The Journal of Foot & Ankle Surgery 51 (2012) 642–644

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Repair of Lacerated Anterior Tibial Tendon with Acellular Tissue Graft Augmentation

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ARTICLE INFO

Level of Clinical Evidence: 4
Keywords:
human dermal tissue matrix
rupture
sports injury
surgery
tibia

ABSTRACT

In the present case report, we describe the surgical repair of a complete laceration of the anterior tibial tendon using acellular human dermal tissue matrix. A 17-year-old, elite league hockey player was injured in the locker room when a teammate still clad in ice skates stepped on his bare left foot. After evaluation at a local emergency department, the patient presented to our office the next day for additional evaluation. It was determined that surgery would be performed using acellular tissue graft augmentation, followed by physical therapy. Within 7 weeks of the injury, the athlete returned to his original level of activity. At 3 years of follow-up, he was playing Division 1 hockey at the university level. We believe that augmentation of the tendon repair with the grafting material enhanced the tendon tensile strength and promoted ingrowth through vascular channels. This, combined with the patient's dedication to physical therapy, led to excellent recovery in less time than anticipated.

Complete laceration of the anterior tibial tendon is a rare acute injury. Most published data surrounding this topic have described cases of closed high-energy fractures in athletes (1,2). Spontaneous ruptures have been reported as a result of chronic mechanical overload (i.e., pes planovalgus), gout, diabetes, and other systemic illnesses (3,4). The mechanism of injury aside, the location of the laceration is an important predictor of o tendonous healing. Petersen et al (5) reported the most susceptible site of vascular embarrassment to be 0.5 to 3.0 cm from the insertion site. The first 3 weeks in tendon healing are critical, because the tendon is still susceptible to repeat rupture owing to its inherent weakness (6). An allograft can address the issue of vascular privileged site by providing a route for revascularization and, therefore, tendon remodeling.

Tendon grafting, transfers, and advancement procedures are often used for tendon repair. The use of an acellular tissue graft in Achilles tendon ruptures has shown great success (1,7–10). We report the surgical repair of a lacerated anterior tibial tendon with adjunct use of acellular human dermal tissue matrix.

Case Report

A 17-year-old elite league hockey player was injured in the locker room when a teammate still clad in ice skates stepped on his bare left foot. The subsequent laceration produced a significant amount of bleeding, and he was taken to an emergency department. His wound was cleansed, and the skin closed primarily with sutures. He was told he had not sustained any additional injury and should abstain from strenuous activity for 1 to 14 days. The next day, the patient had marked difficulty ambulating and sought our office for a second opinion.

The lower extremity examination revealed palpable dorasalis pedis and posterior artery pulses with a capillary fill time immediate to digits 1 to 10. The epicritic sensation was grossly intact with no deficits of sensation at, or distal to, the site of injury. The skin was warm, dry, and supple with transverse laceration noted across the dorsal medial aspect of the left foot at the first cuniform. The sutures were intact, with no obvious signs of infection or dehiscence. The patient exhibited more difficulty on ambulation in regard to ground clearance of the left foot. Manual muscle testing revealed a profound loss of anterior tibial function; the remaining muscle strength results for the left foot were unremarkable. Radiographs demonstrated no osseous pathologic findings. Subsequent magnetic resonance imaging showed complete laceration of the anterior tibial tendon with about 3.0 cm of contraction from approximately the first cuneiform. Both conservative and surgical treatment options were reviewed with the

Financial Disclosure: None reported.
Conflict of Interest: None reported.
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doi:10.1053/j.jfas.2012.05.020

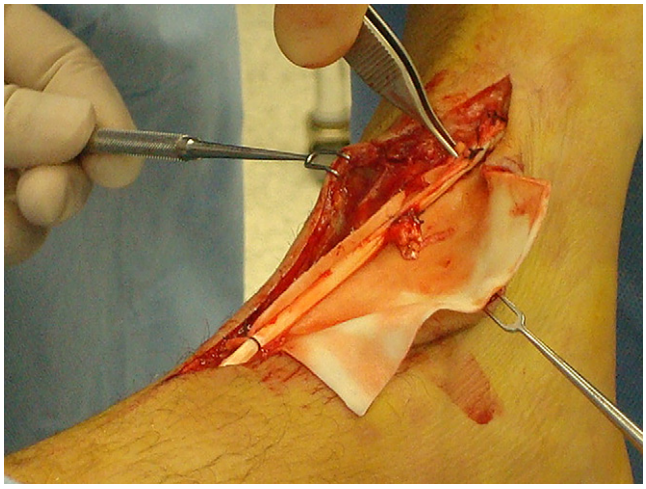

Fig. 1. A 4 cm × 7 cm × 1.5 mm GraftJacket® tubulized around the tendon.

Fig. 3. The patient is able to actively and passively dorsiflex on follow-up examination.

patient and his parents. Functional considerations were emphasized, and, when faced with the prospects of a limited ability to play sports, they chose to proceed with surgical intervention.

On post-injury day 4, the patient underwent surgery. An incision was made along the course of the anterior tibial tendon, and all neurovascular structures were retracted and bleeding vessels cauterized. The anterior tibial tendon was completely ruptured, and the diseased portions were resected for a total length of approximately 1.0 cm, leaving a resultant gap of approximately 4.0 cm. The tendon was then split in half and flapped down to be reinserted into the distal stump using 2-0 multifilament absorbable suture with the foot held at a 90° angle under physiologic tension. At this time, a 4 cm × 7cm × 1.5 mm of GraftJacket® (Wright Medical Technology, Arlington, TN) was tubulized (Fig. 1), placed around, and tacked down to the split area of the anterior tibial tendon (Fig. 2). The deep tissues were closed with 2-0 multifilament absorbable and the skin with 3-0 polypropylene suture. A Jones compression bandage was applied with the foot casted in dorsiflexion and inversion to relieve the tension on the anterior tibial tendon.

The surgical incision healed well with no complications. The patient was kept non–weightbearing in a below-the-knee cast with crutches for 4 weeks. He was then given a support hose and cam walker to be worn every day. Additionally, he underwent 15 physical therapy treatments within the course of 1 month at a local rehabilitation facility. The treatment plan, as outlined by the physical therapist, included stretching and strengthening activities, balance and proprioceptive activities, functional activities, and therapeutic exercises. The patient also performed the exercises daily at home. On the follow-up examination, the young male was able to actively and passively dorsiflex without difficulty (Figs. 3 and 4). The patient was discharged from our practice at 4 months postoperatively after having returned to his former level of activity with full strength in the tendon and no evidence of pain or swelling. We have enjoyed watching this young patient's progress during the past 3 years, and at our last interview, he was a forward with a Division 1 hockey program at a major university in the United States.

Discussion

Isolated anterior tibial tendon ruptures can be difficult to diagnose without an obvious history and can easily be overlooked. Extensor substitution can consequently hide a more obvious foot drop; however, careful gait analysis will reveal the inability to supinate during the swing phase of the gait. On physical examination, a palpable defect can be felt along the course of the anterior

Fig. 2. The material is then tacked down to the split area of the anterior tibial tendon.

Fig. 4. The hypertrophic area represents increased bulk, just as was the most proximal portion for anchorage of the tendon repair. The tendon repair is to the level of the inferior border of the extensor retinaculae.

tibial tendon and will be acutely painful. This can be verified by asking the patient to resist forced plantarflexion with the foot supinated.

Improper management or delayed diagnosis can lead to profound functional loss. Pronation deformity, heel cord contracture, hammer toe deformity, and difficulty ambulating, especially on uneven surfaces, paint a picture of a poor clinical outcome. Conservative measures such as an ankle–foot orthotic or bracing might be viable for an elderly or nonactive patient; however, these are cumbersome and unattractive options for younger, healthy, active individuals. Not surprisingly, a review of the published data favored surgical intervention over conservative measures (11). As such, it falls on the clinician to determine the tendon deficit, in any, using ultrasonography or magnetic resonance imaging. The primary end-to-end repair is ideal, although it might not be entirely realistic. Deficits up to 4.0 cm can be repaired with a tenoplasty, and those that are larger require grafting or tendon transfer. Regardless, expediting and increasing the stability of tendon healing is favored using an acellular tissue graft augmentation (1,7–10).

In conclusion, any of the biologic scaffolds currently being marketed are likely to produce similar results. The products are manufactured from various mammalian tissues, including human, porcine, bovine, and equine sources (12,13). GraftJacket® is made from human cadaver dermis and has been reported to be well tolerated by patients (12). A study by Barber et al (14), in 2006, reported the material to have the strongest mechanical properties among the 5 products then available. Several investigators have suggested that the reticular portion of the product allows vascular ingrowth and the basement membrane portion is slowly absorbed, maintaining the strength until the area has healed (1,10,12). The receiving tissue shows no inflammatory response and allows stable incorporation into the host. Tendons that have ruptured or lacerated in watershed portions will obviously benefit, leading to faster recovery. Additionally, the tensile strength and stiffness of the material allows the patients to initiate physical rehabilitation earlier (15). In 2 studies, Lee (7,8) evaluated the use of GraftJacket® in Achilles tendon repair. Nine patients were followed up for 20 to 30 months and did not experience pain or repeat rupture. The return to activity interval for these patients was 15.2 ± 1.7 weeks (7). In the second study, 11 patients showed no signs of repeat rupture or pain at 20 months and their return to activity interval was 11.8 ± 0.75 weeks (8). Although we could not scientifically determine whether the use of augmentation led to a faster recovery in our patient, one would surmise that the use of a product that encourages incorporation along the watershed portions of tendons while increasing their tensile strength produced favorable and predictable results. Our young patient's progress and follow-up findings at 40 months or longer have added to the evidence that the use of acelluar tissue grafting is a desirable product in tendon repair. In order to better understand the long-term results of using human cadaver dermis to augment the repair of tendons of extrinsic pedal musculature, larger scale prospective cohort studies and randomized controlled trials focusing on this form or tendon repair are required.

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