PASIG PERFORMING ARTS
SPECIAL INTEREST GROUP

ORTHOPAEDIC SECTION
AMERICAN PHYSICAL THERAPY ASSOCIATION

APTA
American Physical Therapy Association
The Science of Healing. The Art of Caring.

PASIG MONTHLY CITATION BLAST: No.48 **March 2010**

Dear PASIG members:

Those of you who joined us at our recent CSM PASIG business meeting and programming in San Diego know the enthusiasm and knowledge our members bring to the practice of performing arts physical therapy. The PASIG sends a warm thank you to our speakers and all those who attended our PASIG programming entitled "*Physical Therapy Management in Gymnastics: Spine, Shoulder, Wrist, Hand Injuries coupled with Stress and Eating Disorders"*. A huge thanks to Tara Jo Manal, PASIG Vice President for her incredible programming efforts!

In addition, there were seven very interesting PA-related research platforms and posters this year. Congratulations to our student scholarship winner, Miho Urisaka from University of Southern California, Class of 2009, for her platform entitled "Is support moment during single-legged hopping influenced by patellar tendinopathy?" To all who presented your performing arts research as a platform or poster, thank you for your contributions. We hope to see your work published in the future. If I or any members of the Research Committee (see below) can be of any assistance, please don't hesitate to contact us.

And a warm welcome to all *Orthopaedic Section* members. We're mailing you this March Citation BLAST as an example of what benefits the PASIG offers to its members. ***If you'd like to continue receiving these BLASTs, check us out and join the PASIG - it's free***. (To join, go to the Orthopaedic Section webpage: http://www.orthopt.org/ and you will find a membership application in the menu on the left).

We welcome our new PASIG Vice President, Lisa Shoaf, as well as new Nominating Committee (NC) Chair, Jason Grandeo, NC members, Kendra Hollman-Gage and Laura Becica. A huge thank you to outgoing board members: Tara Jo Manal, Karen Hamill, and Sheyi Ojofeitimi, To all of our members – get active! We need your ideas! We need you! You form a strong network that is invaluable to the performing arts community.

Based on requests from our members, over the next year, PASIG volunteers will be developing new PA-terminology resources. Areas include ice skating, gymnastics, hip hop dance, cheerleading, baton and flag twirling, instrumentalists, vocalists, ballroom dance, an update of ballet, and modern dance (Graham, Horton, etc.). These will include definitions and photographs and will be published as a Blast and posted on our website. If you'd like to get involved in one of these groups, please contact me, Shaw Bronner.

The PASIG and Orthopeadic 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.

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. PASIG members are currently developing a new Performing Arts Independent Study Course, so be on the lookout for its release.

Performing Arts Medicine Association (PAMA)
28th Annual Symposium on Medical Problems of Musicians and Dancers
July 29 – Aug 1, 2010
Snowmass, CO
Contact: http://www.artsmed.org/

International Association for Dance Medicine and Science (IADMS) 19th Annual Meeting
October 28 – 31, 2010
Birmingham, UK
Contact: www.iadms.org

If you know of other courses of interest to our membership, please send the information to: Amy Humphrey PT, DPT, OCS, MTC; ahumphrey@Bodydynamicsinc.com

For this March Citation BLAST, I've selected *Accessory Bones of the Foot.* The format is an annotated bibliography of articles from 2000 – 2010. The PASIG Research Committee initiated this monthly Citation BLAST on performing arts-related topics in June 2005 in the hopes of encouraging our members to stay current in the literature and, perhaps, consider conducting research themselves. Each month we send a new list of performing arts (PA) citations to members of the PASIG to further the pursuit of PA-related scholarship. 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).

Upcoming citation topics will include Pilates, Taping, Yoga, nutrition, and eating disorders. Anyone interested in contributing to one of these topics or to suggest a new special topic, please contact me.

As always, your comments and suggestions are welcome. As always, your comments and entry contributions to these Citation BLASTs are welcome. Please drop me an e-mail anytime.

Regards,
Shaw

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Accessory Bones of the Foot

Accessory ossicles are sesamoid bones and are common findings (approximately 20% incidence) in foot and ankle radiology. The most common accessory ossicles are accessory navicular (11.7%), os peroneum (4.7%), and os trigonum (2.3%). Others include os supranaviculare, os sustentaculi, os vesalianum, os supratalare, os intermetatarseum, os cuboideum secundarium, calcaneus secundarius, and os vesalianum pedis, in addition to bi and tri-partite sasamooid bones of the great toe.

Accessory ossicles of the foot are commonly mistaken for avulsion fractures. Although in the vast majority these accessory bones are normal variants of anatomy and are asymptomatic, they can lead to painful syndromes, suffer fractures, or undergo degenerative changes in response to overuse and trauma.

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Abramowitz Y, Wollstein R, et al. (2003). Outcome of resection of a symptomatic os trigonum. J Bone Joint Surg Am **85-A**(6): 1051-1057.

BACKGROUND: While an os trigonum at the posterolateral aspect of the talus is usually asymptomatic, this inconsistently present accessory bone has been associated with persistent posterior ankle pain, which has been described as the os trigonum syndrome. We present the clinical results of excision of the os trigonum through a posterolateral approach and report several factors affecting the clinical outcome. METHODS: During a five-year period from 1994 through 1999, forty-one patients had a failure of nonoperative treatment of os trigonum syndrome and underwent excision of a symptomatic os trigonum. In all cases, the os trigonum syndrome was diagnosed on the basis of the history, physical examination, and radiographs. Postoperatively, the patients were evaluated according to the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale. A questionnaire was used to evaluate the effect of several factors on the clinical outcome. RESULTS: The average duration of follow-up was forty-four months. The postoperative AOFAS score averaged 87.6 points. The thirty-three patients who had had symptoms for two years or less prior to the surgery had an average postoperative score of 90 points compared with 78 points for the eight patients who had had preoperative symptoms for more than two years (p = 0.011). Eight patients had sural nerve sensory loss, which was temporary in four and permanent in four. A superficial wound infection developed in one patient, and reflex sympathetic dystrophy developed in another. CONCLUSIONS: An os trigonum that is persistently symptomatic after a minimum three-month trial of nonoperative treatment can be excised through a posterolateral approach with highly satisfactory results. The main complication of this procedure is sural nerve injury.

Bashir WA, Lewis S, et al. (2009). Os peroneum friction syndrome complicated by sesamoid fatigue fracture: a new radiological diagnosis? Case report and literature review. Skeletal Radiol **38**(2): 181-186.

Injuries to the peroneal tendons are relatively common worldwide but tendon rupture without significant trauma is uncommon. Ankle mechanics can be seriously affected by disruption of one or both of the peroneal tendons although complete rupture can also remain

asymptomatic. Accessory ossicles are sesamoid bones and are common findings in routine radiology of the foot and ankle. Although in the vast majority these "os" are normal variants of anatomy, they can lead to painful syndromes and suffer fractures and even undergo degenerative changes in response to overuse and trauma. Although similar syndromes have been discussed in the surgical literature, there is a lack of literature describing the use of modern imaging in the accurate diagnosis and its subsequent assistance towards appropriate management of os peroneum friction syndrome complicated by sesamoid fatigue syndrome. This article presents the plain film, sonographic and magnetic resonance imaging findings in a case of os peroneum friction syndrome complicated by a sesamoid fatigue fracture as well as reviewing the pertinent literature.

Bayramoglu A, Demiryurek D, et al. (2009). Differential diagnosis in a professional basketball player with foot pain: is it an avulsion fracture or an os supranaviculare? Eklem Hastalik Cerrahisi **20**(1): 59-61.

The os supranaviculare is an accessory bone located on the dorsal aspect of the talonavicular joint close to the midpoint. This rare incidental skeletal variant has an estimated prevalence of 1%. It may rarely become symptomatic and should not be confused with cortical avulsion fractures of navicular or talar head. We present the case of a 25-year-old professional basketball player with pain on the dorsum of his right foot after twisting his ankle during a regular season match. Magnetic resonance imaging findings of the player's foot represented a flake of bone on the superior part of the talar head. The differential diagnosis and clinical outcome of this unusual case are briefly discussed.

Bernaerts A, Vanhoenacker FM, et al. (2004). Accessory navicular bone: not such a normal variant. Jbr-Btr **87**(5): 250-252.

The accessory navicular is often erroneously considered as a normal anatomic and roentgenographic variant. Three distinct types of accessory navicular bones have been described. The type 2 and 3 variants have been associated with pathologic conditions such as posterior tibial tendon tear and painful navicular syndrome and therefore should not be arbitrarily dismissed as a roentgenologic variant in a symptomatic patient. The pathogenesis and radiologic findings are discussed and illustrated.

Blitz NM, Nemes KK (2007). Bilateral peroneus longus tendon rupture through a bipartite os peroneum. J Foot Ankle Surg **46**(4): 270-277.

Peroneus longus rupture with associated involvement of the os peroneum is an uncommon injury, and a small number of cases have been reported. Several mechanisms of injury have been suggested, but the most accepted theory is due to an inversion force placed on a cavovarus foot type. The sesamoid often becomes the focal point of the mechanical stresses and may fracture. Although the purpose of the sesamoid is to protect the tendon from rupture, the os peroneum may actually encourage fatigue (tear/rupture) under certain circumstances. Because this injury occurs at the cuboid notch, primary repair is complicated because of the inability to access the tendon as it courses deep within the midfoot. We present a bilateral case of peroneus longus rupture with involvement of the os peroneum in a patient with a cavovarus foot type. The injuries were sustained from an identical mechanism and occurred almost 1 year apart. In both situations, a peroneus longus to peroneus brevis tendon transfer was performed above the ankle joint in conjunction with partial excision of the fractured os peroneum. To the authors' knowledge, this is the only reported case of peroneus longus rupture associated with fracture of the os peroneum to occur bilaterally.

Boya H, Ozcan O, et al. (2005). Os vesalianum pedis. J Am Podiatr Med Assoc **95**(6): 583-585.

Os vesalianum pedis is an accessory bone located proximal to the base of the fifth metatarsal. Its prevalence has been reported to be from 0.1% to 1.0%. This bone is found

within the peroneus brevis tendon and is considered to be asymptomatic in the majority of people. We describe a patient with os vesalianum pedis with a distinct mediocuboidal articulation. The radiologic differential diagnosis of the ossicle is discussed.

Brigido MK, Fessell DP, et al. (2005). Radiography and US of os peroneum fractures and associated peroneal tendon injuries: initial experience. Radiology **237**(1): 235-241.
PURPOSE: To retrospectively evaluate the imaging features of os peroneum fractures and associated peroneus longus tendon injuries at radiography and ultrasonography (US) and to retrospectively compare these imaging features with those of multipartite os peroneum. MATERIALS AND METHODS: Institutional review board approval was obtained and informed consent was waived for this HIPAA-compliant study. Retrospective review of findings in nine patients (five men, four women; age range, 35-59 years) with os peroneum fracture at radiography and lateral foot pain after injury who had undergone US of the foot was performed. Three patients underwent magnetic resonance (MR) imaging, and two underwent surgery. Os peroneum fragment separation and displacement relative to the calcaneocuboid joint were measured on radiographs. Os peroneum fracture and peroneus longus tendon injuries were characterized with US and MR imaging. Review of 43 foot radiographs obtained in 36 control subjects (eight men, 28 women; age range, 18-84 years) who were found to have an os peroneum at radiography but were asymptomatic in that area was completed to measure os peroneum distance from the calcaneocuboid joint and bipartite os peroneum fragment distraction. RESULTS: Os peroneum fragment separation of 6 mm or more or displacement of the proximal fragment by 10 mm or more on a lateral radiograph or 20 mm or more on an oblique radiograph was associated with full-thickness peroneus longus tendon tear in seven of seven patients (100%). Os peroneum fragment separation of 2 mm or less or proximal displacement of 8 mm or less was associated with normal tendons, partial-thickness tears, or tendinosis. In the control subjects, os peroneum location ranged from 7 mm proximal to 8 mm distal to the calcaneocuboid joint on lateral radiographs and from 9 mm proximal to 8 mm distal to the joint on oblique radiographs. Bipartite os peroneum fragment separation was 2 mm or less. CONCLUSION: Os peroneum fragment separation of 6 mm or more suggests os peroneum fracture and associated full-thickness peroneus longus tendon tear. Separation of 2 mm or less may be seen with nondisplaced os peroneum fractures and bipartite os peroneum.

Ceroni D, De Coulon G, et al. (2006). Calcaneus secundarius presenting as calcaneonavicular coalition: a case report. J Foot Ankle Surg **45**(1): 25-27.
Calcaneus secundarius is an accessory ossicle of the anterior calcaneal facet identified in up to 5% of the population. Calcaneus secundarius rarely leads to symptoms, but its presence may generate pain around the ankle. The purpose of this case report is to describe this atypical accessory ossicle, which can mimic a calcaneonavicular coalition, and to explain the clinical approach to reach a diagnosis and determine treatment. The authors report the case of a 13-year-old girl who sustained several lateral sprains of the right ankle and had local chronic pain. Clinical findings were consistent with calcaneonavicular coalition but radiographic examinations revealed a calcaneus secundarius. The location of this ossicle may limit the range of motion of the subtalar joint, mimicking a calcaneonavicular coalition. Surgical excision of this bulky accessory ossicle was performed, and this treatment fully resolved the pain and improved subtalar motion.

Choi YS, Lee KT, et al. (2004). MR imaging findings of painful type II accessory navicular bone: correlation with surgical and pathologic studies. Korean J Radiol **5**(4): 274-279.
OBJECTIVE: To evaluate the MR imaging findings of painful type II accessory navicular bone and to correlate these with the surgical and pathologic findings. MATERIALS AND METHODS: The MR images of 17 patients with medial foot pain and surgically proven type II accessory navicular abnormalities were reviewed. The changes of signal intensity in the

accessory navicular, synchondrosis and adjacent soft tissue, the presence of synchondrosis widening, and posterior tibial tendon (PTT) pathology on the T1-weighted and fat-suppressed T2-weighted images were analyzed. The MR imaging findings were compared with the surgical and pathologic findings. RESULTS: The fat-suppressed T2-weighted images showed high signal intensity in the accessory navicular bones and synchondroses in all patients, and in the soft tissue in 11 (64.7%) of the 17 patients, as well as synchondrosis widening in 3 (17.6%) of the 17 patients. The MR images showed tendon pathology in 12 (75%) of the 16 patients with PTT dysfunction at surgery. The pathologic findings of 16 surgical specimens included areas of osteonecrosis with granulomatous inflammation, fibrosis and destruction of the cartilage cap. CONCLUSION: The MR imaging findings of painful type II accessory navicular bone are a persistent edema pattern in the accessory navicular bone and within the synchondrosis, indicating osteonecrosis, inflammation and destruction of the cartilage cap. Posterior tibial tendon dysfunction was clinically evident in most patients.

Chung JW, Chu IT (2009). Outcome of fusion of a painful accessory navicular to the primary navicular. Foot Ankle Int **30**(2): 106-109.

BACKGROUND: An accessory navicular bone may cause pain due to continuous irritation at its interface with the navicular. The authors performed the fusion of the accessory navicular and navicular with screw(s) to relieve the symptoms while preserving the continuity of the posterior tibial tendon. MATERIALS AND METHODS: We analyzed the clinical and radiological outcomes of 31 consecutive patients (34 feet) with a painful type II accessory navicular. RESULTS: Bone union was confirmed on plain radiography in 28 (82%) of 34 feet. Twenty-two patients (24 feet) were assessed as excellent, two (three feet) as good, and one (one foot) as fair. Nonunion developed in six patients (six feet) and was defined as poor. CONCLUSION: When conservative treatment fails to relieve pain in a type II accessory navicular, fusion of the accessory navicular to the navicular may successfully relieve pain without disrupting the tibialis posterior tendon insertion.

Cilli F, Akcaoglu M (2005). [The incidence of accessory bones of the foot and their clinical significance]. Acta Orthop Traumatol Turc **39**(3): 243-246.

OBJECTIVES: Accessory bones of the foot are often confused with avulsion fractures. This study was designed to investigate the incidence of accessory bones of the foot. METHODS: Anteroposterior and lateral foot radiographs of 464 male patients with an age range of 20 to 46 years were examined with regard to the presence Of 464 radiographs, accessory bones were identified in 85 feet (18.3%), all of which were symptomless. The most common accessory bones in descending order were os peroneum (31.8%), os naviculare (28.2%), os trigonum (23.5%), os vesalianum (5.9%), os supranaviculare (3.5%), os infranaviculare (3.5%), os supratalare (2.4%), and os intermetatarseum (1.2%). CONCLUSION: Accessory bones of the foot should be well recognized and their clinical significance should be appreciated in order to decrease the rate of incorrect diagnoses and unnecessary orthopedic consultations on initial presentations of patients with foot complaints., incidence, and distribution of accessory bones. Identification of the accessory bones were made according to the Kohler classification. RESULTS:

Coskun N, Yuksel M, et al. (2009). Incidence of accessory ossicles and sesamoid bones in the feet: a radiographic study of the Turkish subjects. Surg Radiol Anat **31**(1): 19-24.

Most accessory ossicles and sesamoid bones of the ankle and the foot remain asymptomatic; however, they have increasingly been examined in the radiology literature, because they can cause painful syndromes or degenerative changes in response to overuse and trauma. Our aim was to document a detailed investigation on the accessory ossicles and sesamoid bones of Turkish subjects in both the feet according to the sex, frequency and division of the bones, coexistence and bilaterality by radiography. A double-centered study

was performed retrospectively to determine the incidence of the accessory ossicles and sesamoid bones in the ankle and foot. Accessory ossicles (21.2%) and sesamoid bones (9.6%) were detected by Radiographs of 984 subjects. The most common accessory ossicles were accessory navicular (11.7%), os peroneum (4.7%), os trigonum (2.3%), os supranaviculare (1.6%), os vesalianum (0.4%), os supratalare (0.2%), os intermetatarseum (0.2%). We observed bipartite hallux sesamoid in 2.7% of radiographs. Interphalangeal sesamoid bone of the hallux was seen in 2% of radiographs. Incidences of metatarsophalangeal sesamoid bones were found as 0.4% in the second digit, 0.2% third digit, 0.1% fourth digit and 4.3% fifth digit. We also identified the coexistencies of two different accessory ossicles as 6%, accessory ossicles and sesamoid bones as 7%, and bipartite sesamoid bones and sesamoid bones as 1.9%. Distribution of the most common accessory ossicles in male and female subjects was similar. We reported the incidence of accessory ossicles and sesamoid bones of the feet in Turkish adult population.

Fredrick LA, Beall DP, et al. (2005). The symptomatic accessory navicular bone: a report and discussion of the clinical presentation. Curr Probl Diagn Radiol **34**(2): 47-50.

An accessory navicular bone is a congenital anomaly caused by aberrant ossification. Usually asymptomatic, they are relatively common in our population. They can present in several different locations, which can have an impact on the clinical presentation and the degree of dysfunction. Occasionally, these can become symptomatic, which can manifest as chronic or acute on chronic foot pain. Diagnosis of this condition relies on radiographic evaluation. The 45-degree eversion oblique view of the foot is the most important view for identifying this condition, although several different imaging techniques can be used. Treatment of this condition includes both surgical and nonsurgical options. Ultimately, surgery yields the best outcome for young patients, though conservative management has relevance for less active patients. The following case demonstrates the presence of a symptomatic accessory navicular bone in a young athlete.

Gaulke R, Schmitz HG (2003). Free os cuboideum secundarium: a case report. J Foot Ankle Surg **42**(4): 230-234.

The free os cuboideum secundarium is one of the most rare accessory bones of the foot and is located proximal and plantar to the cuboid. In a 9-year-old boy, a free os cuboideum secundarium of the left foot was resected for persistent pain after trauma. Histologic examination showed degenerative changes of the hyaline cartilage that covered the entire bone. The central spongiosa appeared normal. The patient is free of pain and is still playing football 9.5 years after resection of the accessory bone. Follow-up examination showed no clinical sign of pathology except a soft scar with little discomfort when walking without shoes. Radiographs showed complete remodeling of left cuboid and calcaneus with normal bony configuration of both feet.

Issever AS, Minden K, et al. (2007). Accessory navicular bone: when ankle pain does not originate from the ankle. Clin Rheumatol **26**(12): 2143-2144.

A young girl suffering from ankle pain occurring after gymnastics classes was referred to the rheumatology department by an orthopedic surgeon because a rheumatological condition was suspected to cause her symptoms. MRI was useful in pointing to the correct diagnosis of accessory navicular bone (AN). The morphological classification of ANs is discussed and the imaging modalities for diagnosis are presented.

Jasiewicz B, Potaczek T, et al. (2008). Results of simple excision technique in the surgical treatment of symptomatic accessory navicular bones. Foot Ankle Surg **14**(2): 57-61.

INTRODUCTION: Accessory navicular bones might cause not only cosmetic problems but also be a reason of discomfort and pain. In case of inefficient conservative treatment symptomatic accessory naviculars are treated surgically. Aim of paper: Presentation of

results of simple excision of symptomatic accessory navicular. MATERIAL AND METHODS: Material consists of 22 patients (34 feet), 17 women and 5 men, treated surgically between 1992 and 2006. Mean age at surgery was 14.1 years (9-22 years). Accessory navicular type I was present in 5 feet (14.7%), type II in 17 (50%) and type III-in 12 (35.3%). Main symptom was localized pain on the medial arch of the foot, in the height of navicular bone. Surgery consisted of simple accessory navicular excision and if needed partial resection of navicular bone. The mean follow-up period was 5.6 years (1-13 years). We analyzed: intensity of pain (VAS score system), daily and sport acitvity. Subjective results were analyzed using a questionnaire. RESULTS: The questionnaire was returned from 21 patients: 9 patients had total pain relief, 11 considerable and one patient had persistent pain. Mean VAS results before surgery was 5.9 and 1.7 after surgery. Only one patient required analgesics occasionally. Complications were present in two patients (6.1%). All active patients returned to their sport activities. CONCLUISON: Surgical treatment of symptomatic accessory navicular by simple excision technique gives satisfying results, surgery is minimally traumatic and risk of complications low.

Knackfuss IG, Giordano V, et al. (2003). Compression of the medial branch of the deep peroneal nerve, relieved by excision of an os intermetatarseum. A case report. Acta Orthop Belg **69**(6): 568-570.

The authors report a case of direct compression of the medial branch of the deep peroneal nerve by an os intermetatarseum in a 52-year-old female patient who was referred to their Institution because of pain over the dorsum of her left foot associated with paraesthesias in the first web space. Examination disclosed a positive Tinel sign over the dorsal aspect of the first metatarsal bone. Plain radiographs revealed a small, irregular accessory ossicle on the dorsum of the left foot, between the medial cuneiform and first and second metatarsals. At operation, the os intermetatarseum was found to impinge on the medical branch of the deep peroneal nerve. Excision of the os intermetatarseum and nerve decompression was performed. After four years, the patient has normal function and is completely relieved of her symptoms.

Kopp FJ, Marcus RE (2004). Clinical outcome of surgical treatment of the symptomatic accessory navicular. Foot Ankle Int **25**(1): 27-30.

BACKGROUND: When conservative treatment fails to provide relief for a symptomatic accessory navicular, surgical intervention may be necessary. Numerous studies have been published, reporting the results of the traditional Kidner procedure and alternative surgical techniques, all of which produce mostly satisfactory clinical outcomes. The purpose of this study was to report the clinical results, utilizing the American Orthopaedic Foot and Ankle Society (AOFAS) Midfoot Scale, of surgical management for symptomatic accessory navicular with simple excision and anatomic repair of the tibialis posterior tendon. METHODS: The authors retrospectively reviewed the results of 13 consecutive patients (14 feet) who underwent surgical treatment for symptomatic accessory navicular. The patients ranged in age from 16 to 64 years (average, 34.1 years; mean, 28.2 years) at the time of surgery. All patients had a type II accessory navicular. The average follow-up of the patients involved in the study was 103.4 months (range, 45-194 months). The AOFAS Midfoot Scale was utilized to determine both preoperative and postoperative clinical status of the 14 feet included in the study. RESULTS: The average preoperative AOFAS score was 48.2 (range, 20-75; mean, 38.8). The average postoperative AOFAS score was 94.5 (range, 83-100; mean, 94.3). At last follow-up, 13 of 14 feet were without any pain, no patients had activity limitations, and only two of 14 feet required shoe insert modification. Postoperatively, no patients had a clinically notable change in their preoperative midfoot longitudinal arch alignment. All of the patients in the study were satisfied with the outcome of their surgery and would undergo the same operation again under similar circumstances. CONCLUSIONS: When conservative measures fail to relieve the symptoms of a painful accessory navicular,

simple excision of the accessory navicular and anatomic repair of the posterior tibialis tendon is a successful intervention. Overall, the procedure provides reliable pain relief and patient satisfaction. In the current study, the clinical status of each patient improved significantly postoperatively, quantified utilizing the AOFAS Midfoot Scale.

Kose O, Okan AN, et al. (2006). Fracture of the os trigonum: a case report. J Orthop Surg (Hong Kong) **14**(3): 354-356.

The os trigonum is an inconsistently present accessory bone of the foot situated at the posterolateral aspect of the talus. It may be radiographically confused with fractures of the posterior process of the talus. Fracture of the os trigonum per se is extremely rare. Hyperplantarflexion of the ankle is the mechanism of injury in which the os trigonum is compressed between the posterior malleolus of the tibia and the tuber calcaneus. Computed tomography is the choice of imaging modality in cases where fractures of posterior talus structures, including the os trigonum, are suspected. A high index of suspicion is necessary to diagnose a fracture of the os trigonum after a severe plantarflexion injury to the ankle. Conservative treatment is usually successful. We report a case of a fracture of the os trigonum, its clinical features, treatment and significance.

Mellado JM, Ramos A, et al. (2003). Accessory ossicles and sesamoid bones of the ankle and foot: imaging findings, clinical significance and differential diagnosis. Eur Radiol **13 Suppl 4**: L164-177.

Accessory ossicles and sesamoid bones are frequent findings in routine radiographs of the ankle and foot. They are commonly considered fortuitous and unrelated to the patient's complaint; however, they may eventually cause painful syndromes or degenerative changes in response to overuse and trauma. They may also suffer or simulate fractures. Our aim was to review, illustrate and discuss the imaging findings of some of the more frequent accessory ossicles and sesamoid bones of the ankle and foot region, with particular emphasis on those that may be of clinical significance or simulate fractures.

Mellado JM, Salvado E, et al. (2002). Painful os sustentaculi: imaging findings of another symptomatic skeletal variant. Skeletal Radiol **31**(1): 53-56.

The os sustentaculi is a rare accessory bone of the ankle and foot region. We describe the imaging findings of a symptomatic os sustentaculi in a 49-year-old man. Its clinical significance and associated conditions are also briefly discussed.

Miller TT (2002). Painful accessory bones of the foot. Semin Musculoskelet Radiol **6**(2): 153-161.

Sesamoid bones and secondary centers of ossification account for the accessory bones of the foot, and there is a wide range of frequency with which these different ossicles appear. They are usually incidental asymptomatic findings on imaging studies, and their clinical importance lies in not mistaking them for fractures. Occasionally these ossicles can become painful due to fracture, degenerative changes, avascular necrosis, and irritation or impingement of adjacent soft tissue.

Mosel LD, Kat E, et al. (2004). Imaging of the symptomatic type II accessory navicular bone. Australas Radiol **48**(2): 267-271.

Accessory ossicles of the foot are commonly mistaken for fractures. The accessory navicular is one of the most common accessory ossicles of the foot. There is a higher incidence in women and the finding might be bilateral in 50-90%. This entity is usually asymptomatic, although populations with medial foot pain have a higher prevalence. Three types of accessory navicular bone have been described. The type II accessory navicular is the most commonly symptomatic variant with localized chronic or acute on chronic medial foot pain and tenderness with associated inflammation of overlying soft tissues. Plain

radiographic identification of the accessory navicular is insufficient to attribute symptomatology. Ultrasound allows for comparison with the asymptomatic side and localization of pain. Bone scintigraphy has a high sensitivity but positive findings lack specificity. Magnetic resonance imaging is of high diagnostic value for demonstrating both bone marrow and soft tissue oedema.

Muehleman C, Williams J, et al. (2009). A radiologic and histologic study of the os peroneum: prevalence, morphology, and relationship to degenerative joint disease of the foot and ankle in a cadaveric sample. Clin Anat **22**(6): 747-754.

The present study investigated the prevalence of an os peroneum (OP, a sesamoid bone) in a cadaveric sample and its relationship to the shape of the cuboid tuberosity, and cartilage degeneration at the cuboid tuberosity and in regional joints within the foot (first metatarsophalangeal and calcaneocuboid) and ankle. The fibularis longus tendon of 33 embalmed human cadavers (mean age 81 years) were obtained from the anatomy laboratory. Nineteen of 64 tendons (30%) displayed an OP both radiographically and histologically. The os peronei ranged in size from small spicules to prominent masses: mean area 2.48 mm(2) (left) and 2.70 mm(2) (right). Histologically, the os peronei were cancellous bone, the largest occupying most of the tendon at the point of contact with the cuboid tuberosity. Fibrocartilage was present at their borders, merging with dense regular fibrous tissue and peritenon. The talocrural, calcaneocuboid, and first metatarsophalangeal joints were examined for cartilage integrity and osteophytes based on an earlier suggestion that there may be an association between degenerative joint disease and endochondral bone formation. There was no statistical correlation between presence of an OP with any of the following parameters: age, gender, body size, cartilage degeneration, or osteophytes within any of the joints examined. Therefore, the presence of an OP does not appear to be associated with increased endochondral ossification or degenerative joint disease. This study does not preclude the possibility that sesamoid bone formation may be associated with biomechanical functions within the foot; thus, future studies may be warranted.

Okazaki K, Nakashima S, et al. (2003). Stress fracture of an os peroneum. J Orthop Trauma **17**(9): 654-656.

Fracture of the os peroneum is relatively rare, and a stress fracture of the os peroneum is even rarer. We report a case of stress fracture of the os peroneum in a 38-year-old laborer who had been working in a crouching position. X-rays showed a multipartite os peroneum. Bone scintigram showed uptake at the os peroneum. The histology of the excised os peroneum revealed various stages of fracture healing. Excision of the fractured os peroneum and reconstruction of the peroneus longus tendon by end-to-end suture resulted in an excellent outcome.

Requejo SM, Kulig K, et al. (2000). Management of foot pain associated with accessory bones of the foot: two clinical case reports. J Orthop Sports Phys Ther **30**(10): 580-591; discussion 592-584.

STUDY DESIGN: Case study. OBJECTIVES: To discuss the differential diagnosis, the nonsurgical and postoperative management of common accessory bones of the foot. BACKGROUND: Accessory bones of the foot that are formed during abnormal ossification are commonly found in asymptomatic feet. Two of the most common accessory bones are the accessory navicular and the os peroneum. Their painful presence must be considered in the differential diagnosis of any acute or chronic foot pain. The optimal treatment for the conservative and postoperative management of painful os peroneum and accessory navicular bones remains undefined. METHODS AND MEASURES: Therapeutic management of the fractured os peroneum included bracing, taping, and foot orthotics to allow healing of involved tissues, and stretching. The focus of the postoperative management of the accessory navicular was joint mobilization and progressive

strengthening. Dependent variables included level of pain with provocation and alleviation tests of joint and soft tissue; girth and sensory tests of the foot and ankle; goniometric measures of foot and ankle; strength of ankle and hip muscles; functional tests; and patient's self-reported pain status. RESULTS: The patient with the fractured os peroneum was treated in 13 visits for 10 weeks. At discharge from physical therapy, the patient had the following outcomes relative to the noninvolved side: 100% return of normal sensation tested by light touch and vibration; pain decreased from 6/10 to 1/10; 100% reduction of swelling with ankle girth to normal; 100% range of motion of ankle and subtalar joints. Strength in plantar flexion and eversion remained 20% impaired (80% return to normal) secondary to pain. Upon discharge, he still reported mild pain when walking but was able to return to previous leisure activities. The second patient with the accessory navicular was treated in 18 visits over 9 weeks. Relative to the uninvolved side, she was discharged with the following: 70% return of range of motion in the foot and ankle, 100% of strength in hip and ankle, and 100% return of balance. She could squat and jump without pain and she returned to full premorbid activity level. CONCLUSIONS: Rehabilitative management of both cases addressed specific impairments and was successful in improving the patients' activity limitation. Clinicians should be aware that these accessory bones are possible sources of disability, secondary to foot pain.

Salekzamani Y, Shakeri-Bavil A, et al. (2009). Ankle patella: a report of a large accessory bone in the ankle: a case report. Cases J **2**: 8512.

INTRODUCTION: Sesamoids are ovoid bones with variable size and shape in the course of tendons, can be found in different parts of skeletal system. CASE PRESENTATION: We report a case of 61-year-old woman in whom we observed a large accessory bone located in the anterior aspect of the left ankle joint. Since such accessory bones are found very infrequently, their presence may cause some diagnostic confusion. CONCLUSION: Regarding complaints in foot area one has to be familiar with such bones in order to make a correct diagnosis.

Sammarco VJ, Cuttica DJ, et al. (2009). Lasso Stitch with Peroneal Retinaculoplasty for Repair of Fractured Os Peroneum: A Report of Two Cases. Clin Orthop Relat Res.

Fracture of the os peroneus with retraction of the peroneus longus tendon can lead to weakness, instability, and progressive foot deformity. Treatment recommendations vary and include simple immobilization, repair of the fractured ossicle, excision of part or all of the fractured ossicle with repair of the tendon and tenodesis with the peroneus brevis tendon. We present two patients treated with excision of the proximal fragment and repair of the tendon to the distal fragment with relief of pain and restoration of function. The distal fragment was captured with a looped suture which allowed avoidance of a plantar exposure while still achieving an adequate repair. We also describe a technique for retinaculoplasty of the inferior peroneal retinaculum which we believe important to prevent postoperative adhesions to the tendon. Level of Evidence: Level V, expert opinion. See Guidelines for Authors for a complete description of levels of evidence.

Sarin VK, Erickson GM, et al. (1999). Coincident development of sesamoid bones and clues to their evolution. Anat Rec **257**(5): 174-180.

Sesamoid bones form within tendons in regions that wrap around bony prominences. They are common in humans but variable in number. Sesamoid development is mediated epigenetically by local mechanical forces associated with skeletal geometry, posture, and muscular activity. In this article we review the literature on sesamoids and explore the question of genetic control of sesamoid development. Examination of radiographs of 112 people demonstrated that the relatively infrequent appearances of the fabella (in the lateral gastrocnemius tendon of the knee) and os peroneum (in the peroneus longus tendon of the foot) are related within individuals ($P < 0.01$). This finding suggests that the tendency to form

sesamoids may be linked to intrinsic genetic factors. Evolutionary character analyses suggest that the formation of these sesamoids in humans may be a consequence of phylogeny. These observations indicate that variations of intrinsic factors may interact with extrinsic mechanobiological factors to influence sesamoid development and evolution.

Saupe N, Mengiardi B, et al. (2007). Anatomic variants associated with peroneal tendon disorders: MR imaging findings in volunteers with asymptomatic ankles. Radiology **242**(2): 509-517.

PURPOSE: To evaluate prospectively, on magnetic resonance (MR) images in volunteers with asymptomatic ankles, various features of anatomic variants that are potentially associated with peroneal tendon disorders. MATERIALS AND METHODS: The study had institutional review board approval; informed consent was obtained from each volunteer. The prevalence of accessory peroneus quartus muscles, the location of the muscle-tendon junction of the peroneus brevis muscle, the prevalence and size of the peroneal tubercle and the retrotrochlear eminence, and the shape of the retromalleolar fibular groove were evaluated on MR images in 65 volunteers with asymptomatic ankles (35 women, 30 men; age range, 23-70 years; median age, 45 years). MR images were analyzed by two radiologists in consensus. The relationship between anatomic features and age and sex was analyzed by using Spearman rank correlation and the Wilcoxon rank sum test. RESULTS: A peroneus quartus muscle was identified in 11 (17%) ankles. Ninety percent of the musculotendinous junctions of the peroneus brevis muscle were located in a range between 27 mm proximal to and 13 mm distal to the fibular tip (median, 0 mm). A peroneal tubercle was identified in 36 (55%) ankles. Ninety percent of all peroneal tubercles were 4.6 mm or smaller (median height, 2.9 mm). A retrotrochlear eminence was seen in all ankles (median, 3.0 mm; 90% were 4.6 mm or smaller). The retromalleolar groove was concave in 18 (28%), flat in 28 (43%), convex in 12 (18%), and irregular in seven (11%) volunteers. A significant difference (P = .04) for the height of the retrotrochlear eminence was found between men (median, 3.4 mm) and women (median, 2.5 mm). All other P values were greater than .05. CONCLUSION: Anatomic variants thought to predispose individuals to peroneal tendon disorders can be seen in volunteers with asymptomatic ankles.

Scott AT, Sabesan VJ, et al. (2009). Fusion versus excision of the symptomatic Type II accessory navicular: a prospective study. Foot Ankle Int **30**(1): 10-15.

BACKGROUND: Patients with symptomatic Type II accessory naviculars that fail nonoperative measures may be treated with excision, percutaneous drilling, a modified Kidner procedure, or a fourth option, arthrodesis of the accessory ossicle to the navicular body. There is little information in the literature on the relative merits of arthrodesis. MATERIALS AND METHODS: A prospective evaluation of 20 patients undergoing surgical intervention for symptomatic Type II accessory naviculars was performed. The decision to perform either an arthrodesis (10 feet) or a modified Kidner (10 feet) was made intraoperatively based on the size of the accessory ossicle. Outcomes were measured using pre- and postoperative American Orthopaedic Foot and Ankle Society (AOFAS) Midfoot scores, plain radiographs, and chart reviews. RESULTS: At an average followup of 35 months, the mean AOFAS score for the arthrodesis group improved from 50 to 93 points. There were two non-unions (20%) and one patient complained of painful hardware. At an average followup of 48 months, the mean AOFAS score for the modified Kidner group improved from 52 to 80 points. However, in this group, three of ten patients (30%) had persistent midfoot pain and radiographic evidence of progressive loss of the longitudinal arch. CONCLUSION: Although the methods do not represent a randomized comparison of treatments for the same condition, the results suggest that arthrodesis may be a reasonable treatment option in selected cases of patients with symptomatic recalcitrant Type II accessory naviculars that are large enough to accept small fragment screws.

Ugolini PA, Raikin SM (2004). The accessory navicular. Foot Ankle Clin **9**(1): 165-180.
The accessory navicular is a common presence in the human foot and must be included in the differential diagnosis of medial foot pain in patients who are of appropriate age. Imaging modalities aid in diagnosis of a symptomatic ossicle and guide classification and treatment. Often, a combination of studies is needed to establish an accessory navicular as the source of foot pathology. Although conservative measures always are the first line of treatment, the benefits of surgical management are well-defined in the literature. Most foot surgeons rely on resection procedures with varied handling of the PTT insertion, although newer modifications that use bony fusion techniques are being investigated. As with any musculoskeletal condition, proper diagnosis and individually-tailored treatment plans are of the utmost importance to a satisfactory outcome. With meticulous patient selection and a thorough understanding of the condition, management of the painful accessory navicular often is successful in alleviating the disability it causes.