Hamstring Autograft Reconstruction of the Anterior Tibial Tendon

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Abstract: Injuries to the tibialis anterior tendon (TAT) are rarely reported in the literature, and, in existing reports, there are varied treatment options. Many authors recommend operative treatment over conservative treatment in young, healthy, and active patients, in order to give the patient as much strength back as possible and to allow them to avoid the use of a brace. Different types of operative repair have been described, including: extensor digitorum longus transfer, extensor hallucis longus transfer, plantaris transfer, Achilles autograft, as well as gracilis and semitendinosus autografts and allografts. We advocate using a hamstring autograft, either gracilis in isolation, semitendinosus in isolation, or a combination of the 2, depending on the size of the patient's tendons, to operatively reconstruct ruptured TATs.

Level of Evidence: Diagnostic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Key Words: tibialis anterior rupture, tibialis anterior reconstruction, hamstring autograft, semitendinosus, gracilis

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HISTORICAL PERSPECTIVE

There are limited reports of ruptures of the tibialis anterior tendon (TAT), the main dorsiflexor of the foot.[1,2] Because of its rarity, diagnosis of a TAT rupture is often delayed as many physicians do not know to look for it.[3] When treating a TAT rupture, both conservative treatment, which is nonoperative with bracing, orthotics, and a change of activities, as well as operative repair are possible options. Conservative treatment is indicated in elderly, inactive patients. Otherwise, operative treatment is recommended by many authors to help the patient regain as much strength as possible and to allow them to avoid having to wear an AFO brace.[2,4–6] Operative reconstruction of the TAT has been reported using a wide variety of methods, including: primary tendon repair, a tendon turndown, sliding TAT lengthening, and tendon transfers, using either autografts or allografts.[1,3,7] Direct tendon repair is possible if there is enough healthy tendon to reconstruct the TAT without adding any extra tension.[3] However, in many cases of TAT rupture, there is a significant gap which requires reconstructing with a tendon graft as opposed to primary repair.

Reconstructing ruptured TAT's with large gaps has historically been done using a number of different tendons, including: extensor hallucis longus (EHL) transfer, peroneus brevis transfer, extensor digitorum longus (EDL) transfer, plantaris transfer, TAT allograft, Achilles autograft, gracilis autograft, semitendinosus autograft, gracilis allograft, and semitendinosus allograft.[1,2,4,5,7–10] In the literature, EHL, EDL, and peroneus brevis transfers are the most commonly used options for operative repair; however, these all involve large procedures with high levels of associated foot morbidity.[4] More recently, multiple authors have advocated the use of hamstring grafts, to minimize the increased foot morbidity associated with local tendon transfers.[1,2,4] Furthermore, hamstring grafts have been commonly used in anterior cruciate ligament (ACL) repairs and the hamstring tendons have shown to be easily harvested with little long-term morbidity.[11] Michels et al[2] report success using a semitendinosus autograft in 12 consecutive patients with TAT ruptures. Although their data is promising, they lack objective strength testing data. Their reported outcomes primarily consist of confirming that all patients were satisfied with the procedure and that their AOFAS Ankle Hindfoot scores improved significantly postoperatively.[2] Other authors advocate using hamstring allografts.[1,2,4,8–10] Though functional outcomes and patient satisfaction after using allografts seems to be positive, using allografts has potential disadvantages, including the cost and risk of immune rejection to the donor graft.[2] Furthermore, in our experience, many of these patients are diabetic, which increase the risks associated with allografts.

There are few reports of series of TAT ruptures which makes it hard to assess the different techniques and compare older ones with more recently reported techniques. Most reported series use different types of functional outcome testing, and a few also use objective strength testing. Kopp and colleagues reporting their own strength testing measures as well as previously published results, showing ankle dorsiflexion strength of the operative side as compared to the nonoperative side has been reported as being 81% and 40% as strong, using the Cybex system at 60 and 120 degrees per second (1 patient, direct repair), respectively, and 83% and 84% as strong as the operative side at 60 and 120 degrees per second, respectively, in a measurement of peak torque using the LIDO Multi-Joint II system (9 patients overall; primary tendon repair in 5, EHL transfer in 3, and EDL transfer in 2).[7] Stavrou and colleagues used a gracilis autograft for 2 patients and performed strength testing at 2 years postoperatively using a Cybex system. Speed of testing was not reported, but the 2 patients showed the operative side had dorsiflexion strength 83% and 78% of the nonoperative side.[10]

M.C.D. has performed a TAT reconstruction using a hamstring autograft on over 15 patients since 2012. It is our belief that use of either a gracilis autograft, semitendinosus autograft, or both, offers patients the best recovery and least foot morbidity following TAT ruptures.

INDICATIONS AND CONTRAINDICATIONS

If the patient presenting with a TAT rupture is elderly and inactive, conservative treatment can be considered. Otherwise, operative reconstruction is recommended to help the patient regain as much strength as possible. We recommended using a

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All patients were enrolled in our tibialis anterior strength testing study as well as our department's Foot and Ankle Registry. Both our study and registry are approved by our institution's IRB and all patients were consented following our IRB's consenting protocol.

M.C.D.: is a paid consultant for Extremity Medical and Fast Form, neither of whose products are involved in the current paper. S.C.K. declares no conflict of interest.

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hamstring autograft to reconstruct the TAT. Depending on the girth of the patient's TAT and their hamstring tendons, either gracilis in isolation, semitendinosus in isolation, or both should be used. In our experience, the gracilis is usually between 3.5 mm and 4.5 mm in diameter and between 22 cm and 28 cm in length. The semitendinosus is usually between 4 mm and 5 mm in diameter and between 23 cm and 30 cm in length. The TAT is usually 5 to 6.5 mm, and so if either tendon is used in isolation, we recommended doubling it over to recreate the natural girth of the TAT.

PREOPERATIVE PLANNING

Patients are evaluated in the office. Care is taken to observe the area of the TAT, noting any swelling and pain in the area. Range of motion of the area is also assessed, with attention paid to the patient's ability to dorsiflex. When the patient is dorsiflexing, it is noted whether or not the EHL and EDL are being recruited to help. If they are, this can indicate an injury to the TAT. Gait analysis should also be conducted. Patients with a ruptured TAT usually have a steppage gait, which is when they walk with excessive hip extension to avoid tripping over a drop foot. Weight bearing anteroposterior, lateral, and oblique radiographs are obtained and assessed for overall alignment as well as any fractures in the area. In addition, an MRI of the injured ankle is obtained in order to help the surgeon conclusively decide if the TAT is ruptured and, if so, the exact location of the rupture.

All of our patients have had chronic ruptures of the TAT. Furthermore, we have not seen a large amount of degeneration or atrophy in the TAT muscle belly and thus have not found it necessary to consider augmenting the muscle belly with other muscles or by using the EHL. If a large amount of atrophy is present, muscle augmentation during the operation should be considered.

TECHNIQUE

The patient is placed in a supine position on the operating room table. A tourniquet is placed on the operative thigh and inflated to 250 mm Hg.

Hamstring Autograft Harvest and Preparation

First, a 3 cm incision is made with a medial approach to the tibia at the midway point between the posteromedial border of the tibia and the top of the tibial tubercle. Next, the sartorial fascia is divided in line with its fibers, in order to expose the gracilis and semitendinosus. They will be in-between the superficial MCL and sartorial fascia. On the basis of the size of the patient's hamstring tendons, the choice is made whether to use just gracilis, just semitendinosus, or both. The adhesions holding the tendons to the medial head of the gastroc are then removed using Metzenbaum scissors. Using a Linveteck tendon stripper (ConMed, Utica, NY), the tendons are harvested. The tendon(s) being used are then brought to a side table where the flat edge of a ruler is used to remove the muscle remnants from the tendon(s). They are then attached to a Graft Master III (Smith & Nephew, Andover, MA) and prepared to be used for a graft through tubularization with a 0-vicryl suture with a modified Krakow stitch (Fig. 1). Before putting the graft into the site of the TAT rupture, the final length and diameter are measured.

TAT Reconstruction Using Hamstring Autograft

First, the area of the TAT rupture is located and a 2 to 3 cm incision is made. The TAT stump is resected down to the normal looking tendon (Fig. 2). A 2 cm incision is then made

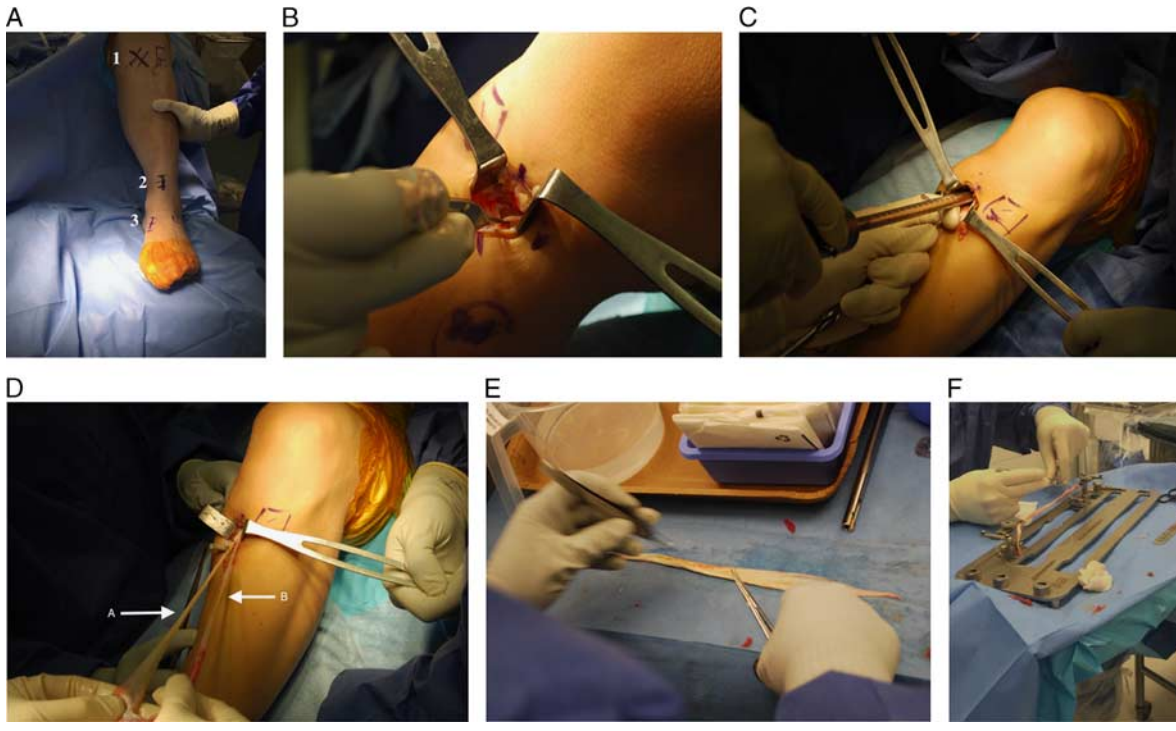

FIGURE 1. A, The 3 incision sites are marked on the patient. The hamstrings (1). The proximal TAT stump (2). The TAT insertion at the medial cuneiform (3). B, The hamstring tendons are identified between the sartorial fascia and MCL. C, The Linvateck tendon stripper is used to harvest the gracilis and/or semitendinosus. D, The gracilis (B) and semitendinosus (A) are harvested. E, Muscle remnants are removed from the harvested tendon(s) using a ruler. F, The tendons are attached to the Graft Master and tubularized.

FIGURE 2. A, An incision is made to identify the TAT stump. B, The tendon stump is resected back to normal appearing tendon. C, The tendon is mobilized.

over the medical cuneiform and the TAT attachment is located. A bone tunnel is drilled obliquely in the medial cuneiform in the same vector as the native TAT (Fig. 3). The diameter of the bone tunnel should be within 0.5 mm of the hamstring graft. The hamstring graft is then inserted into the tunnel and a Bio-Tenodesis screw is then used to secure the distal end of the hamstring graft to the medial cuneiform within the tunnel (Fig. 4). This is a blind tunnel made with the use of a nitonol wire. The graft is then passed subcutaneously and proximally to the tendon stump. At this point, an extensor retinaculum release is performed in order to prevent stenosis of the tendon's path and also to help relieve tension in the area. With the foot in neutral or up to 5 degrees of dorsiflexion and 5 degrees of inversion, a pulvertaft type maneuver is then used to bring the graft through the tendon stump. The tendon is secured in place using #2 orthocord sutures, and then the graft is tunneled distally back to the insertion site. The other limb of the suture from the Bio-Tenodesis screw is used to secure the tendon in place (Fig. 5). The graft is then tubularized using a 3-0 vicryl suture.

FIGURE 3. A, A bone tunnel is drilled. B, The guide wire is shown in place. C, Intraoperative fluoroscopy is used to confirm the orientation of the wire in the cuneiform. D, The tunnel is shown.

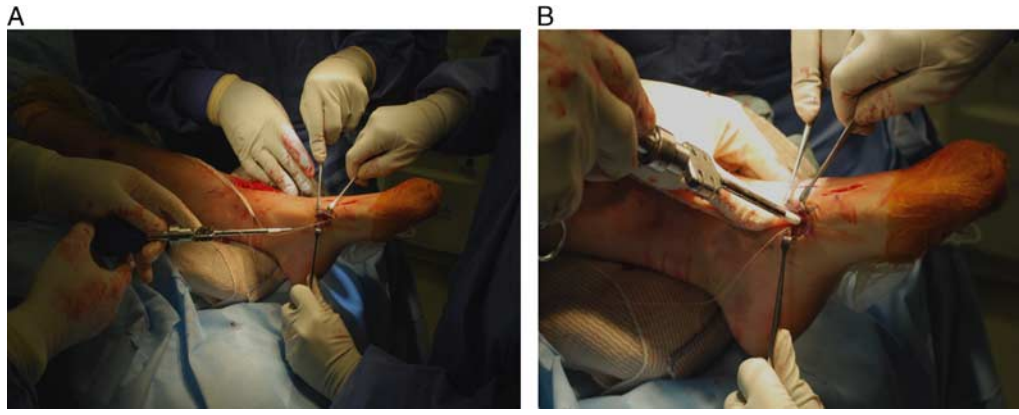

FIGURE 4. A, The hamstring graft is brought into the bone tunnel. B, The hamstring graft is secured in the bone tunnel.

Closing

The wound is irrigated with sterile saline solution and the subcutaneous tissues are then repaired with 3-0 vicryl sutures. The skin is closed with 3-0 proline. The patient is placed in a non-weight bearing splint for 2 weeks.

RESULTS

The senior author (M.C.D.) has been using hamstring autografts to reconstruct TAT since 2012. The results have been positive so far, with limited complications and no return to the OR. In a study currently in progress by the senior author (M.C.D.), 9 patients were brought in for postoperative isokinetic strength testing, using a dynamometer at least 6 months postoperatively. These patients showed only small deficits in strength and endurance in inversion. They showed greater deficits in strength and endurance in dorsiflexion but, of note, on average, patients showed 85% strength on the operative side as compared to the nonoperative side in measures of peak torque in dorsiflexion.[12] This number is similar to those previously reported for TAT repairs with other surgical techniques, showing that using a hamstring autograft offers similar levels of functional recovery as previous reports of TAT reconstructions. In addition, 7 of these patients were assessed for satisfaction. 6 responded that they were very satisfied and 1 responded that they were satisfied with the results of the operation. All 7 would recommended the surgery to somebody else.[12] Patients were also given preoperative and postoperative Foot and Ankle Outcome Score Questionnaires, and improvements were noted in all five measures (pain, symptoms, daily activities, sports activities, and quality of life).[12]

COMPLICATIONS

Complications include risk of rerupture of the TAT as well as postoperative wound infection. In addition, loss or effected function of the site of harvest is a possible complication with

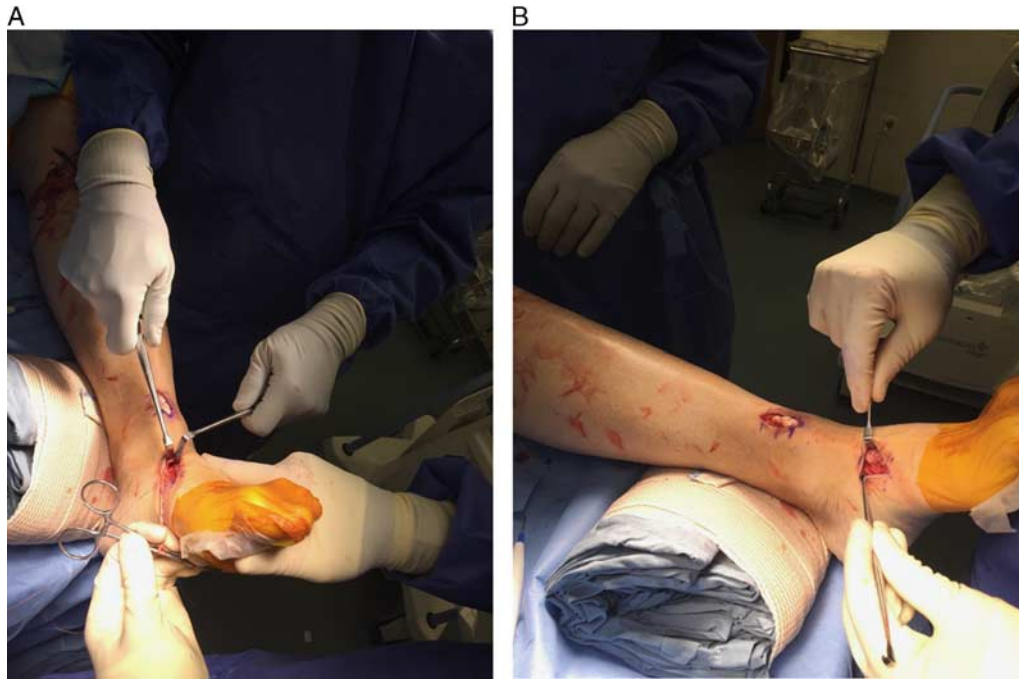

FIGURE 5. A, The hamstring graft is brought back down to create a double bundle effect. B, The hamstring graft is tied to sutures in the Bio-Tenodesis screw and native tendon stump.

any procedure using an autograft. In a separate ongoing study being conducted by M.C.D., donor site morbidity when hamstring tendons are used for foot and ankle applications is being investigated. Preliminary results show little donor site morbidity. Significant strength differences have only been found in peak knee flexion torque at high degrees of flexion (70 and 90 degrees) on the operated side as compared to the nonoperated side. Furthermore, 89% (32/36) of the patients enrolled in the study reported no pain at the donor site. The remaining 11% (4/36) reported only mild to moderate symptoms.[13] We believe that harvesting hamstring tendon(s) instead of other foot tendons helps to minimize this risk as the hamstrings have been shown to be safe, suitable tendons to harvest with little to no associated loss of strength and complications.

POSTOPERATIVE MANAGEMENT

After the procedure, patients are placed in a non-weight bearing splint for 2 weeks. After 2 weeks, they should be transitioned into either a Controlled Ankle Movement (CAM) walker boot or cast, depending on their skin quality, whether or not they are diabetic, and the degree of compliance of the patient, with compliant patients being transitioned into a boot at 2 weeks. At this point, they can begin slight range of motion activities, focusing primarily on active dorsiflexion without resistance. They should begin partial weight bearing in a CAM walker boot at 6 weeks postoperatively and also begin physical therapy at this point. Their physical therapist will guide their weight-bearing as they progress. Patients can transition into a sneaker at 3 months postoperatively.

POSSIBLE CONCERNS, FUTURE OF THE TECHNIQUE

We believe that using hamstring autograft to reconstruct a ruptured TAT offers an operative technique that can restore as much strength as possible without sacrificing additional foot morbidity that is associated with transfer of a local foot tendon or the chance of an immune response or tendon rejection that is associated with the use of an allograft. There are still relatively few cases of reconstructing a TAT with hamstring autografts and it is important that patient outcomes continue to be followed and assessed, both with functional survey outcomes as well as with objective isokinetic strength testing.

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