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Allograft reconstruction for symptomatic chronic complete proximal hamstring tendon avulsion

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Abstract Complete proximal hamstring tendon avulsion is an uncommon injury that can cause significant disability in young, athletic individuals. Surgical reattachment is recommended and can be performed on a delayed basis if the tissue is sufficiently mobile. We report 2-year follow up for two cases where interpositional allograft tissue was used for reconstruction because the tendon was too retracted for primary repair. Two 30-year-old patients with complete proximal hamstring avulsion at least 2 years earlier reported severe hamstring weakness and restrictions with respect to sport and recreational activities. Proximal hamstring tendon reconstruction with Achilles tendon allograft was performed for both patients. They were immobilized for 8 weeks with the hip in extension and the knee in flexion using a custom orthosis, followed by physical therapy and weight bearing as tolerated. The patients were followed for over 2 years after the surgery and were evaluated with physical examination, isokinetic strength testing and detailed questions about their function. Following the procedure, both patients returned to a more active lifestyle that was greatly improved with respect to participation in sport and function. This procedure should be considered as a salvage operation as the patients did not return to completely normal function and demonstrated hamstring weakness on the operated side.

Keywords Thaumatin-like protein · Crystal structure · Antifungal protein · β-Glucanase activity

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Introduction

Complete proximal hamstring tendon avulsion is an uncommon injury. It generally occurs with sudden resisted hip flexion with the knee extended [1–3]. In young active patients, these injuries can cause significant disability [4, 5]. Therefore, if these injuries are recognized in such individuals, surgical reattachment is recommended. The surgery can be performed on a delayed basis if the tissue is sufficiently mobile to reach the ischial tuberosity. However, in cases where the injury is chronic and the tissue is severely retracted, repair has generally not been indicated.

Previous reports have described augmentation of the repair with autogenous or synthetic tissue [6, 7], and there has been only one description of surgery using a graft to bridge a large defect [8]. In this paper, the authors described five patients who had various procedures for chronic injuries and only one of the five patients was evaluated with strength testing at greater than 1-year after surgery.

We report a technique for reconstructing such injuries with achilles tendon allograft interposition in the setting of inadequate and retracted tissue where primary repair was impossible. The procedure was performed for young, active patients who were disabled by early fatigue and weakness and inability to run or participate in sport related to a chronic proximal hamstring avulsion.

Methods

Proximal hamstring tendon reconstruction with Achilles tendon allograft was performed for two patients who were disabled secondary to a remote injury. Both patients had severe hamstring weakness with obvious distal migration of the entire hamstring muscle belly on physical examination (each case described in more detail below). Both were severely restricted with respect to sport and recreational activities. Both patients were followed for over 2 years after the surgery (see details below).

Surgical technique

After epidural anesthesia, a Foley catheter was inserted and the patient was positioned prone. A long posterior midline incision was fashioned, extending from the ischial tuberosity distally down the middle of the posterior thigh. The posterior femoral cutaneous nerve (Fig. 1) was identified by a fellowship-trained hand surgeon who also performed the sciatic nerve dissection. In both cases, the sciatic nerve was extensively scarred and the dissection of the sciatic nerve was difficult and tedious. A nerve stimulator was used and careful dissection under loupe magnification was necessary to preserve the multiple branches of the sciatic nerve to the retracted hamstring muscles.

The common hamstring tendon was identified, and the muscle (including semimembranosis, semitendinosis and biceps femoris) was mobilized distally as much as possible to achieve maximum length. The allograft was then attached to the hamstring tendon stump with non-absorbable Krakow sutures (see Fig. 2). The additional length of tendon (approximately 10 cm) required to reach the ischial tuberosity was measured with the knee flexed to 90°, which was also the position of final immobilization. With less knee flexion, an even longer graft would have been required which may have

Fig. 1 Identification of the posterior femoral cutaneous nerve

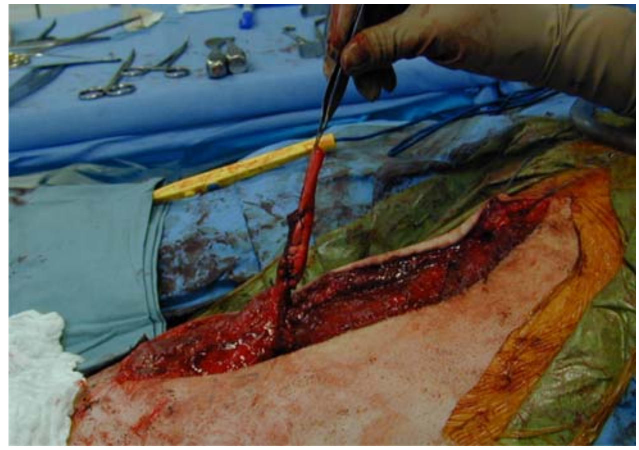

Fig. 2 Achilles tendon allograft attached to hamstring with non-absorbable sutures

resulted in persistent weakness due to over lengthening of the musculotendinous unit. Two suture anchors were placed in the ischial tuberosity, and a suture (No. 2 Ethibond) from each anchor was placed through the proximal end of the allograft tendon with Krakow sutures. The graft was then secured to the ischial tuberosity, bridging the gap. The patient was immobilized for 8 weeks with the hip in extension and the knee in flexion using a custom orthosis that was fabricated pre-operatively (see Fig. 3). Post-operative X-rays were obtained at 2 weeks when the skin staples were removed. After 8 weeks of immobilization, the brace was discontinued and the patient started on physical therapy and allowed weight bearing as tolerated. Therapy consisted initially of active knee extension with passive flexion and hamstring strengthening was started at 12 weeks after surgery. Full return of knee motion occurred by 4 months after surgery and was not difficult because the joint was not directly traumatized by the surgery. Normal gait without crutches was at approximately 16 weeks after surgery. The recovery was lengthy and the patients continued to note improvement with running and sport for 2 years after the surgery.

Patients were followed up at greater than 2 years after the procedure. They were evaluated with physical examination and isokinetic strength testing as well as detailed questions about their functional ability. We elected to describe their function qualitatively for each case due to the fact that there were only two patients and no patient-oriented outcome measures exist for this type of injury or specific anatomic region.

Results

Case 1

A 30-year-old male attorney was injured when he was attacked from behind while breaking up a fight. He fell and

Fig. 3 Patient immobilized in hip–knee–ankle orthosis with the knee in flexion. Note that the knee extends slightly beyond 90° of flexion with the patient upright

ruptured his proximal hamstring. He underwent proximal hamstring repair at another institution 8 months following the original injury. This procedure was unsuccessful.

Prior to the injury, the patient was a well-trained endurance athlete, ran many miles at a time and participated in competitive soccer. Four years after the initial surgery, the patient did not have trouble walking, but had difficulty participating in sports such as soccer and volleyball. He could run a maximum of 1–1.5 miles at a 5–7 miles/h pace. Physical examination revealed a clear detachment of the proximal hamstring tendon from the ischial tuberosity with distal migration of the muscle belly.

The patient underwent right proximal hamstring reconstruction with Achilles tendon allograft. Three and a half years after surgery, he reported a return to athletic activities. Hamstring flexibility was assessed using the Hamstring 90°/90° test [6]. During this test, the patient is positioned supine with the hip in 90° of flexion. The knee is then brought passively into extension until firm resistance to movement is felt. With the hip flexed to 90° and passive knee extension, the patient had full knee extension on the involved side compared to 15° of knee flexion on the uninvolved side. He is jogging up to 3 miles and plays in a men's soccer league, which he was unable to do prior to surgery. He did not feel he had a strength deficit, but reported that his endurance and lateral movements were limited. However, he stated that his movements were much improved compared to his condition prior to surgery.

Case 2

A 30-year-old female office worker injured her left hamstring while playing softball. She was playing first base and reached forward with her left foot to stretch out for a catch. She felt and heard an audible pop in her left hamstring and fell down. The patient was carried off the field, and a MRI confirmed the diagnosis of a left proximal hamstring disruption. She did not have surgery initially. Prior to the injury she was very active in softball and hiking.

Two years after the injury, the patient was unable to run, sprint, or play sports such as softball which she did prior to the injury. She reported that her hamstring was very weak and painful. The patient was able to walk on flat ground and climb stairs, but was only able to jog a maximum of one block before her hamstring became too fatigued to continue.

The patient underwent left proximal hamstring reconstruction with Achilles tendon allograft. Twenty-six months after surgery, the patient reported that she was able to return to all activities except for jogging. Hamstring flexibility with the 90°/90° test indicated 20° of knee extension on the involved side compared to 30° of knee extension on the uninvolved side. The patient ruptured her contralateral Achilles tendon playing softball 19 months after surgery. Before the Achilles tendon rupture, the patient had returned to softball and was able to hike at a level she was unable to do prior to surgery.

Isokinetic strength testing

Prior to isokinetic testing, both patients warmed up on a stationary bicycle for 10 min and then performed gentle static stretching of the hamstring muscle group. Hamstrings and quadriceps muscle function were tested on the Biodex System 4 (Biodex Corporation, Shirley, NY) calibrated isokinetic dynamometer at velocities of 60° and 240°/s. Testing ROM was preset to between 0° and 100° of knee flexion. Both patients performed three submaximal and one maximal warm-up repetition for each test speed prior to test data collection. Warm-up repetitions were immediately followed by five maximal consecutive concentric contractions at 60°/s and 15 repetitions at 240°/s. All tests were performed by one examiner. Measures of peak torque, total work and agonist to antagonist ratios (%) were stored and analyzed with Biodex System 4 software. The data is summarized in the two tables below indicating that the

Table 1 Peak torque and total work values (ft pds and kg m) for knee flexion and extension at 60°/s

	Knee flexion (hamstrings) 60°/s			Knee extension (quadriceps) 60°/s		
	Noninvolved	Involved	Deficit	Noninvolved	Involved	Deficit
Case 1						
Peak torque	85.6 ft pds	61.2 ft pds	28.5 ft pds	144.1 ft pds	126.7 ft pds	12.0 ft pds
	11.84 kg m	8.46 kg m	3.94 kg m	19.92 kg m	17.52 kg m	1.66 kg m
Total work	433.1 ft pds	322.5 ft pds	25.5 ft pds	656.9 ft pds	613.1 ft pds	6.7 ft pds
	59.90 kg m	44.6 kg m	3.53 kg m	90.85 kg m	84.79 kg m	0.93 kg m
Case 2						
Peak torque	59.1 ft pds	37.5 ft pds	36.5 ft pds	94.6 ft pds	104.6 ft pds	−10.6 ft pds
	8.17 kg m	5.19 kg m	5.05 kg m	13.08 kg m	14.47 kg m	−1.47 kg m
Total work	223.8 ft pds	184.9 ft pds	17.4 ft pds	330.1 ft pds	393.5 ft pds	−19.2 ft pds
	30.95 kg m	25.57 kg m	2.4 kg m	45.65 kg m	54.42 kg m	−2.66 kg m

Table 2 Peak torque and total work values (ft pds and kg m) for knee flexion and extension at 240°/s

	Knee flexion (hamstrings) 240°/s			Knee extension (quadriceps) 240°/s		
	Noninvolved	Involved	Deficit	Noninvolved	Involved	Deficit
Case 1						
Peak torque	64.8 ft pds	54.9 ft pds	15.3 ft pds	69.0 ft pds	78.5 ft pds	−13.8 ft pds
	8.96 kg m	7.59 kg m	2.12 kg m	9.54 kg m	10.86 kg m	−1.91 kg m
Total work	833.3 ft pds	653.4 ft pds	21.6 ft pds	939.9 ft pds	1175.3 ft pds	−25.0 ft pds
	115.25 kg m	90.37 kg m	2.99 kg m	129.99 kg m	162.52 kg m	−3.46 kg m
Case 2						
Peak torque	33.4 ft pds	35.1 ft pds	−5.3 ft pds	58.4 ft pds	66.9 ft pds	−14.6 ft pds
	4.62 kg m	4.85 kg m	−0.73 kg m	8.08 kg m	9.25 kg m	−2.02 kg m
Total work	391.1 ft pds	385.0 ft pds	1.5 ft pds	653.2 ft pds	804.9 ft pds	−23.2 ft pds
	54.09 kg m	53.25 kg m	0.21 kg m	90.34 kg m	111.32 kg m	−3.21 kg m

hamstrings remained weaker than the contralateral side (Tables 1, 2). Isokinetic testing was not performed prior to surgery.

Discussion

Chronic complete proximal hamstring avulsion can lead to significant limitation of function in young, athletic individuals. Non-surgical treatment for cases where the tendon is too retracted for primary repair has been reported previously in the literature, but these individuals complain of important limitations in activity that affect their quality of life [7]. In our technique allograft tissue was used to bridge the defect in cases where the patients' own hamstring tissue could not reach the ischial tuberosity, even with extensive mobilization of the tissue and the knee flexed at the time of surgery.

Following the procedure, both of our patients returned to their active lifestyle including sports participation. On examination, both patients had an increased side to side hamstring length difference demonstrating relative lengthening on the involved side. Isokinetic testing demonstrated hamstring weakness on the operated side [9]. Quadriceps peak torque and total work was significantly higher at higher isokinetic test speeds (240°/s). This may be related to the relative weakness of the hamstrings, which does not allow this muscle group to effectively act as a braking force and counteract the quadriceps force especially at higher speeds, and subsequently leads to greater quadriceps peak torque and total work value in this situation [10, 11].

Both patients derived significant improvement in function, but were not returned to normal function, and therefore, this procedure should be viewed as a salvage operation. Despite this, young active patients who are very limited in terms of athletic activities following a remote complete proximal hamstring avulsion that is too retracted for delayed primary repair may be considered for this procedure. Patients must understand the lengthy rehabilitation involved as well as the fact that the goal of the operation is improvement and not complete recovery.

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