The Foot and Ankle Online Journal
Official Publication of the International Foot & Ankle Foundation
faoj.org / ISSN 1941-6806

Neglected Achilles tendon rupture and repair with cadaver allograft, extracellular matrix, and platelet enriched plasma

by Al Kline, DPM[1*]

The Foot and Ankle Online Journal 9 (3): 8

Neglected Achilles tendon ruptures can be challenging to repair. A case report is presented using a cadaver allograft supplemented with an acellular dermal extracellular matrix and platelet enriched plasma in a neglected, chronic Achilles tendon rupture of over 5 years old. Graft sterilization, rejection, incorporation, and the use of supplemental materials such as dermal matrix and the benefits of platelet enriched plasma are discussed. This report emphasizes the viability and success of using a cadaver graft and supplemental materials with platelet enriched plasma to help restore Achilles tendon function in a neglected Achilles tendon rupture.

Keywords: Neglected Achilles tendon rupture, cadaver allograft, dermal extracellular matrix, platelet enriched plasma

Acute rupture of the Achilles tendon is often a surgical emergency that requires primary repair. There has been a long history of surgical versus non-surgical repair of the Achilles tendon. And, depending on the extent of rupture, sometimes, immobilization and non-surgical treatment, such as casting, is preferred and even indicated over surgical repair. If surgical repair is chosen, it is preferable to do the repair within a week of the rupture.

Unfortunately, there is a 10-25% misdiagnosis of early Achilles ruptures. This can be the result of misdiagnosis, failure of conservative treatment or degeneration of the tendon causing improper healing [1].

A chronic Achilles rupture is defined as a tendon rupture that is older than 4 weeks [2]. Presently, I have found very few documented cases of repairs performed on the Achilles tendon using Allografts that are over 5 years old.

The trouble with delaying treatment of the Achilles rupture is contracture. In severe cases, the tendon can retract significantly causing a palpable gap on examination along the tendon course. Clinical symptoms can include pain, failure to toe off and trouble walking up-hill or along an incline.

This is a recent case involving a neglected Achilles rupture that occurred 5 years prior to presentation. The tendon was successfully reconstructed with a cadaver Achilles tendon and supplemented with an extracellular matrix and platelet enriched plasma.

Case Report

A 62-year-old male with a history of chronic right Achilles tendon that ruptured over 5 years ago. He sustained the injury after trying to climb up into his truck and instantly felt and heard a loud 'pop' to the back of the right leg. He initially went to an orthopedic surgeon who placed him in a walking boot. He states he did not have surgery for fear of termination from his job.

1 - Podiatry Staff, Doctors Regional Medical Center, Corpus Christi, Texas.
* - Corresponding author: alklinedpm@gmail.com

ISSN 1941-6806 doi: 10.3827/faoj.2016.0903.0008

He has a history of diabetes mellitus and is well controlled. He finds it difficult to walk and states it affects his balance and he has since had a partial rupture of the left Achilles tendon.

Clinically, there is some muscle and plantarflexory strength on range of motion (+2/5). This could be due to an intact and hypertrophied plantaris tendon which was confirmed in surgery. He lacks a proper toe raise and limps during gait.

There is a large palpatory 'knot' with a distal gap of approximately 5 cm along the course of the right Achilles tendon. MRI reported a 5cm gap with complete rupture of the Achilles tendon.

The MRI report states: "There is complete rupture of the Achilles tendon from the distal insertion with a small avulsion fracture of the calcaneus at the insertion site of the Achilles tendon. There is about a 4.7 cm retraction of the ruptured Achilles tendon. The Achilles tendon is markedly thickened with increased signal, and finding consistent with severe tendinopathy. There is a prominent plantaris longus tendon seen along the medial side of the Achilles tendon, which inserts to the posteromedial aspect of the calcaneus."

Our surgical plan included reconstruction of the tendon using a fresh frozen allograft with reinforcement using decellularized extracellular dermis (Arthrex GRAFTJACKET®) and infusing the graft using the patient's own platelets.

The patient underwent primary repair and reconstruction of the right Achilles tendon using an allograft Achilles tendon with calcaneus cadaver graft and implant system using the Arthrex BioComposite Achilles SpeedBridge™ system with decellularized dermis for Achilles repair. All grafts were infused with platelet enriched plasma.

Operative Course

The patient underwent a reconstructive surgery replacing and reinforcing a large section of his retracted Achilles tendon. An incision was made exposing the ruptured Achilles tendon and atrophic tendon ball (Figure 1).

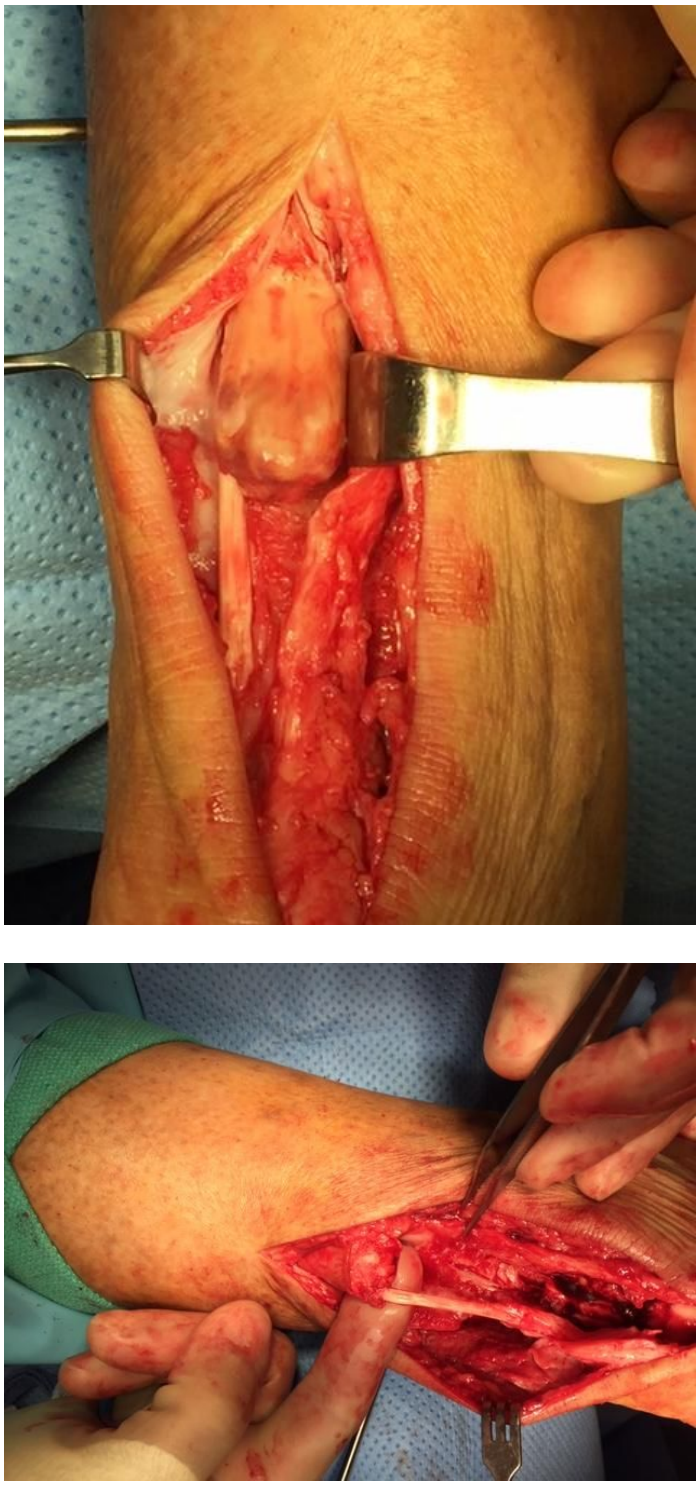


Figure 1A and 1B Once the tendon sheath is incised, a large proximal Achilles tendon ball is exposed with atrophic changes to the end of the tendon rupture. The end was calcified and hardened. This was resected prior to repair (A). The plantaris tendon remains intact after rupture, but is thickened. This was the only remaining attachment along the posterior compartment (B).

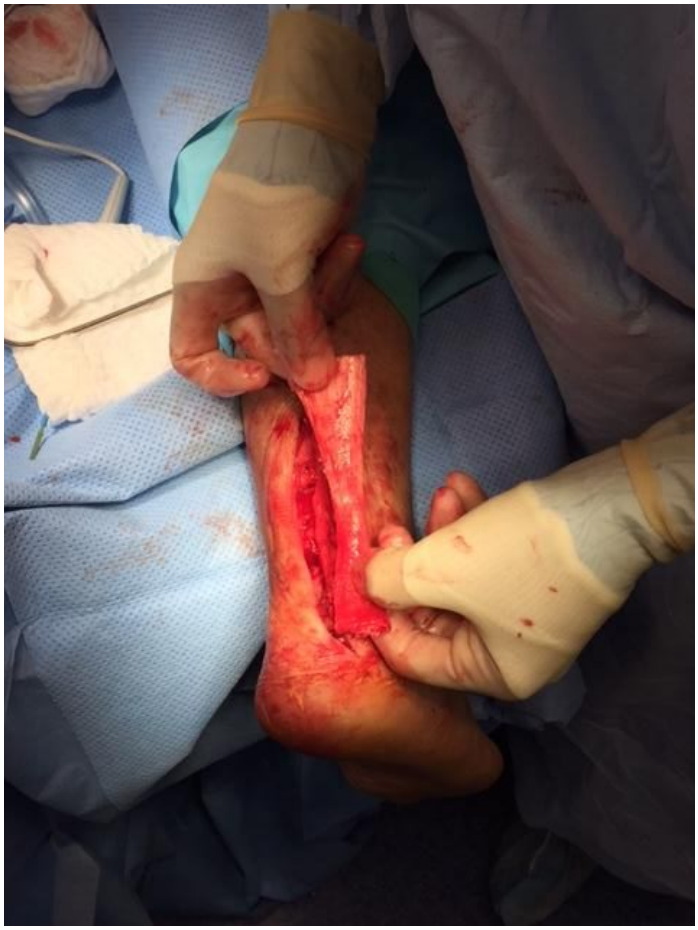
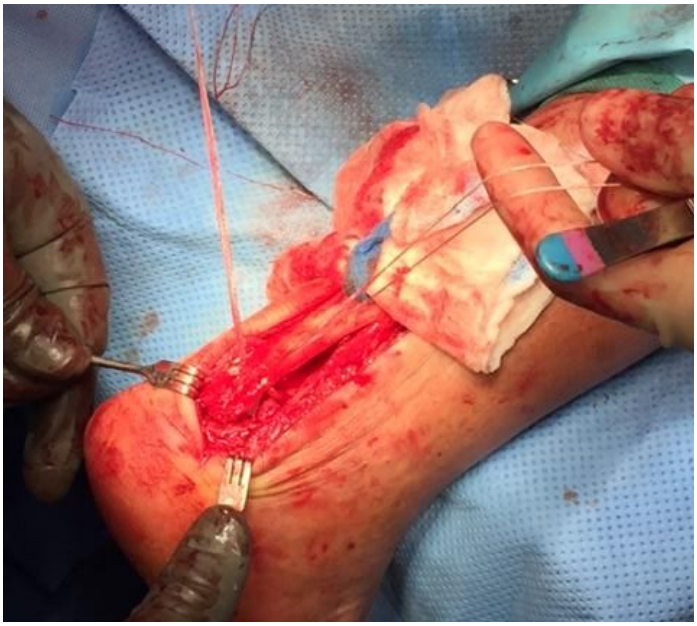


Figure 2 The Allograft tendon after platelet infusion. It is measured and then sutured into the native proximal tendon. It is important to secure some tension into the tendon, bringing the foot to about 90 degrees to the ankle, ensuring not to overstretch or place too much tension through the Allograft.

Along the insertion of the native Achilles tendon, there was very little tendon attachment. The end of the retracted tendon ball was then resected down a few centimeters to viable tendon fiber. The allograft tendon was then prepared. The bone was removed from the cadaver tendon (a portion of the calcaneus) and then left to thaw in saline. Once the tendon was supple, it was dropped into a basin of the patients own enriched plasma. It was left to infuse for several minutes (Figure 2).



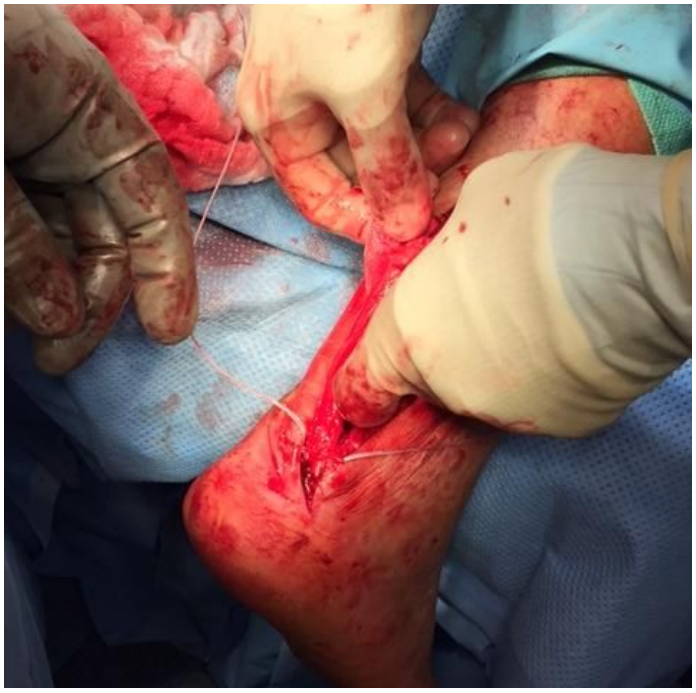
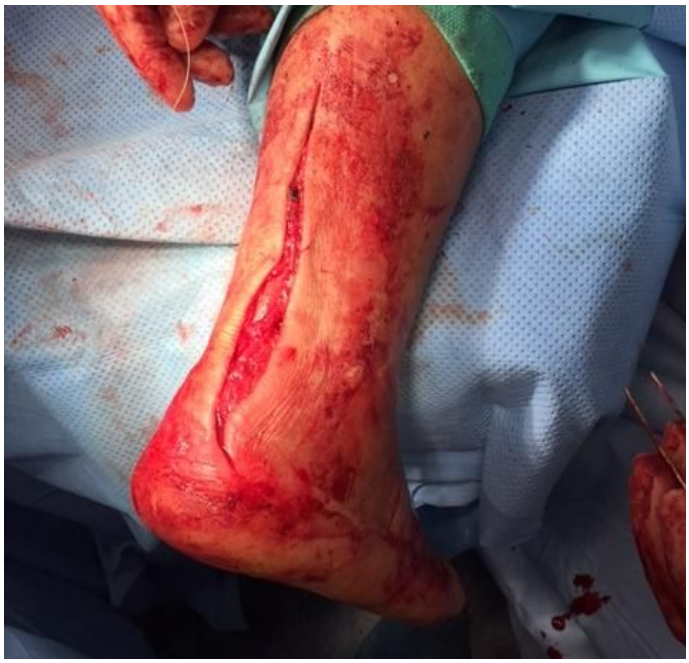


Figure 3A and 3B Once the Allograft tendon is tensioned, the distal portion is placed and sutured into the bone of the calcaneus using the BioComposite Achilles SpeedBridge™ (A). Once secure, the proximal portion of the tendon is encased in the extracellular matrix to give the proximal anastomosis strength and to cover this portion of the tendon that lost a portion of the tendon sheath (B).



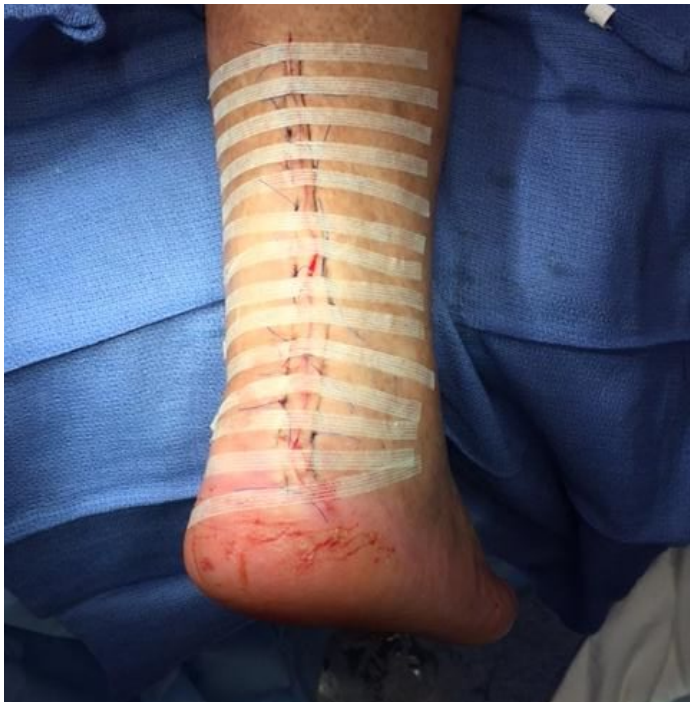


Figure 4A and 4B The tendon is encased in the extracellular matrix after reconstruction of the Allograft tendon both proximal and distally. Prior to closure of the subcutaneous layer, the entire construct is infused with additional platelets enriched in potential growth factors (A). The incision is then closed with horizontal mattress sutures and buttressed with skin strips (B). The patient is then placed in a posterior fiberglass splint and kept non-weightbearing.

Once prepared, the tendon was then sutured into the proximal native Achilles tendon. Distally, the tendon is then plicated into bone using the BioComposite Achilles SpeedBridge™ system by Arthrex. A 4.7mm swivel-lock anchor (x2) is used with fibertape to secure the tendon with proper tension into the calcaneus. The suture is then used to repair the thickened tendon sheath to encase the distal tendon (Figure 3A).

Proximally, the tendon is sutured into the native portion with fiberwire. Once the tendon is tensioned properly, it can then be supplemented and reinforced decellularized extracellular dermis (GraftJacket-Arthrex) (Figure 3B).

The extracellular jacket is then pulled down to cover and encase the tendon where there is no tendon sheath coverage. The incision is then closed (Figure 4A, 4B).

Discussion

Biomaterial supplementation of tendon repairs gained prominence in the past 10 years in an effort to strengthen repairs. The extracellular matrix (ECM) of tendons is composed of collagen and a smaller fraction of elastin embedded in a hydrated proteoglycan matrix. The principal role of the collagen fibers is to resist tension, whereas proteoglycans are primarily responsible for the viscoelastic properties of the tendon [3].

In one small report, Park and Sung report two cases using frozen allograft for neglected Achilles tendon rupture. They recommended removal of the distal bone from the allograft if there was sufficient tendon attachment along the posterior heel [1].

In this case report, I found it easier to remove the bone graft and plicate the graft tendon into the bone using a simple Arthrex SpeedBridge™ technique that is often done in reattachment procedures of Achilles tendon repair.

In a series of 12 patients with chronic Achilles ruptures, Park and Sung concluded that "Chronic Achilles tendon ruptures can be successfully treated by careful selection of the reconstruction method according to the length of defect gap and state of the remaining tissue. With an extensive defect, use of an Achilles tendon allograft can be a good option" [1].

The use of allograft tendon repair is rare in neglected Achilles ruptures. It has been successfully used to repair patellar tendon ruptures and ACL and cruciate repairs of the knee [4]. In fact, the failure rate in one study of 158 patients undergoing ACL repair with Achilles tendon allograft was less than 5.6% [4].

The rarity of repair using a cadaver allograft may be partly due to various other techniques used such as a autografting using free fascia lata and even V-Y advancement flaps and the use of tendon augmentation using the Flexor Hallucis tendon and even Xenografts. There is also suggestion of a risk of failure in the use of allograft tendon and 'rejection' or potential for disease transmission in an allograft tendon.

Host Rejection and Allograft Strength

Bio-sterilization techniques are also thought to impair the mechanical properties of graft tissue. There is a potential concern of the loss of tensile strength in tendons and tissue undergoing sterilization. Does irradiation, when done properly retain the normal tensile strength of human tissue tendon grafts?

In an article published through the Arthrex website, Dr. Liisa M. Eisenlohr describes the use of controlled-dose, low-temperature gamma irradiation for complete sterilization of tissue [5].

Dr. Eisenlohr writes, " . . . excessively high dose(s) of uncontrolled radiation has been shown to have a deleterious effect on the material properties of most allograft tissue, particularly of structural allografts, and is therefore generally not recommended for processing of allogeneic tissue. The temperature at which radiation is administered appears to play a critical role . . . Studies have shown that uncontrolled gamma irradiation of freeze-dried or hydrated samples at room temperature negatively affects biomechanical tissue properties. In contrast, irradiated deep-frozen bone allografts seem to be less brittle than similar grafts irradiated at room temperature. " [5].

She also describes a technique using Allowash XG, described as non-irradiation technique of sterilization that retrains tissue and bone tensile strengths and structure.

Most studies now conclude that present day sterilization techniques using both gamma irradiation and non-irradiation does not adversely affect the biomechanical or biochemical properties of tissue needed for their intended clinical applications.

Graft Incorporation and Platelet Enriched Plasma

To understand how a tendon allograft is incorporated as normal tissue, we must understand the proper healing cascade in normal tendon injury. This cascade can be discussed in terms of both allograft tendon and acellular extracellular matrix (ECM) incorporation, since the tendon dry mass is basically composed of 60% Type 1 collagen and 95% of the total collagen base [6].

In tendon healing, the repair process passes through three main phases containing distinctive cellular and molecular cascades. The initial inflammatory phase forms a clot or hematoma, which is propagated by platelets. In additional to inflammatory cells such as neutrophils, monocytes and macrophages attracted to the site of injury by pro-inflammatory cytokines, platelets also release potentially hundreds of healing proteins called growth factors. The angiogenic process with formation of new blood vessels is also important in the initial cascade, to set up the vascular network for tendon repair and incorporation into the host tissue.

There has also been suggestion that tendons often repaired without the use of extracellular supplementation and cellular proteins are prone to re-rupture or failure [3]. In this case, rehydration of the allograft was performed with platelet enriched plasma (PRP) in an effort to facilitate the healing cascade, improve graft incorporation into surrounding tissues and decrease the overall acute inflammatory responses. The benefits of extracellular grafting and the use of platelet enriched plasma allows for rapid cellular repopulation and revascularization of the graft.

In the second phase of tendon healing, often called the reparative or proliferative phase, there is proliferation of Type III collagen and proteoglycans, another major component in the tendon ECM providing more structural integrity to the tendon. This phase is highlighted by increased collagen, hydration and vascular proliferation.

The final or remodeling phase is subdivided into two distinct phases called the consolidation and then maturation phase. Consolidation occurs 6-8 weeks after injury and may take 1-2 years to complete depending on the age of the patient. During this time, collagen fibers organize in a longitudinal axis restoring tendon tensile strength. After 10 weeks, the maturation phase includes collagen fibril cross-linking and formation of mature tendon. Maturation can also take up to a year to complete.

All three phases do overlap and vary. However, in the first 48 hours after injury, the introduction of hematoma and the release of growth factors seem to be the most crucial phase in overall progression of this cascade. This is why a concentration of these factors are thought to help incorporate and increase the likelihood of graft success [3].

A sterilized allograft is incorporated into the body in a similar fashion as autografts. Again, graft incorporation has been shown to go through a series of histological changes including graft necrosis, cellular repopulation, revascularization, and collagen remodeling [7].

In a histologic presentation of Achilles autograft 11 years after its use in posterior cruciate ligament reconstruction, Miyamoto concluded that allograft can remain successfully incorporated for extended periods and histologically appeared as "indistinguishable from those of normal, native cruciate ligament." [7]. In these terms, it appears that graft incorporation will propagate within its normal tissue environment.

Conclusion

To date, the patient had very little pain or swelling post surgically. He is presently undergoing strengthening exercises and is wearing a walking boot prior to transition back to his shoes. The present case report does support similar findings as reported in the literature. Deese, et al. reported in 2015 a retrospective study of 78 patients with chronic Achilles tendon ruptures. Of that study, they only identified 8 patients who underwent repair by tendon allograft. All 8 patients had over a 5 cm gap and did well after follow-up. They suggest that "patients undergoing Achilles allograft reconstruction technique demonstrated promising results and suggests that allograft reconstruction is a reasonable solution" [8].

References

1. Park Y-S, Sung K-S. Surgical Reconstruction of Chronic Achilles Tendon Ruptures Using Various Methods. Orthopedics. 2012. doi:10.3928/01477447-20120123-13.
2. Grove DJR. Autograft, Allograft and Xenograft Options in the Treatment of Neglected Achilles Tendon Ruptures: A Historical Review with Illustration of Surgical Repair. The Foot & Ankle Journal. 2008;1(5). doi:10.3827/faoj.2008.0105.0001.
3. Docheva D, Müller SA, Majewski M, Evans CH. Biologics for tendon repair. Advanced Drug Delivery Reviews. 2015;84:222-239. doi:10.1016/j.addr.2014.11.015.
4. Crossett LS, Sinha RK, Sechriest VF, Rubash HE. Reconstruction of a ruptured patellar tendon with achilles tendon allograft following total knee arthroplasty. J Bone Joint Surg Am. 2002;84-A(8):1354-61.
5. Eisenlohr LM. Allograft Tissue Sterilization using Irradiation – What are the implications for clinical performance?, LifeNet Health, Bio-Implants Division. June 2007.
6. Riley G. The pathogenesis of tendinopathy. A molecular perspective. Rheumatology. 2003;43(2):131-142. doi:10.1093/rheumatology/keg448.
7. Miyamoto RG, Taylor S, Desai P, Bosco J. Histologic presentation of achilles allograft 11 years after its use in posterior cruciate ligament reconstruction. Am J Orthop. 2009;38(1):E25-7.
8. Deese JM, Gratto-cox G, Clements FD, Brown K. Achilles allograft reconstruction for chronic achilles tendinopathy. J Surg Orthop Adv. 2015;24(1):75-8.