PERFORMING ARTS
SPECIAL INTEREST GROUP

ORTHOPAEDIC SECTION
AMERICAN PHYSICAL THERAPY ASSOCIATION

APTA
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The Science of Healing. The Art of Caring.

**PASIG MONTHLY CITATION BLAST: No.52** **July 2010**

Dear PASIG members:

We're thick into the doldrums of summer here in New York with temperatures in the 90's and above. I hope all of you are managing to stay cool in some way.

All of the CSM abstract submissions have been reviewed and acceptances for CSM abstracts should go out in September. In the meantime, PASIG Vice President, Lisa Shoaf, has been hard at work planning our PASIG programming at the next Combined Sections Meeting, which will be held in New Orleans, February 9 –12, 2011. It's time to start making plans to attend!

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 medicine and research. For more information on the research award please check our webpage (www.orthopt.org/sig_pa.php). Students with additional questions can contact Amy Humphrey (ahumphrey@bodydynamicsinc.com).

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.

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/

**NEW PASIG monograph in development. Topics include figure skating, gymnastics and instrumental musicians. Be on the lookout for its release in Fall 2010.**

International Association for Dance Medicine and Science (IADMS) 20th Annual Meeting

October 28 – 31, 2010
October 31: Biomechanics and Dance Workshop
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

Thank you to those members who have updated their membership profile. You can now be found easier by your colleagues and we have received good feedback from you. **For those members who have not yet updated your membership profile, it only takes a few minutes, so please use the link below** (must log in): https://www.orthopt.org/surveys/membership_directory.php"

Did you know that the Orthopaedic Section has a Facebook site? Check it out and become a friend. You'll find a link on the Orthopaedic Section website: http://www.orthopt.org/

For this July Citation BLAST, I've selected the topic *Extensor Hallucis Longus Laceration.* The general 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).

I also have a request for PASIG volunteers working on PA-related terminology papers: *please send me an update on your work*! Hopefully some of these will be completed by fall and available to our members as a BLAST or on our webpage.

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

Regards,
Shaw

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*Extensor Hallucis Longus Laceration*

Injury to the extensor hallucis longus and brevis are rare but is most commonly caused by laceration via dropping a knife onto the foot. The deep peroneal nerve can also be compromised. Delayed repair may require autogenous grafting due to extreme retraction of the tendon. However, immediate repair within 24 hours can usually achieve an excellent primary repair. The need to immobilize the repair to allow adequate healing creates the challenge of achieving the extreme dorsiflexion – plantar flexion functional motion required for the dancer or gymnast. In addition, the immobilization can also create significant calf muscle atrophy.

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Al-Qattan MM (2007). Surgical treatment and results in 17 cases of open lacerations of the extensor hallucis longus tendon. J Plast Reconstr Aesthet Surg **60**(4): 360-367.

There is a scarcity of information on extensor hallucis longus tendon injuries and published studies frequently offer conflicting treatment recommendations and results. PATIENTS AND METHODS: This paper reports on the treatment and results of open lacerations of the extensor hallucis longus tendon in 17 patients treated by a plastic surgeon over a period of 12 years. All injuries occurred due to industrial accidents. All patients were males with a mean age of 30 years (range=21-49 years). All zones of tendon injury were represented except zones 2 and 5. Sixteen patients underwent surgical exploration within 24h of injury and one patient had a delayed repair using a tendon graft. The laceration of the tendon was complete in 15 patients, and in these patients, the tendon repair was protected for 6 weeks using k-wires to the big toe and short-leg walking cast. The remaining two patients had partial tendon lacerations and were treated conservatively (without tendon suturing) and immediate unrestricted mobilisation. One patient had significant soft tissue loss requiring reverse sural artery flap cover. At final follow-up (mean=3 months), the results of tendon repair were assessed as per the grading system of Lipscomb and Kelly, and the AOFAS hallux score for pain (maximum score of 40 points indicating no pain) and for functional capability (maximum score of 45 points). RESULTS: All patients healed with no infections or painful neuromas. Two patients experienced prolonged mild aching pain in the foot on walking, but the pain eventually resolved in both patients. All patients returned back to work 2.5-5 months after surgery. As per Lipscomb and Kelly's grading system, the result was graded as good in four patients and fair in the remaining 13 patients. No poor results were seen. The AOFAS hallux pain score was 40 points in all patients and the mean functional capability score was 42.1 points (range=40-45 points). CONCLUSION: A large series of extensor hallucis longus tendon lacerations is reported. Treatment and the methods of immobilisation are given for various zone and injury types. Although it is difficult to obtain a completely normal range of motion of the big toe after surgery, all patients are expected to recover good active extension and return back to work pain-free.

Berens TA (1990). Autogenous graft repair of an extensor hallucis longus laceration. J Foot Surg **29**(2): 179-182.

The author presents an overview of tendon healing with particular attention to the principles of tendon graft repair. A clinical case of a patient who experienced an extensor hallucis

longus laceration 8 weeks prior to the graft repair is reviewed. The extensor hallucis longus tendon was repaired using an autogenous graft taken from the extensor hallucis brevis.

Bronner S, Ojofeitimi S, Rose, D (2008). Repair and rehabilitation of extensor hallucis longus and brevis tendon lacerations in a professional dancer. J Orthop Sports Phys Ther **38**(6): 362-370.

STUDY DESIGN: Case report. BACKGROUND: Tendon lacerations of the hallux are potentially devastating to a dancer. Strength of the hallux musculature is necessary to attain and maintain balance, push-off in multiple turns, and decelerate in jumps and hops. The purpose of this paper is to report on the repair and rehabilitation of extensor hallucis longus and extensor hallucis brevis tendon lacerations in a professional dancer. CASE DESCRIPTION: A 30-year-old dancer sustained complete laceration of her extensor hallucis longus and extensor hallucis brevis tendons, and partial laceration of the dorsal aspect of the hallux metatarsophalangeal (MTP) joint capsule. Following primary repair, at 9 weeks postsurgery, hallux MTP joint active dorsiflexion was limited to 5 degrees and passive dorsiflexion to 70 degrees . First toe dorsiflexion and plantar flexion strength was 4/5 at the MTP and 3+/5 at the interphalangeal joint. Rehabilitation included functional electrical stimulation to address considerable calf atrophy, strengthening exercises, functional retraining, and progressive return to dance. OUTCOME: The dancer returned to her previous level of dancing in 18 weeks, with 73 degrees and 85 degrees of hallux MTP joint active and passive dorsiflexion, and 30 degrees and 35 degrees of active and passive plantar flexion, respectively. Hallux MTP and interphalangeal joint muscle strength were 5/5 and 4+/5, respectively. Improvement, manifested in her SF-36 and Dance Functional Outcome System scores, accompanied her full functional recovery. DISCUSSION: Hallux stability provided by coactivation of the great toe extensors and flexors is crucial to accomplish the demands of bipedal and unipedal balances and activities in dance. This report demonstrates the success of primary surgical repair and rehabilitation in a dancer/athlete experiencing this injury.

Denk CC, Oznur A, et al. (2002). Double tendons at the distal attachment of the extensor hallucis longus muscle. Surg Radiol Anat **24**(1): 50-52.

The distal attachments of the extensor hallucis longus (EHL) tendons in 47 amputated legs and in eight cadavers were examined. The EHL had two tendons in 34 of the amputated legs and bilaterally in five cadavers. The lateral tendon was inserted to the middle of the dorsal aspect of the base of the distal phalanx of the hallux and the medial tendon to the medial side of the insertion of the lateral tendon. The length and thickness of these two tendons were measured and compared in order to obtain data for using these tendons in tendon repair and hallux varus corrections by autogenous tendon transfer surgery. Additionally, on the right foot of one of the cadavers, it was observed that the extensor hallucis brevis tendon united with the lateral tendon of the EHL. We recommend that foot-ankle surgeons be aware of the various accessory EHL tendons and their potential use in problematic cases.

Elgafy H, Ebraheim NA, et al. (2002). Extensor hallucis longus innervation: an anatomic study. Clin Orthop Relat Res(398): 245-251.

Thirty legs from skeletally mature embalmed cadavers were dissected to define the most common pattern and the variants of innervation of the extensor hallucis longus muscle and its clinical significance. Twenty-seven muscles had only one innervating branch (90%). Only three muscles had two innervating branches (10%). Twenty-one of the branches entered the muscles from the fibular side (63.6%), six entered the muscles from the tibial side (18.2%), and six entered the muscles from the anterior edge (18.2%). The branches innervating the extensor hallucis longus from the fibular side had a closer relation with the fibular periosteum than those entering the muscle from the tibial side or the anterior edge. The

mean length of these branches between their points of origin and entry in the extensor hallucis longus was 5.0 +/- 1.5 cm. The high risk zone for the iatrogenic injury to the muscular branch of the extensor hallucis longus was located between 5.9 +/- 1.7 and 10.9 +/- 1.7 cm inferior to the most distal palpable point of the fibular head. The current study confirmed that the extensor hallucis longus was supplied mostly by one nerve that usually entered the muscle from the fibular side and had a close relation to the fibular periosteum in the dangerous zone.

Franck WM, Olk A, et al. (2005). Combined rupture of the tibialis anterior and the extensor hallucis longus tendons--functional reconstruction. Arch Orthop Trauma Surg **125**(4): 277-280.
BACKGROUND: Traumatic rupture of the tibialis anterior (TA) tendon represents a very rare foot injury. A combined injury of both the TA and the extensor hallucis longus (EHL) tendons has not yet been reported. Within the scope of this work we will prove that tendon transfers in cases of combined tendon injuries are a reasonable course of action in order to achieve the aim of a functional reconstruction. METHODS: A combined rupture of the tibialis anterior (TA) and the extensor hallucis longus (EHL) tendons was treated by suturing the EHL tendon to the distal TA tendon stump. The TA insertion was secured and the distal portion of the EHL tendon attached to an extensor digitorum slip. The TA muscle was proximally attached to the tendinous EHL segment. RESULTS: A 1 year follow-up verified very good results, showing the patient without complaints in regard to the trauma. Compared with the contralateral non-affected side, the repaired foot showed very satisfactory results in reference to range of motion, strength and gait. CONCLUSION: With this work we proved that tendon transfers in cases of combined tendon injuries make sense in order to achieve functional reconstruction. This approach preserves function and strength and avoids the problems and risks of alternate treatment techniques, including tendon grafting.

Harvey L, Rockett MS (2000). Mechanical comparison of two extensor tendon repairs of ankle tendons. J Foot Ankle Surg **39**(4): 232-238.
Complete disruption of the extensor tendons is commonly encountered with lacerations to the dorsal aspect of the ankle. The purpose of this study was to compare two tendon repairs (modified Krackow and Kessler-Tajima) to determine which repair was stronger in an anatomical cadaver model. Twenty tendons (10 extensor hallucis longus and 10 tibialis anterior tendons) from 10 fresh-frozen cadaver legs were lacerated and then repaired with either a modified Krackow or Kessler-Tajima repair. Each tendon repair was tested for gap formation and maximum load failure. Results showed that the mean force to produce gap formation in the modified Krackow repair was 64.7 N in the extensor hallucis longus and 82.3 N with the tibialis anterior. Mean gap formation for the Kessler-Tajima in the extensor group was 26.0 N and the tibialis anterior was 41.8 N. This represented a 40% and 50% greater resistance to gap formation for the modified Krackow in these groups. With maximum load failure, the mean for the modified Krackow was 99.5 N for the extensor hallucis longus and 126.8 N for the tibialis anterior, while the Kessler-Tajima was 45.6 N and 72.1 N for these groups. This represented a 45% and 58% greater difference in the maximum load failure for the modified Krackow. Statistical analysis using a Student's t-test ($p < .05$) showed that there was a significant statistical difference between the two repairs for gap formation and maximum load failure. The authors conclude that the modified Krackow is stronger than the Kessler-Tajima repair.

Kass JC, Palumbo F, et al. (1997). Extensor hallucis longus tendon injury: an in-depth analysis and treatment protocol. J Foot Ankle Surg **36**(1): 24-27; discussion 80.
This article analyzes the controversial topic of whether or not to repair a lacerated extensor hallucis longus tendon. A literature review of extensor hallucis longus tendon injuries is presented. The authors then provide a treatment protocol for extensor hallucis tendon injuries.

Lawrence SJ, Botte MJ (1995). The deep peroneal nerve in the foot and ankle: an anatomic study. Foot Ankle Int **16**(11): 724-728.

Injury to the deep peroneal nerve in the foot and ankle may result from trauma, repetitive mechanical irritation, or iatrogenic harm. The nerve is most susceptible to injury along its more distal anatomic course. Dissection of 17 cadaver specimens was undertaken to describe the course of the deep peroneal nerve and quantify its branch patterns. In the distal one third of the leg, the nerve was located superficial to the anterior tibial artery between the tibialis anterior and extensor hallucis longus muscles. Typically, the nerve crossed deep to the extensor hallucis longus tendon to enter the interval between the extensor hallucis longus and extensor digitorum longus at an average distance of 12.5 mm proximal to the ankle. A proximal bifurcation was usually present at an average distance of 12.4 mm distal to the mortise. The lateral terminal branch penetrated the deep surface of the extensor digitorum brevis to provide motor innervation. The medial terminal branch passed over the talonavicular joint capsule, and coursed an average of 2.9 mm lateral to the first tarsometatarsal joint. Within the forefoot, it passed deep to the extensor hallucis brevis tendon, bifurcated in the midmetatarsal region, and then arborized, supplying sensibility to the first toe interspace and the adjacent sides of the first and second toes.

Leung YF, Ip SP, et al. (2002). A new method of functional tendon transfer for the dysfunction of extensor hallucis longus. Foot Ankle Int **23**(12): 1124-1125.

A surgical technique of functional tendon transfer for the treatment of extensor hallucis longus (EHL) rupture is described. By using the extensor digitorum longus tendon of the second toe, the patient regains active dorsiflexion of the big toe and the deformity of the toe is corrected.

Lui TH (2007). Arthroscopically assisted Z-lengthening of extensor hallucis longus tendon. Arch Orthop Trauma Surg.

Extensor hallucis longus tendon contracture can lead to hyperextension deformity of the big toe. We describe an endoscopic approach of Z-lengthening of the tendon. Extensor hallucis longus tendoscopy is performed with a distal portal at the level of the metatarsal neck and a proximal portal at the level of the navicular. At the distal portal, the medial half of the extensor hallucis longus tendon is cut and a stay stitch of No. 2 ethibond is applied. It is then stripped proximally with a tendon stripper to the proximal portal. A stay stitch of No. 2 ethibond is applied to the lateral half of the tendon at the proximal portal and it is cut proximal to the stitch. With the ankle plantarflexed and the big toe kept in the similar position as the lesser toes, the tendon segments are kept in tension through the stay stitches via the proximal and distal portals. The stay stitches of distal tendon segment are sutured to the proximal segment at the same level of the cut end of the distal fragment with the aid of an eyed needle under arthroscopic visualization through the distal portal. The needle is passed through the tendon and then the skin. The suture is also passed through the skin and then retrieved to the proximal portal by a hemostat. It is then sutured to the proximal tendon segment at the proximal portal. Similarly, the proximal tendon end is sutured to the distal tendon segment at the corresponding level and the endoscopic Z-lengthening of the extensor hallucis longus tendon is then completed.

Mowlavi A, Schall J, et al. (2004). Extensor hallucis longus tenorrhaphy by using the Massachusetts General Hospital repair. J Foot Ankle Surg **43**(6): 412-418.

Extensor hallucis longus tendon injury and surgical treatment recommendations are infrequently reported. In contrast to long extensor tendon injuries to the foot, flexor and extensor tendon injuries of the hand have been extensively studied and surgical treatment protocols have been delineated. In biomechanical studies, the Massachusetts General Hospital technique has been shown to have superior strength to other tenorrhaphies and to

allow for early active mobilization. The purpose of this study was to examine the use of this technique for repair of extensor hallucis longus tendon injuries to allow for early active motion with minimal risk of rupture. We performed a retrospective review of 6 extensor hallucis longus tendon repairs at the toe level. These patients all regained active motion of the great toe. None had loss of extension. There were no tendon ruptures with this technique of tendon repair. The Massachusetts General Hospital technique can be used to repair the extensor hallucis longus tendon with good functional outcome and minimal risk of tendon rupture.

Mubarak SJ (2002). Extensor retinaculum syndrome of the ankle after injury to the distal tibial physis. J Bone Joint Surg Br **84**(1): 11-14.

We describe six patients aged from 10 to 15 years who, after injury to the distal tibial physis, presented with the following clinical findings: 1) severe pain and swelling of the ankle; 2) hypoaesthesia or anaesthesia in the web space of the great toe; 3) weakness of extensor hallucis longus and extensor digitorum communis; and 4) pain on passive flexion of the toes, especially the great toe. In four patients, the fractures were not reduced for more than 24 hours. The intramuscular pressure beneath the superior extensor retinaculum of the ankle was greater than 40 mmHg in all cases (40 to 130 mmHg), and less than 20 mmHg in the anterior compartment. Treatment consisted of release of the superior extensor retinaculum and stabilisation of the fracture. All patients had prompt relief of pain and improved strength and sensation within 24 hours, although two had some residual numbness in the web space of the great toe.

Ozkan K, Goksan B, et al. (2006). A previously unreported etiology of trigger toe. J Am Podiatr Med Assoc **96**(4): 356-358.

Trigger toe is a rare entity, with only a few cases reported in the literature. It is usually seen in ballet dancers as a result of compression of the flexor hallucis longus tendon in the tarsal tunnel beneath the medial malleolus. We report a case of trigger toe due to a constricting lesion on the extensor hallucis longus tendon.

Park HG, Lee BK, et al. (2003). Autogenous graft repair using semitendinous tendon for a chronic multifocal rupture of the extensor hallucis longus tendon: a case report. Foot Ankle Int **24**(6): 506-508.

Chronic multifocal closed rupture of the extensor hallucis longus tendon is an extremely rare injury. Previously, chronic multifocal partial rupture of the extensor hallucis longus tendon had not been reported. This case study reports one case of autogenous graft repair of a chronic multifocal rupture of the extensor hallucis longus tendon using a semitendinous tendon autograft.

Poggi JJ, Hall RL (1995). Acute rupture of the extensor hallucis longus tendon. Foot Ankle Int **16**(1): 41-43.

A 40-year-old man with a history of previous cheilectomy and two steroid injections for first metatarsophalangeal degenerative joint disease sustained an acute rupture of the extensor hallucis longus tendon. He was treated successfully with delayed primary repair of the tendon.

Scaduto AA, Cracchiolo A (2000). Lacerations and ruptures of the flexor or extensor hallucis longus tendons. Foot Ankle Clin **5**(3): 725-736, x.

Lacerations and ruptures of the flexor hallucis longus or extensor hallucis longus tendon are frequently managed with operative repair. Tendon injuries of the hallux are not all alike; careful consideration should be given to the mechanism and site of injury, the timing of presentation, and the presence of other injuries. Not all tendon injuries of the hallux require repair. The effectiveness of a repair will depend on the goals of surgery, which may include

pain relief, active joint motion, or correction of deformity. When goals are clearly defined, a satisfactory result can be expected in most patients.

Skoff H (1988). Dynamic splinting after extensor hallucis longus tendon repair. A case report. Phys Ther **68**(1): 75-76.

Surgery often is recommended to prevent the symptomatic hallux flexus and equinus deformity that may result from traumatic laceration of the extensor hallucis longus (EHL) tendon. Surgical repair of the EHL tendon, however, may cause scarring and adhesion formation that results in a loss of EHL tendon function. Dynamic splinting may be used during rehabilitation to prevent these complications. The purpose of this case report is to describe the use of dynamic splinting in the treatment of a patient after EHL tendon laceration and surgical repair.

Smith B, Coughlin M (2008). Reconstruction of a chronic extensor hallucis longus tendon laceration with a gracilis tendon autograft. Orthopedics **31**(10).

Extensor hallucis longus tendon injuries are uncommon, representing < 2% of tendon injuries. Lacerations are more common than spontaneous ruptures, and if neglected are often difficult to primarily repair because of tendon retraction and scarring. Few reports address the operative treatment of chronic extensor hallucis longus tendon injuries. To our knowledge the use of a gracilis tendon autograft has not been reported. We describe the use of this free tendon autograft with a hallux interphalangeal joint arthrodesis in one patient.

Tomlinson MP, Williams LA (2006). Extensor hallucis longus calcific tendonitis: a case report. Foot Ankle Int **27**(2): 144-145.

Zielaskowski LA, Pontious J (2002). Extensor hallucis longus tendon rupture repair using a fascia lata allograft. J Am Podiatr Med Assoc **92**(8): 467-470.

The authors present a case of a traumatic extensor hallucis longus tendon rupture sustained 2 days after hallux valgus and hammer toe correction. The ruptured tendon, separated by a 6-cm defect, was repaired using a fascia lata allograft. This case demonstrates a serious complication of a commonly performed procedure and a salvage technique useful for dealing with large tendon defects.