term results of treatment. Foot Ankle Int **23**(11): 1018-25.

INTRODUCTION: An interdigital neuroma is a common source of forefoot pain, and while second metatarsophalangeal joint instability is a less common entity, it can be a concomitant source of pain. The purpose of this study was to evaluate the long-term clinical course and surgical outcomes of the treatment of these concomitant problems. METHODS: 121 consecutive patients (131 feet and 136 neuromas) were evaluated and treated for a symptomatic interdigital neuroma from 1981 to 1997. Of these, 24 patients (20%) had a concurrent interdigital neuroma (IDN) and second metatarsophalangeal (MTP) capsular instability that underwent surgical treatment. At the final follow-up examination, 20 patients

(21 feet) were evaluated by an independent orthopaedic surgeon with a standardized clinical and radiographic examination, patient self-assessment and outcome measures. RESULTS: Overall, there were 18 females and two males (21 feet) treated with an average age of 54 years at the time of surgery that returned for examination and follow-up at an average of 80 months (48 to 108 months) following surgery. Seventeen patients (85%) rated their result as good or excellent and three as fair. Six patients had mild continued symptoms referable to the second toe and none to the neuroma. Simultaneous neuroma excision and second MTP stabilization was performed in 15 cases and in six cases a staged repair was performed. The mean visual analog pain score was 1.4 (0=no pain, 10=severe pain) and mean MHAQ score was 1.13 (1-1.625) with activity modification stemming from hip, back and knee complaints. CONCLUSION: With careful patient selection and preoperative assessment, resection of an interdigital neuroma and stabilization of second metatarsophalangeal joint instability resulted in a high percentage of successful results at greater than four years following the procedure. Objective results were comparable to previous reports on the surgical treatment of isolated interdigital neuroma and crossover second toe reconstruction. Subjective patient satisfaction was high but both subjective and objective results were lower in patients with persistent symptoms of MTP instability.

Deland JT, Lee KT, et al. (1995). Anatomy of the plantar plate and its attachments in the lesser metatarsalphalangeal joint. Foot Ankle Int **16**(8): 480-6.

The plantar plate is a rarely seen, yet central structure to the lesser metatarsal phalangeal (MP) joint. Thirty cadaver lesser MP joints were studied to obtain a detailed description of the plate, including its dimensions, connections, and histology. The plate was found to be made of fibrocartilage with fiber orientation that suggests that it withstands tensile loads in line with the plantar fascia as well as the compressive loads from the metatarsal head. The plantar plate was the most substantial distal insertion of the plantar fascia. Impressive plantar plate attachments were noted to the proximal phalanx, the major longitudinal bands of the plantar fascia, and the collateral ligaments. The plate and collateral ligaments formed a substantial soft tissue box connected to the sides of the metatarsal head. From the dissections, it is apparent that malposition of the toe at the MP joint is likely over time to be associated with pathology in both the collateral ligaments and the plate. Because of these attachments and a close association with the flexor tendons to the lesser toe, the plate can be compared with the sesamoid mechanism of the first MP joint.

Deland JT, Sobe MI, et al. (1992). Collateral ligament reconstruction of the unstable metatarsophalangeal joint: an in vitro study. Foot Ankle **13**(7): 391-5.

Anatomic reconstruction of the collateral ligaments of the lesser metatarsophalangeal joints is proposed for certain cases of metatarsophalangeal instability. The suggested reconstruction involves replication of the attachments of the collateral ligaments. As an example of such a reconstruction, the interosseous tendon was used in this study as a graft for anatomic replacement of the collateral ligaments. The tendon was left attached distally where its attachments include the volar plate and proximal phalanx, thereby resembling the distal attachment of the collateral ligament. The proximal portion of the tendon was inserted into the metatarsal head, replicating the attachment of the collateral ligament at that location. Preliminary testing of such a reconstruction shows that it can re-establish stability caused by loss of the collateral ligaments. Such a procedure may be applicable in select cases of crossover toe deformity and straight vertical instability.

Deland JT, Sung IH (2000). The medial crossover toe: a cadaveric dissection. Foot Ankle Int **21**(5): 375-8.

The development of a medial crossover second toe (second toe crossing over the first toe) is not a rare clinical condition. It often occurs in the setting of hallux valgus, although not exclusively so. The resulting displacement of the second toe can cause pain in shoes, with surgical correction being problematic. The pathologic anatomy of this condition has not been fully described. In an effort to better understand it, dissection of a cadaveric specimen with a full crossover toe is presented. The dissection revealed findings not previously documented. They include medial displacement of the flexor tendons and plantar plate along with deformity of the plate itself. These changes are in addition to contracture of the medial collateral ligaments and the previously described rupture of the lateral collateral ligaments. Both the plantar plate and the collateral ligaments, the two major static soft tissue stabilizers of the lesser MP joint, were found to be significantly involved. Pull on the flexor tendons only accentuated the malalignment of the toe. Clinical Significance: The extensive soft tissue changes explain the difficulty in achieving a successful longterm correction of a full medial crossover toe with a soft tissue procedure. With attenuation of the plantar plate and medial displacement of the flexor tendons, there is an imbalance of muscle forces across the MP joint. This muscle imbalance would not be corrected by release of the medial collateral ligament, dorsal capsular release or extensor tendon lengthening. Reconstruction of the collateral ligament is at risk for incomplete correction since it is unlikely to resolve deformity in the plate if already present.

Ford LA, Collins KB, et al. (1998). Stabilization of the subluxed second metatarsophalangeal joint: flexor tendon transfer versus primary repair of the plantar plate. J Foot Ankle Surg **37**(3): 217-22.

Surgical treatment of the subluxed second metatarsophalangeal joint (MTPJ) has been a consistently frustrating problem for the foot and ankle surgeon. The plantar plate is the principal stabilizing structure of the second MTPJ and compromise to its integrity has been implicated as the cause of the subluxed second toe. Flexor tendon transfer has been reported as the mainstay of treatment to stabilize the subluxed second MTPJ. Recently, primary repair of the plantar plate has been advocated, yet no research exists comparing it to flexor tendon transfer. Eight freshly frozen lower extremity cadaver specimens were mounted on a custom-fabricated load frame. A vertical dorsally directed force was applied to the base of the proximal phalanx of the second toe via a pneumatic actuator to stimulate the Lachman test. Dorsal displacements of the proximal phalanx were measured with a linear variable distance transducer. This investigation examined the comparative strength of flexor tendon transfer versus primary repair of the plantar plate in stabilizing the second MTPJ. Results showed a significant difference between the transected plantar plate and the intact plantar plate. Displacements for the repair groups were similar to the intact plantar plate group and also significantly different from the transected plantar plate. Primary repair of the plantar plate is a viable alternative to flexor tendon transfer in stabilizing the second MTPJ with the advantage of addressing the pathology anatomically. Clinical studies are needed to substantiate these laboratory findings.

Gazdag A, Cracchiolo A (1998). Surgical treatment of patients with painful instability of the second metatarsophalangeal joint. Foot Ankle Int **19**(3): 137-43.

An unstable second metatarsophalangeal joint may produce pain in the forefoot. Eighteen patients (20 feet) had a transfer of the flexor digitorum longus to the extensor side of the base of the proximal phalanx performed as the primary procedure to stabilize this painful joint. Most patients had a hallux valgus deformity that also required correction, because it either was also symptomatic or was preventing adequate reduction of the second toe. A ruptured plantar plate of the second metatarsophalangeal joint was demonstrated in 13 feet and in these joints appeared to be the cause of the vertical instability. However, all feet

showed an unstable joint upon clinical examination. A vertical-stress test almost always reproduced the patient's pain while demonstrating instability in the joint; this was the most prominent physical finding in these patients. Eleven patients (13 feet) had an excellent result. Seven patients (seven feet) had a fair result, but they complained only of mild and occasional pain at the joint on exertion. Although difficult to quantify, it appears that postoperative stiffness in the joint provided some of the joint stability seen in our patients. The flexor tendon transfer appears to be a satisfactory method to treating the unstable metatarsophalangeal joint and of relieving patients' pain, but may not, however, restore a normal alignment of the second toe. Correction of other forefoot deformities as hallux valgus and hammertoes may also be important in restoring metatarsophalangeal stability.

Gregg J, Marks P, et al. (2007). Histologic anatomy of the lesser metatarsophalangeal joint plantar plate. Surg Radiol Anat **29**(2): 141-7.

The plantar plate is the fibrocartilaginous structure that supports the ball of the foot, withstanding considerable compressive and tensile forces. This study describes the morphology of the plantar plate in order to understand its function and the pathologic disorders associated with it. Eight lesser metatarsophalangeal joint plantar plates from three soft-embalmed cadavers (74-92 years, two males, one female), and eight lesser metatarsophalangeal joint plantar plates from a fresh cadaver (19-year-old male) were obtained for histology assessment. Paraffin sections (10 microm) in the longitudinal and transverse planes were analyzed with bright-field and polarized light microscopy. The central plantar plate collagen bundles run in the longitudinal plane with varying degrees of undulation. The plantar plate borders run transversely and merge with collateral ligaments and the deep transverse intermetatarsal ligament. Bright-field microscopic evaluation shows the plantar aspect of the plantar plate becomes ligament-like the further distally it tapers, containing fewer chondrocytes, and a greater abundance of fibroblasts. The enthesis reveals longitudinal and interwoven collagen bundles entering the proximal phalanx with multiple interdigitations. Longer interdigitations centrally compared to the dorsal and plantar aspects suggest that the central fibers experience the greatest loads.

Gregg J, Silberstein M, et al. (2006). Sonographic and MRI evaluation of the plantar plate: A prospective study. Eur Radiol **16**(12): 2661-9.

The purpose of this study was to establish the accuracy of ultrasound in the examination of the plantar plate by comparing it with MRI, or if available, surgical findings. The lesser metatarsophalangeal joint plantar plates of 40 symptomatic and 40 asymptomatic feet (160 asymptomatic and 160 symptomatic plantar plates) were examined with ultrasound and MRI. Patients treated with surgery were chosen on a clinical basis and provided surgical correlation for the imaging techniques. Symptomatic patients with metatarsalgia and suspected metatarsophalangeal joint instability were referred by an orthopedic foot specialist; asymptomatic feet were obtained either through examination of the contralateral foot of the symptomatic patients or volunteers. Ultrasound detected 75/160 and 139/160 plantar plates torn in the asymptomatic and symptomatic groups, respectively. MRI detected 56/160 and 142/160 tears in the symptomatic and asymptomatic groups, respectively. The sensitivity of MRI and ultrasound with surgical correlation was calculated to be 87 and 96%, respectively, with poor specificity. Ultrasound correlates moderately with MRI in the evaluation of the plantar plate. Surgical correlations, although limited (n = 10), indicate ultrasound is superior to MRI with more accurate detection of tears.

Gregg JM, Silberstein M, et al. (2006). Sonography of plantar plates in cadavers: correlation with MRI and histology. AJR Am J Roentgenol **186**(4): 948-55.

**OBJECTIVE:** The purpose of our study was to describe the sonographic appearance of the lesser metatarsal plantar plates in cadavers and to correlate these findings with MRI and histology. **MATERIALS AND METHODS:** Six soft-embalmed cadaveric feet (74-92 years old; two male, one female) were imaged with sonography and MRI. Tear dimensions of the plantar plate were recorded in the long and short axes. Orthopedic surgeons directly inspected the plantar plates before removing samples for histologic correlation. One young fresh cadaver was imaged with sonography before histologic assessment. **RESULTS:** The normal plantar plate appearance on sonography was a slightly echoic, homogeneous, curved structure. At direct inspection, a tear was present in 23 (96%) of 24 of the lesser plantar plates in the soft-embalmed feet. This direct inspection correlated with sonography detecting 23 tears correctly and MRI, 22 tears. Both sonography and MRI falsely reported one tear, but MRI also failed to detect one tear. Histologically, the abnormal plantar plate showed loss of the normal dense regular tissue and replacement with vessels, hydropic tissue, and a mixture of loose connective tissue and dense irregular connective tissue. **CONCLUSION:** Sonography, being noninvasive, shows promise as an imaging tool of the plantar plate. With ongoing research in this area we hope to determine the reliability and significance of such a technique in the evaluation of the plantar plate.

Johnston RB, Smith J, et al. (1994). The plantar plate of the lesser toes: an anatomical study in human cadavers. Foot Ankle Int **15**(5): 276-82.

The purpose of this study was to evaluate the anatomic structure and biochemical composition of the plantar plate of the lesser toes. Fresh frozen-human cadaveric feet were used to study 20 metatarsophalangeal and proximal interphalangeal plantar plates. The observations of foot dissections were compared with the finger volar plate. The plantar plate of the toe is a rectangular structure with a stout distal insertion and relatively flimsy proximal origin. The anatomic relationships to adjacent structures and composition are similar between the volar plates of the fingers and plantar plates of the toes. The plantar plate is known to experience extension forces that the volar plate does not experience. The weightbearing nature of the foot and forces imposed by toe-off may create chronic hyperextension of the metatarsophalangeal joint and predispose the plantar plate to attenuation or rupture, thus leading to instability of the metatarsophalangeal joint. These findings may explain in part the clinical condition of spontaneous metatarsophalangeal joint dislocation, most commonly found in the second toe.

Kaz AJ, Coughlin MJ (2007). Crossover second toe: demographics, etiology, and radiographic assessment. Foot Ankle Int **28**(12): 1223-37.

**BACKGROUND:** The purpose of this study was to determine the demographics, etiology, and radiographic findings associated with a crossover second toe deformity. **METHODS:** Patients treated operatively for a crossover second toe deformity between 2001 and 2006 were identified. Charts were reviewed for clinical information, and radiographs were examined for pertinent angular measurements. **RESULTS:** Of 169 patients in the study, 146 (86%) were women. The mean age at surgery was 59 (range 33 to 87) years. The most common complaints of preoperative pain were at the second (156 patients) and first (35 patients) metatarsophalangeal joints (several patients had more than one area of pain). A positive drawer sign was noted in 112 patients. The mean second and third metatarsophalangeal joint angles were -3 degrees and 6 degrees, respectively. There was a significant association of hallux valgus with first metatarsophalangeal joint arthritis ( $p < 0.01$ ). The relative length of the second metatarsal averaged 0.2 mm less than the first metatarsal. **CONCLUSIONS:** Crossover second toe deformity had a peak incidence in women over the age of 50 years. There was an increased incidence of both hallux valgus and first metatarsophalangeal joint degenerative arthritis in the patient cohort. A positive



drawer sign was a reliable and consistent physical examination finding. The most reliable radiographic indicator of a second crossover toe was medial angular deviation of the second metatarsophalangeal joint in relationship to the third metatarsophalangeal joint angle, although the angle was not necessarily a negative value. There was no correlation between a crossover second toe deformity and second metatarsal length, medial cortex thickness or shaft thickness, the 1-2 intermetatarsal angle, metatarsus adductus, metatarsus primus elevatus, or pes planus.

Khoury V, Guillin R, et al. (2007). Ultrasound of ankle and foot: overuse and sports injuries. Semin Musculoskelet Radiol **11**(2): 149-61.

Sports and overuse injuries of the ankle and foot are commonly encountered in clinical practice. Ultrasound (US) has been established as an excellent diagnostic modality for foot and ankle injuries, providing a rapid noninvasive, economical, and readily available tool that is well tolerated by the patient with acute or chronic pain. The opportunity for dynamic examination is another advantage of US in evaluating ankle and foot pathology, where maneuvers such as muscle contraction and stressing of the joint may be particularly helpful. In many cases, US can be used as a first-line and only imaging modality for diagnosis. This article focuses on ankle disorders related to sports or overuse that affect tendons, including tendinosis, tenosynovitis, paratendinitis, rupture, dislocation, and ligaments that are commonly torn. The sonographic features of certain common foot disorders related to physical activity and overuse are also discussed, including plantar fasciitis, Morton's neuroma, stress fractures, and plantar plate injury.

Lui TH (2007). Arthroscopic-assisted correction of claw toe or overriding toe deformity: plantar plate tenodesis. Arch Orthop Trauma Surg **127**(9): 823-6.

Hyperextension of the metatarsophalangeal joint is the key component of claw toe deformity. We describe an arthroscopic technique to stabilize the plantar plate and reduce the metatarsophalangeal joint. Under arthroscopic guide, the dorsal capsule is released. The plantar plate is anchored and sutured to the extensor digitorum longus tendon. In case of overriding toe deformity, the medial capsule is also reduced and lateral capsule is plicated under arthroscopic guide.

Powless, S. H. and M. E. Elze (2001). Metatarsophalangeal joint capsule tears: an analysis by arthrography, a new classification system and surgical management. J Foot Ankle Surg **40**(6): 374-89.

Metatarsalgia is a common presenting symptom with an established list of differential diagnoses. The authors present a classification system and surgical treatment algorithm for chronic metatarsophalangeal pain due to metatarsophalangeal joint capsule tear. A series of 58 metatarsophalangeal joints with partial tear diagnosed by arthrogram and treated by surgical repair are reviewed. The authors propose a classification system based on preoperative arthrography and a surgical repair procedure for each type of three distinct patterns. A study was developed and funded to perform postoperative arthrograms on 15 patients who had undergone surgical repair using the procedures presented. The purpose of the study was to validate the utility of the arthrogram in the diagnosis and clarification of the nature of the capsular tear. The authors were also able to demonstrate that the arthrographic findings became normal postoperatively, and that surgical repair of a seemingly innocuous capsule tear relieves pain. Fifty-six patients in the series reported relief of their preoperative symptoms. Postoperative arthrograms in 15 patients demonstrated a normal pattern in 73%, 20% had decreased extravasation, and 7% were unchanged.

Stainsby GD (1997). Pathological anatomy and dynamic effect of the displaced plantar plate and the importance of the integrity of the plantar plate-deep transverse metatarsal ligament tie-bar. Ann R Coll Surg Engl **79**(1): 58-68.

Normal and deformed forefeet have been investigated by cadaver anatomical dissections and experiments, by radiographs, CT and MRI scanning, and by clinical studies. Evidence is presented to show that the skeleton of the foot rests on and is controlled by a multi-segmental ligamentous and fascial tie-bar system. Transversely across the plantar aspect of the forefoot, the plantar plates and the deep transverse metatarsal ligaments form a strong ligamentous structure which prevents undue splaying of the forefoot. Longitudinally, the five digital processes of the deeper layer of the plantar fascia are inserted into the plantar plates and control the longitudinal arch of the foot. It is suggested that many forefoot deformities result from the failure of parts of the tie-bar system and the dynamic effect of displacement of the plantar plates. Understanding this allows a more logical approach to their treatment.

Thompson FM, Deland JT (1993). Flexor tendon transfer for metatarsophalangeal instability of the second toe. Foot Ankle **14**(7): 385-8.

Flexor to extensor transfer was used to treat painful second metatarsophalangeal joint instability in thirteen feet in eleven patients. All patients had their pain reproduced with vertical stress motion of 50% to 100% at the metatarsophalangeal joint. Seven feet had concomitant hallux valgus correction, two feet had no hallux valgus, and four feet underwent no correction for asymptomatic hallux valgus. Results at an average of 33.4 months followup showed that all patients had substantial pain relief, with eight patients becoming pain-free, and five patients experiencing mild pain. All but one were satisfied with their result. Stiffness appeared to be the source of the mild residual pain. All toes, including six toes with preoperative medial crossover toe deformity, were corrected into valgus alignment with adjacent toes. All toes operated on for the first time were able to touch the ground with grasp postoperatively. Flexor to extensor transfer is successful in reducing the second toe and relieving pain caused by instability of the second metatarsophalangeal joint, but may require rapid postoperative mobilization to ensure passive dorsiflexion equal to that of the adjacent toes to reduce postoperative uncomfortable stiffness.

Thompson FM, Hamilton WG (1987). Problems of the second metatarsophalangeal joint. Orthopedics **10**(1): 83-9.

Diagnosis and treatment of second metatarsophalangeal joint (MTPJ) problems are discussed. A new staging for Freiberg's disease is presented with differential treatment for each stage. Subluxation of the second MTPJ occurs commonly but is often unrecognized. A simple test in physical examination, the "positive Lachman" of the MTPJ is illustrated and explained. Although controversial, the etiology of synovitis of the second MTPJ is probably diverse; it can occur idiopathically or because of mechanical instabilities relating to malalignment of the first ray or disproportionate length of the second ray. When conservative treatment fails, surgical debridement of the joint is indicated. The second MTPJ is the most common chronically dislocated joint in the foot. The surgical goal is a reduced metatarsophalangeal joint and a stable toe. Surgical correction detailed by the authors involves a stepwise approach depending on the severity of the contracture, bony overlap, and deformity.

Umans HR, E. Elsinger E (2001). The plantar plate of the lesser metatarsophalangeal joints: potential for injury and role of MR imaging. Magn Reson Imaging Clin N Am **9**(3): 659-69, xii.

This article reviews the normal anatomy of the plantar plate and surrounding support structures at the lesser metatarsophalangeal joints, and demonstrates degenerative change and rupture using high resolution MR imaging of the forefoot. The etiology of plantar plate

and collateral ligament degeneration and rupture, most commonly occurring at the second metatarsophalangeal joint, is discussed as it relates to chronic synovitis and instability. Both conservative and surgical treatment options are discussed.

Yao L, Do HM, et al. (1994). Plantar plate of the foot: findings on conventional arthrography and MR imaging. AJR Am J Roentgenol **163**(3): 641-4.

The plantar plate of the foot is formed by the plantar aponeurosis and plantar capsule. The plantar plate arises from the distal plantar aspect of the metatarsal neck and inserts on the plantar aspect of the proximal phalangeal base. This thick plate supports the undersurface of the metatarsal head and resists hyperextension of the metatarsophalangeal joint (MTPJ). Plantar plate rupture may present as lesser metatarsalgia (the lesser metatarsals are the second through fifth), occasionally with exuberant synovitis. Plantar plate derangement also plays a central role in the genesis of the common hammertoe. Rupture or degeneration of the plantar plate destabilizes the MTPJ, allowing dorsal subluxation of the proximal phalanx. The resulting "cock-up" deformity at the MTPJ shortens and compromises the action of the extensor digitorum longus tendon, contributing over time to a flexion deformity at the interphalangeal joints.

Yu GV, Judge MS, et al. (2002). Predislocation syndrome. Progressive subluxation/dislocation of the lesser metatarsophalangeal joint. J Am Podiatr Med Assoc **92**(4): 182-99.

Progressive subluxation/dislocation of the lesser toes resulting from idiopathic inflammation about one or more of the lesser metatarsophalangeal joints is a common cause of metatarsalgia that is frequently unrecognized or misdiagnosed. The disorder results from a failure of the plantar plate and collateral ligaments that stabilize the metatarsophalangeal joints and is typically associated with abnormal forefoot loading patterns. The authors refer to this condition as predislocation syndrome and have devised a clinical staging system that is based on the clinical signs and symptoms present during examination. A thorough review of predislocation syndrome and an overview of the conservative and surgical treatment options available for this disorder are presented.