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Reconstruction of the Achilles Tendon after Tumor Excision with Flexor Hallucis Longus Tendon Transfer

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Abstract

Reconstruction following excision of tumors of the Achilles tendon poses a challenge to the treating surgeon. Described techniques for restoration of plantarflexion in the setting of an unrepairable tendon include the use allograft, autograft, tendon transfer, and free flap. In tumor surgery, options may be limited as total tendon resection may be necessary - leaving little or no residual tendon to which allograft or autograft can be secured. Patient factors such as a radiated field or need for timely commencement of adjuvant therapies may make the use of avascular allografts or microvascular anastomosis for free flap application disadvantageous. This report describes two cases in which patients underwent removal of large neoplasms involving the Achilles tendon and reconstruction of the tendon with flexor hallucis longus (FHL) tendon transfer and primary closure. Both patients had good outcomes as relates to function and cosmesis. Though minor wound complications arose, neither the patient required flap coverage. Both wounds healed with local wound care. We believe the described technique is a safe, effective adaptation of the FHL transfer described for neglected Achilles tears and is useful in the management of patients with plantarflexion deficits following tumor resection.

Keywords: Soft tissue tumors; Achilles tendon; Tendon transfer; Autograft

Introduction

Soft tissue tumors are commonly encountered in many orthopedic practices. Most estimates cite a 100:1 incidence of benign to malignant (soft tissue sarcoma) tumors. Many of these lesions are small and superficial and can be excised without extensive reconstruction or marked functional impairment. Larger and deeper tumors pose more of a challenge as whole muscle groups may be compromised in excision. This is particularly true in soft tissue sarcoma where in addition to the malignancy itself, a cuff of healthy, unaffected tissue is excised to decrease the risk of local recurrence (wide resection). Though more distal tumors may be identified earlier (and at a smaller size), the functional consequences of excision are still marked. As an example, a thigh mass necessitates resection of one belly of the quadriceps muscle would have less functional impairment than a smaller resection of quadriceps tendon proper. As most soft tissue tumors (benign and malignant) arise in muscle bellies, need for tendon reconstruction is less often encountered.

Despite this proclivity for muscle belly, soft tissue tumors can involve the Achilles tendon. Partial or complete tendon excision may be indicated for symptomatic relief or for oncologic therapy. Resections resulting in loss of active ankle plantarflexion warrant consideration for reconstruction – techniques for which are adopted from the sports and trauma literature.

Indications for reconstruction are dependent on both tumor and patient factors. Sarcomas and locally aggressive processes must be amenable to wide resection – otherwise, amputation should be considered. Patients with metastatic disease may be better served by evaluation for systemic therapy before local measures are pursued. As the FHL is needed for reconstruction, the deep posterior compartment must be free of disease. Preoperative neurologic examination is essential as tibial nerve compromise may render the FHL non-functional. Regardless of pathology, patients with concurrent infection or skin loss over the area necessitate careful consideration. Overlying skin loss may require additional soft tissue procedures at the time of surgery – or amputation. Patients medically unfit for surgery or non-ambulatory are contra-indicated.

While the goal of an Achilles reconstruction is to maximize function, minimizing complications is an equally important consideration. Acute, subacute, and chronic Achilles repairs/ reconstructions have well documented outcomes and complications [1-3]. In tumor surgery, the complication risk is heightened where resections can result in sizeable soft tissue voids [4]. Further, previous radiation therapy or skin sacrificed with the specimen increases the reconstruction's complexity. Since an open or infected wound will likely delay adjuvant therapy, a functional reconstruction that is durable in the setting of a large resection and allows timely return to cancer therapy is ideal.

Multiple techniques for Achilles reconstruction have been described; they include local tissue advancement, allograft, fascia/ tendon autograft, and myotendinous free tissue transfer [5-8]. In tumor surgery, the excision may leave only muscle belly proximally and calcaneus distally. This lack of residual proximal or distal tendon limits reconstructive options as there is insufficient tissue to which allograft or autograft can be secured. The lack of the triceps aponeurosis negates turndown and advancement techniques.

Proximally transected muscle belly does not provide a reliable host to which allograft can be secured. Additionally, allograft raises significant infection concern in a radiated field.

Given the limitations of the aforementioned Achilles reconstructions when applied to the tumor setting, we adapted a functional reconstructive technique for management of these large voids – transfer of the FHL tendon [6]. This procedure allows for a one-stage resection-reconstruction in the setting of proximal tendon resection to the gastrocnemius and soleus muscle bellies. Further, it eliminates the need for micro-surgical reconstruction and limits tissue bulk in the operative field, potentially facilitating local surveillance.

Case Reports

Patient #1: A healthy 23 year old female was evaluated for a 6 month history of fullness involving the Achilles tendon. MRI demonstrated a heterogeneous lesion limited to the Achilles tendon with a fascial plane preserved between the lesion and deep posterior compartment (Figure 1). Histologic diagnosis of clear cell sarcoma was made on open biopsy; staging was negative for metastatic disease.

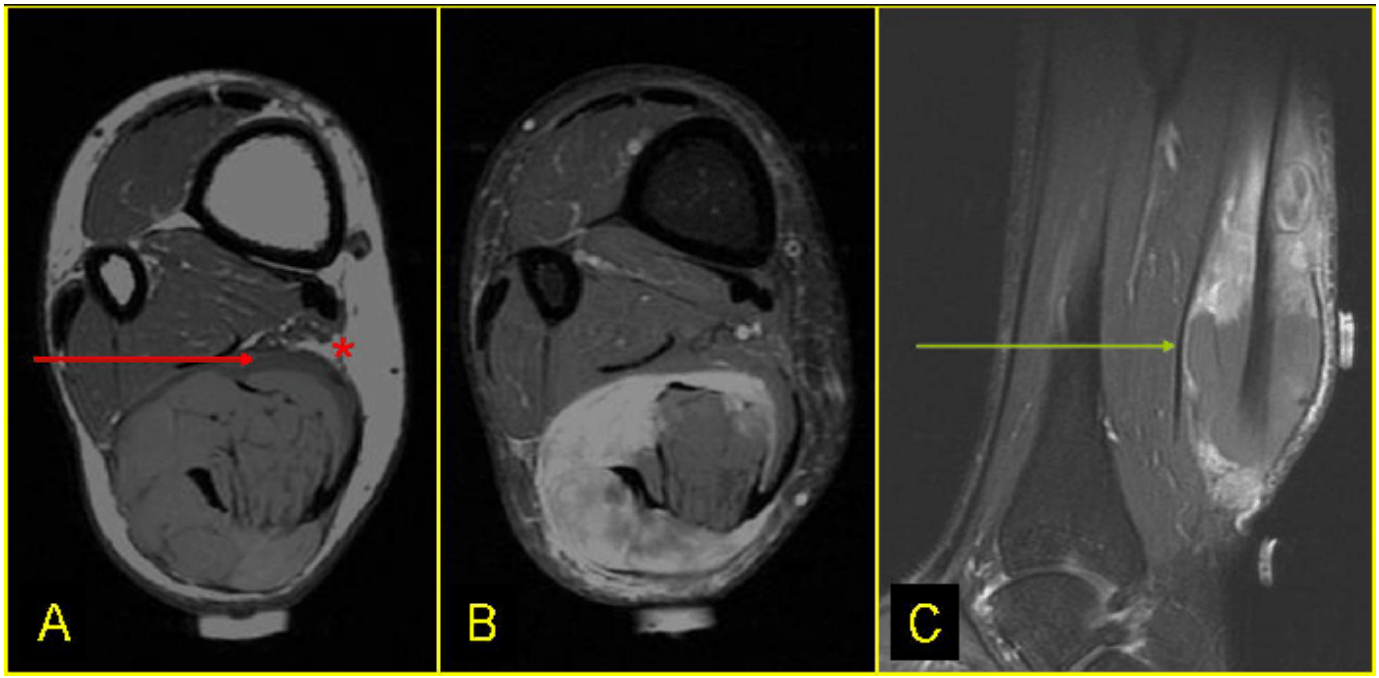

Figure 1: Patient 1. a: Preoperative T1 axial image demonstrating the mass involving the Achilles tendon and superficial posterior compartment of the leg. Signal isointense to muscle (arrow) is present deep to the sarcoma but within the superficial posterior compartment as is healthy appearing fat adjacent to the posterior neurovascular bundle (star). b: Preoperative FS-T1 post contrast administration axial image demonstrating the large heterogenous, enhancing lesion. c: Preoperative FS-T1 post contrast administration sagittal image demonstrates extensive peritendinous tumor with a preserved FHL tendon (arrow).

She underwent resection to the gastrocnemius and soleus muscle bellies proximally and less than 1 cm of tendon was retained distally. FHL transfer reconstruction was performed through a calcaneal drill hole. The resection specimen measured approximately 15 cm cephalad to caudad. Margins were negative.

Post-operative, the patient developed a suture abscess which was treated with local dressing changes. Progression from resting equinus to neutral was initiated at six weeks and therapy was initiated at 12 weeks. Adjuvant external beam radiation (64 Gy) was administered at 3½ months.

At four months postoperative, she was able to maintain a single-leg toe rise and had returned to preoperative employment (Figure 2) despite lacking active flexion of the hallux interphalangeal joint. At two years postoperative, she has no signs of local recurrence or distant disease. Her MSTS score at two years was 25/30 (83.3%) with mild pain, recreation activity limitations, and difficulty with distance walking. Contrast-enhanced MRI demonstrated edema within the FHL muscle belly.

Patient #2: A 33 year old male with history of neurofibromatosis presented to the orthopaedic clinic with a chronic Achilles tendon rupture in the setting of a large neurofibroma of the posterior calf and Achilles tendon. He underwent tumor debulking during which a 7 cm gap was created. A turn-down flap with allograft human epidermal tissue matrix was performed for the Achilles tendon repair (Figure 3). FHL tendon transfer was performed to the calcaneus and secured with an interference screw. Given the size of the tumor (and subsequent debulking), abundant redundant tissue complicated closure. Soft tissue rearrangement, including further resection, was necessary to satisfactorily close the operative wound.

Figure 2: Patient 1. a: 5 month postoperative photograph demonstrating loss of soft tissue contour and residual radiation associated skin changes. b: 8month postoperative photograph demonstrating the patient's ability to maintain single leg toe stance.

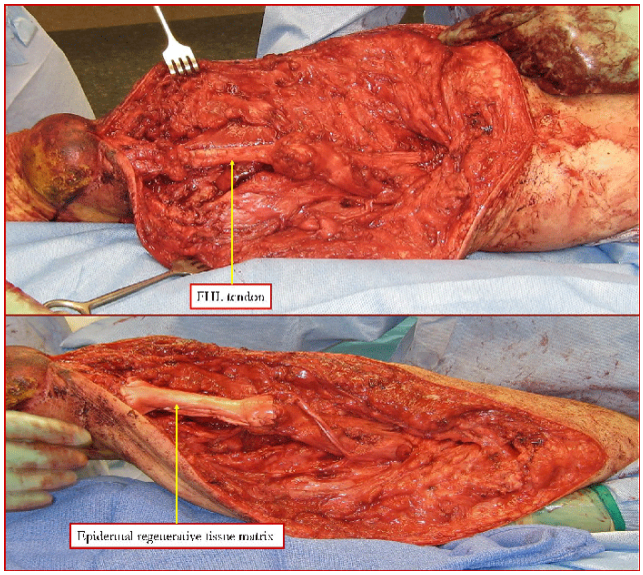

Figure 3: Patient 2. a: Intraoperative photograph after tumor debulking. The FHL tendon is seen after being passed through calcaneal drill hole and being augmented to distal stump of residual Achilles tendon remaining on calcaneus. b: Intraoperative photograph demonstrating graft jacket application to FHL tendon.

Postoperatively, the patient developed a small incision dehiscence that was treated with local incision and debridement followed by oral antibiotics. This subsequently healed. By 8 weeks, he was ambulating without assistive devices and physical therapy was initiated. He had full function and returned to work by 4 months postoperative. His MSTS score at two years was 29/30 (96.7%).

Evaluation and Techniques

Pre-operative

Patients are evaluated with a thorough history, physical examination, and review of all staging studies and biopsy specimens. Patients who have undergone neoadjuvant radiation should be allowed a period of rest for skin recovery. Patients who have undergone neoadjuvant chemotherapy should be allowed a period for correction of any myelosuppression. Neurovascular examination is imperative.

Contrast enhanced magnetic resonance imaging (MRI) guides preoperative planning. In the setting of a malignancy, the surgeon must adhere to strict oncologic principles of wide resection [9]. Lesions involving the deep posterior compartment must be identified as the ability to retain the FHL may be compromised (Figure 1).

Sarcoma resection

The patient is positioned prone after anesthesia is administered. The affected extremity is prepped and draped free to the gluteal cleft in the event that thigh skin is needed for grafting. A sterile thigh tourniquet is applied. The leg is gravity exsanguinated and the tourniquet inflated. Resection is through a longitudinal incision. The location of tumor dictates incision location, but a medial incision is favored to decrease the risk of adhesions and injury to the sural nerve and lesser saphenous vein [10]. The biopsy site is ellipsed and remains on the resection specimen. Full thickness skin flaps are favored and subcutaneous tissue is left on the tumor to extend the margin.

The proximal and distal extents of dissection are dictated by preoperative planning. Laterally, dissection is taken to the deep intermuscular septum; medially it is to medial border of the soleus. The deep fascia of the leg over the lateral compartment is incised the length of the measured resection. This allows the posterior intermuscular septum and transverse intermuscular septum to serve as the deep margin. Proximally, the gastrocnemius, soleus, and plantaris are transected at the pre-planned level. Distally, the Achilles tendon is transected. The specimen is elevated lateral to medial being careful not to compromise the neurovascular bundle lying deep to the transverse intermuscular septum. Fascia is incised medially and the specimen is passed off.

Reconstruction begins with the release of the FHL tendon. This can be performed at its insertion on the distal phalanx of the hallux to maximize length. This can be of particular utility when there is no residual Achilles tendon on the calcaneus to which the re-routed FHL could otherwise be sutured. An additional incision over the midfoot is needed to release the FHL tendon from the fibrous knot of Henry. Supernumerary slips to the lesser toes may be present and can be released through this incision. The tendon is delivered to the proximal wound (Figure 4).

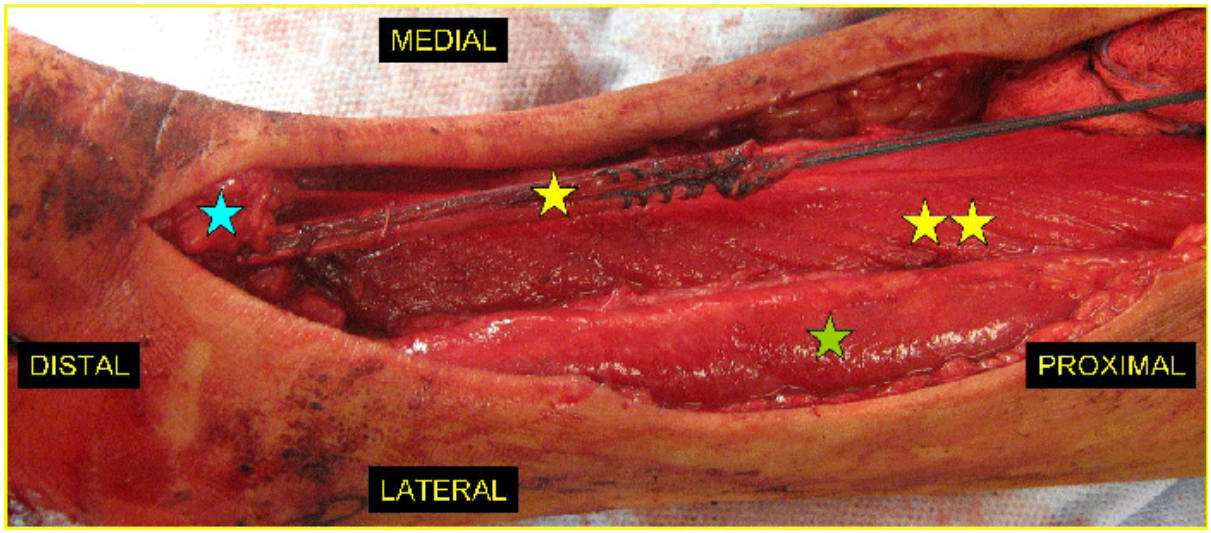

Figure 4: Patient 1. Intraoperative photograph demonstrating the FHL tendon (single yellow star) prior to being secured to proximal tendon and reinforced distally to residual Achilles tendon remaining on the calcaneus (blue star). FHL muscle belly – double yellow star. Lateral compartment – green star.

Using large, non-absorbable suture, Krackow stitch is applied to the free end of the FHL tendon. A 4.0 mm drill is used to prepare a trans-calcaneal tunnel. Fluoroscopy is used to assist in drill hole placement 2 cm distal and posterior to the tip of the medial malleolus. Hole placement can be more posterior to increase the plantar flexion lever arm. The tendon is passed trans-osseously (medial to lateral) and tunneled from the lateral calcaneal incision back to the post-resection field. It can be helpful to prep the contralateral leg into the field to compare tension. The FHL should be sewn to itself (or fixed in place with a tenodesis screw) with the foot plantar flexed to a tension equivalent to the contralateral side. Residual distal Achilles tendon can be sewn side-to-side to the transferred tendon for additional fixation.

One or more medium suction drains can be used if there is a residual potential space. The wound is irrigated and closed in a layered fashion. A resting equinus splint is applied.

Debulking

For cases of debulking of a tumor with extensive involvement of the Achilles tendon, the patient is similarly positioned prone and prepped. A longitudinal incision is made over posterior aspect of calf, just medial to midline of Achilles tendon [10]. In the setting of a benign tumor, operative principles employed during Achilles repair dictate location of incision in contrast to cases of malignancy where oncologic principles are prioritized. Maintain full thickness skin flaps. In cases of large soft-tissue tumors, multiple aberrant vasculature formations may be encountered that must be suture ligated.

Dissection is carried down to the fascia of superficial posterior compartment. The fascia is opened and debulking commences. Both the proximal and distal aspects of the Achilles tendon must be identified and dissected free of tumor and, if needed, resected to healthy tissue. Resection may extend to bone distally and muscle belly proximally. The FHL tendon and muscle belly are identified. In instances where less tendon length is needed, the FHL can be released at the most distal aspect of what is visible in the operative field. The tendon is transferred to the calcaneus through a drill hole. Supplementation of fixation, such as an interference screw, can be used to assist in securing the transfer.

Meticulous hemostasis is obtained to minimize risk of postoperative hematoma. In the setting of a large debulking, soft tissue rearrangement is often needed both to decrease potential space where a fluid collection may develop and to provide adequate closure. A resting equinus splint is applied.

Post-operative

The patient remains non-weight bearing in resting equines until gentle passive, progressive casting/splinting is initiated to bring the ankle into neutral after 6 weeks. The patient is then transitioned to a walker boot with a peel-away heel lift. The lifts are peeled away over a 2 week period. Physical therapy is initiated at 8 weeks for range-of-motion and gentle progressive resistance. Strengthening begins at 12 weeks. Adjuvant therapy (if indicated) is initiated after wound healing. The Musculoskeletal Tumor Society (MSTS) lower extremity functional scores were tabulated for both patients in this study [11].

Discussion and Conclusion

Tumor resection of the Achilles is a rarely indicated procedure. Few malignancies originate in tendon or aponeuroses and benign processes can often be treated with observation, avoiding the risk of operative complications in Achilles surgery [12-14]. In cases of tendon resection compromising plantar flexion, a durable, safe reconstruction is needed. We believe the technique described provides the surgeon a technique that allows for appropriate tumor excision, functional reconstruction, and an acceptable complication profile.

The described reconstructions provided both patients with functional plantar flexion. Neither required adaptive footwear nor tissue transfer. Both were able to return to their vocation but patient

#1 was unable to return to full recreational activity. The lack of bulk from a tissue transfer provided a cosmetically acceptable outcome.

This case series has several obvious limitations. Neither patient in this study underwent neoadjuvant radiation. Generalizations about outcomes and complications cannot be made about the procedure when performed in a radiated field. Patient 2 had adjuvants to reconstruction (allograft and screw). No conclusion can be drawn about the efficacy of these augments in this setting. Reports, though, have advocated their use for facilitating early rehabilitation [15] A larger series would be needed to fully understand their utility in the setting of tumor resection.

Both patients have loss of calf mass that could have been addressed by flap use. Neither had complaints regarding cosmesis. Both were able to wear a regular shoe. Although both patients returned to preoperative employment and excellent function, neither regained full strength. Both patients had superficial wound complications but were able to be treated without additional soft tissue coverage and in Patient 1 this resulted in only a minimal delay to commencement of adjuvant radiotherapy.

FHL tendon transfer provides a safe, effective Achilles reconstructive option following tumor excision. The technique employs operative principles developed for management chronic tendon tears but is applicable to scenarios in which there is no residual tendon due to tumor resection.

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