Article

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Strength and Functional Outcomes Following Achilles Tendon Reconstruction With Hamstring Tendon Autograft Augmentation

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Abstract

Background: The proposed advantages of hamstring autograft reconstruction when compared to alternative procedures, such as flexor hallucis longus (FHL) transfer, V-Y lengthening, and allograft reconstruction, are improved healing and reproduction of normal tendon biomechanics and reduced morbidity within the foot and ankle. In this study, we examined the effect of Achilles tendon reconstruction using hamstring autografts on strength and functional outcomes.

Methods: Patients who underwent Achilles repair with a hamstring autograft for insertional or midsubstance tendinopathy, delayed diagnosis of rupture, or infection after primary repair were evaluated for inclusion. Forty-six patients were identified; 12 further augmented with an FHL transfer are included in the analysis. Isokinetic testing was completed with a Biodex dynamometer under supervision of a physical therapist masked to surgical side. Pre- and postoperative Foot and Ankle Outcome Scores (FAOS, before March 2016) or Patient-Reported Outcomes Measurement Information System (PROMIS, after March 2016) surveys were collected.

Results: For knee flexion, peak torque was not significantly different when comparing operative and nonoperative sides at 180 degrees/second (45.38 Nm vs 45.96 Nm; $P = .69$) nor at 300 degrees/second (44.2 Nm vs 47.02 Nm; $P = .069$). Knee extension absolute peak torque was only found to be significantly weaker on the operative side at the faster testing (75.5 Nm vs 79.56 Nm; $P < .05$). Peak ankle plantarflexion torque was significantly weaker on the operative side at both the slower speed (60 degrees/second: 39.9 Nm vs 48.76 Nm; $P < .005$) and the faster speed (120 degrees/second: 31.3 Nm vs 40.7 Nm; $P < .001$). Average power for ankle plantarflexion did not differ significantly from the operative side to the nonoperative side in the slower test (26.46 W vs 27.48 W; $P = .60$) but did significantly differ on the faster test (32.13 W vs 37.63 W; $P = .041$). At an average of 19.9 months postoperation, all physical function and pain-related patient-reported outcome scores showed clinically and statistically significant improvement.

Conclusion: Achilles reconstruction with a hamstring autograft ± FHL transfer allowed patients with severe Achilles pathology to return to good subjective function, with modest deficits in calf strength compared with the uninjured side. Overall knee flexion strength did not appear impaired. These results suggest that hamstring autograft reconstruction is a viable method to treat these complex cases involving a lack of healthy tissue, allowing patients to return to symptom-free physical function and athletic activity.

Level of Evidence: Level IV, case series.

Keywords: Achilles tendon reconstruction, hamstring autograft, Achilles rupture, sports, foot and ankle

Introduction

Extensive Achilles tendon pathology may leave a gap in the healthy tissue, making direct repair impossible. Such pathology may develop by various mechanisms, including misdiagnosed or conservatively managed acute rupture, chronic tendinopathy, and infection. These cases are especially challenging for clinicians and patients because of the high mechanical demands placed on the Achilles tendon during normal activities and the relatively poor vascularity of the surrounding area.[13,26] In such cases, the current literature is unclear on what optimal treatment should be, and attempts to create a treatment algorithm based on the size of the deficit have not been validated.[15] When direct repair is not possible, surgeons have turned to V-Y lengthening,[8] turndown flaps,[1,17] flexor hallucis longus (FHL) or other tendon transfer,[9,24] or the introduction of a graft to bridge the gap in healthy tissue. Graft types documented in the literature include hamstring autografts,[6] allografts,[4] and synthetics.[11,18]

We primarily rely on hamstring autograft reconstruction to treat cases lacking a significant amount of healthy tendon. We prefer this method because it restores continuous, native collagen to the Achilles tendon and avoids some of the downfalls of other operative techniques. For example, V-Y lengthening has been associated with a significant and lasting deficit in ankle plantarflexion strength compared to the nonoperative side.[8,9,22,24] Additionally, the larger incisions of around 10-15 cm or more that are required for these methods increase the risk of postoperative infection and wound breakdown, as this is an area of poor vascularity.[21] FHL transfer may lead to a loss of push-off strength at the big toe, which may affect return to activity or sport.[9,20,24] Finally, although FHL transfers can be performed endoscopically, V-Y and turndown flap procedures are performed with a large incision.[1,8,10] This is a particular risk in the Achilles tendon region, where skin healing can be complicated by limited vasculature.[26] Reconstruction with a graft can be performed through a much smaller incision and may offer patients better ultimate function and strength.[5,6,16,21] Although data directly comparing autograft and allograft are lacking, we opt for autograft to avoid potential issues associated with allograft, including cost, rejection, and poor biomechanics due to denaturing of collagen from sterilization procedures.[2] Despite the benefits of autograft reconstruction, drawbacks such as the potential for pain or loss of function at the knee do exist. Although past results have indicated that any loss of knee flexion strength following hamstring harvest is minor,[3] this risk warrants consideration.

Achilles tendon reconstruction with a hamstring autograft is a relatively novel procedure, and objective outcomes are lacking in the literature. The goals of the present study are to determine hamstring and calf strength following this procedure and collect patient-reported outcome data. To our knowledge, this study represents the largest cohort in the literature that underwent Achilles tendon reconstruction with hamstring autograft and completed isokinetic strength testing to evaluate ankle and knee strength postoperatively. We hypothesized that patients would not experience a significant deficit in knee flexion strength, as measured by peak torque and average power during isokinetic testing and would recover clinically significant ankle plantarflexion strength by 1 year postoperation.

Methods

Approval was obtained from the Institutional Review Board at our institution. Patients who underwent Achilles tendon reconstruction with hamstring autograft by a single surgeon between 2015 and 2020 were retrospectively identified and screened. Patients younger than 18 years or with a history of contralateral lower extremity pathology that might affect strength testing results were excluded. All eligible patients were asked to return for isokinetic strength testing at a minimum of 6 months after surgery.

Retrospective chart review was performed for all patients who completed testing. Patient demographic information, including age and gender, was collected. Diagnosis and concomitant procedures were noted. Postoperative complications, including infection, delayed wound healing, persistent pain at the ankle or at the harvest site, and need for revision, were evaluated. Type, length, and diameter of hamstring graft were recorded. Patient-Reported Outcomes Measurement Information System (PROMIS) scores were also collected at a minimum of 1-year follow-up.

Strength Testing

Isokinetic strength testing was completed at a minimum of 6 months postoperatively with a Biodex dynamometer under supervision of a physical therapist masked to surgical side. Patient instructions throughout the duration of the test were standardized, and testing was performed on both the operative and nonoperative sides. The first side tested was randomly assigned during setup of the Biodex machine in order to minimize the influence of a potential learning effect on the results. Patients were asked to perform the testing by pushing and pulling as hard and as fast as possible against the resistance given by the machine for the entire duration of the test.

Patients first performed ankle testing to evaluate plantarflexion and dorsiflexion strength. The first test included 5 repetitions at 60 degrees/second followed by a 30-second rest. The second test included 15 repetitions at 120 degrees/second. Plantarflexion and dorsiflexion peak torque and average power were recorded at both speeds.

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After completing the ankle testing, patients performed knee isokinetic testing to evaluate flexion and extension strength. The first test included 5 repetitions at 180 degrees/second followed by a 30-second rest. The second test included 15 repetitions at 300 degrees/second. Extension peak torque and flexion peak torque at 30, 70, and 90 degrees of flexion were measured at both speeds, as was average power. All calculations compared the strength on the operative side to the strength on the nonoperative side.

Patient-Reported Outcomes

Pre- and postoperative Foot and Ankle Outcome Scores (FAOS) or PROMIS scores were prospectively collected both preoperatively and at a minimum of 1 year postoperatively. FAOS domains included Pain, Symptoms, Activities of Daily Living, Sports, and Quality of Life. PROMIS domains included Physical Function, Pain Interference, Pain Intensity, Global Physical Health, Global Mental Health, and Depression. Our institution administered FAOS surveys until a departmental change in March 2016, at which point PROMIS surveys were routinely administered. In a survey administered on the day of testing, all patients were also asked about their level of satisfaction, with 5 options ranging from very satisfied to very dissatisfied. They were additionally asked if they would recommend the surgery to someone else with an equivalent injury, if they had any additional surgeries since the index procedure, and if they experienced pain at the hamstring harvest site.

Surgical Technique

Our Achilles reconstruction technique and its variations for different types of Achilles pathology has been described previously.[12] This description will thus be brief. The hamstring tendons are harvested in the prone position, and we typically harvest both the gracilis and semitendinosus for defects larger than 5 cm. For smaller defects, the gracilis alone is harvested. The tendons are prepared for insertion by removing any remaining muscle tissue and tubularizing them with a running stitch. At 4.5 to 5 cm, we reconstitute the tendon, which is around 2 cm in width, with as many Percutaneous Achilles Repair System (PARS) passes as possible across the defect when using a gracilis and semitendinosus, as opposed to making 4 passes resulting in a quad bundle with gracilis alone.

The Achilles defect is typically approached through a medial midline incision that is 3 to 4 cm in length. Although the incision location will vary slightly depending on the pathology being treated, we avoid a direct midline approach as this area may face healing difficulties because of the potential of a diminished blood supply.[26] Once the Achilles defect has been identified, all diseased tendon is thoroughly debrided.

The distal portion of the graft can be docked in the distal stump of the Achilles using a Pulvertaft weave if 2 to 3 cm of healthy tendon remains. If the distal stump is inadequate, we dock the graft in the posterosuperior aspect of the calcaneus using a tenodesis screw. The graft is then secured to the proximal native tendon under tension equivalent to the other side at 10 degrees of plantarflexion. Depending on the size of the graft and defect, it can be passed distally and proximally again multiple times. Finally, the medial and lateral limbs of the graft are tubularized with running suture tape.

The autograft construct can be augmented with an FHL transfer in cases of severe tendinopathy or in cases where increasing muscle bulk is particularly desired. This may include cases of significant calf atrophy or patient perception of noticeable weakness. Augmentation with FHL transfers is also indicated for chronic Achilles cases greater than 1 year out with tendon shortening. FHL transfers were concomitant procedures when tendon strength was still inadequate with hamstring graft alone as determined intraoperatively by the senior surgeon, typically for severe retraction, or for chronically retracted tendons over one year. We harvest the tendon through the posterior incision made to access the Achilles defect. It is tubularized and secured distally to either the native tendon stump or the osseous fixation device. The FHL should be tensioned with the foot in 10 to 15 degrees of plantarflexion.

Once the wound has been closed, patients are placed in a splint while resting at approximately 10 degrees of plantarflexion. They remain nonweightbearing for 2 weeks, at which point the sutures and splint are removed. Patients are placed in a controlled ankle motion walking boot with a heel lift and may begin partial weightbearing. Home physical therapy also begins at this point with an initial focus on range of motion exercises. Six weeks postoperatively, a supervised physical therapy program begins, and patients may return to a normal shoe. Therapy is advanced to focus on strength and proprioception. Patients typically may resume light exercise after 3 months and full activity after 6 months. Care is taken to avoid early motion and weightbearing until the wound is adequately healed.

Statistical Analysis

Descriptive analyses were performed to compare torque and average power measurements between the operative leg and the nonoperative leg. The assumption of normality was evaluated using Shapiro-Wilk tests. Differences between legs were tested using the paired *t* test and Wilcoxon signed-rank test, with statistical significance established at alpha = 0.05. For secondary outcomes, the average of postoperative survey scores, and percentage of satisfaction survey responses were calculated. All analysis was conducted using Microsoft Excel and SPSS.

Table 1. Demographic and Surgical Information for the Cohort.

Demographics and presenting pathology	
Average age at surgery	48 (range, 21-70)
Female	20/46
Chronic insertional tendinopathy	21
Chronic midsubstance tendinopathy	8
Acute rupture treated conservatively	15
Infection	2
Surgical procedures	
Calcaneal exostosis	19/21 insertional cases
Tendons transferred	
Gracilis alone	27
Gracilis and semitendinosus	7
Gracilis, semitendinosus, flexor hallucis longus	12

Results

Demographics

Forty-six patients were identified who met eligibility criteria and all 46 patients were included in the analysis. Demographic and surgical information are presented in Table 1. Average age at the time of surgery was 48 (range, 21-70) years. Twenty patients (43.5%) were female. All patients presented preoperatively with a sizeable area of tendinopathy such that direct repair was not possible. Twenty-one cases (51%) involved chronic insertional tendinopathy with a Haglund deformity that resulted in a significant gap in healthy tendon. In 15 cases (29%), the defect was due to an acute rupture that was either misdiagnosed or treated conservatively. There were 8 cases (17%) of chronic midsubstance tendinopathy, involving significant attenuation. The final 2 cases (2%) both involved infection after Achilles repair at an outside institution that required dissection of a significant amount of diseased tendon. Across all cases, the median gap size after the release of adhesions was 2.5 (IQR, 2.15-4.5) cm. No patient was able to walk on their toes or perform a one-legged heel raise on the affected side. Plantarflexion was graded at 4/5 for manual muscle testing in all cases, although formal preoperative testing was not performed.

Concomitant procedures included calcaneal exostectomy in 19 of the chronic insertional cases. The gracilis alone was harvested in 27 cases, both the gracilis and semitendinosus were harvested in 7 cases, and the gracilis, semitendinosus, and FHL were all harvested in 12 patients. Across all gracilis tendons harvested, median graft diameter was 4.5 (IQR, 4.0-5.25) mm and median length was 26.0 (range, 24.5-27.5) cm. Across all semitendinosus tendons harvested, median graft diameter was 4.5 (range, 4.0-5.0) mm and median length was 28.5 (range, 27.25-30.75) cm.

Strength Testing Results

All eligible patients were asked if they could return for strength testing, and 30 patients (65%) ultimately returned to complete the testing. Of these 30, 18 were treated with gracilis transfer alone; 4 with gracilis and semitendinosus; and 8 with gracilis, semitendinosus, and FHL. Strength testing was completed at an average of 23.0 months after surgery (range, 6-60 months). Median outcomes for the entire cohort comparing the peak torque and average power output of the operative and nonoperative sides are displayed in Tables 2 and 3. For knee flexion, peak torque was not significantly different when comparing operative and nonoperative sides at 180 degrees/second (45.38 Nm vs 45.96 Nm; $P = .69$) nor at 300 degrees/second (44.2 Nm vs 47.02 Nm; $P = .069$). Knee extension absolute peak torque was only found to be significantly weaker on the operative side at the faster testing (75.5 Nm vs 79.56 Nm; $P < .05$).

Peak ankle plantarflexion torque on the operative side was significantly weaker at both the slower speed by 18.2% (39.9 Nm vs 48.76 Nm; $P < .005$) and the faster speed by 23.1% (31.3 Nm vs 40.7 Nm; $P < .001$). Average power for ankle plantarflexion did not differ significantly from the operative side to the nonoperative side in the slower test (26.46 W vs 27.48 W; $P = .60$) but did significantly differ on the faster test (32.13 W vs 37.63 W; $P = .041$).

The results of the extension vs flexion and plantarflexion vs dorsiflexion comparisons are displayed in Tables 4 and 5. Relative extension torque between the operative and nonoperative side significantly differed from relative flexion at 30-degree torque on the slower test alone ($P < .01$). Relative plantarflexion peak torque between the operative and nonoperative side differed significantly from relative dorsiflexion peak torque ($P < .01$). The other comparisons of extension vs flexion and plantarflexion vs dorsiflexion did not demonstrate statistically significant differences.

In postoperative follow-up in the office, all patients could walk on their toes for gait.

Patient Reported Outcome Surveys

Ten patients treated before March 2016 completed postoperative FAOS surveys. Four of these patients received gracilis autograft alone; 3 gracilis and semitendinosus; and 4 gracilis, semitendinosus, and FHL. All 10 of these patients completed surveys at an average of 21.8 (range, 11-34) months after surgery. Significant pre- to postoperative improvement was detected for FAOS Pain ($P = .025$), Activities of Daily Living ($P = .016$), Sports ($P = .034$), and Quality of Life ($P < .01$). Thirty-five of the remaining 36 patients (97.2%) completed postoperative PROMIS surveys at an average of 19.4 (range, 9-47) months after surgery. Of these 35, 22 received gracilis transfer alone; 5 gracilis and semitendinosus; and 8 gracilis, semitendinosus, and FHL.

Table 2. Strength of Operative Leg vs Nonoperative Leg: Knee Flexion and Extension.

		180 degrees/s			300 degrees/s		
Motion	Output[a]	Operative	Nonoperative	*P* Value	Operative	Nonoperative	*P* Value
Knee flexion	Peak (Nm)	45.38 (37, 58)	45.96 (40, 62)	.69	44.20 (34, 54)	47.02 (38, 60)	.07
	30 degrees (Nm)	36.67 (23, 53)	33.81 (31, 54)	.16	21.84 (13, 32)	22.68 (15, 32)	.67
	70 degrees (Nm)	36.6 (27, 46)	37.76 (31, 51)	.53	25.86 (19, 30)	27.91 (15, 38)	.20
	90 degrees (Nm)	25.49 (18, 30)	29.73 (23, 38)	.07	16.77 (8, 22)	19.09 (12, 25)	.15
	Average power (W)	72 (58, 103)	76.9 (58, 122)	.32	70.50 (49, 92)	73.41 (61, 93)	.40
Knee extension	Peak (Nm)	93.63 (79,117)	96.73 (75, 130)	.35	79.56 (67, 93)	75.50 (65, 97)	**.02***
	30 degrees (Nm)	52.82 (39, 66)	58.65 (54, 73)	.06	37.53 (25, 53)	39.60 (25, 51)	.43
	70 degrees (Nm)	88.45 (67, 106)	90.69 (69, 122)	.56	71.19 (55, 92)	74.69 (48, 95)	.16
	90 degrees (Nm)	76.77 (58, 98)	79.13 (69, 97)	.49	60.21 (39, 79)	61.92 (43, 85)	.49
	Average power (W)	169.16 (122, 248)	176.64 (129, 249)	.28	181.08 (142, 243)	185.80 (144, 238)	.37

[a]Median (25th percentile, 75th percentile) values for torque (Nm) and power (W) outputs. *P* Values reflect the results of a comparison between operative and nonoperative outputs.
[*]Boldface indicates statistical significance, $P < .05$, when comparing operative versus nonoperative side.

Table 3. Strength of Operative Leg vs Nonoperative Leg: Ankle Plantarflexion and Dorsiflexion.

		60 degrees/s			120 degrees/s		
Motion	Output[a]	Operative	Nonoperative	*P* Value	Operative	Nonoperative	*P* Value
Ankle plantarflexion	Peak (Nm)	39.94 (27, 48)	48.76 (41, 63)	**<.01***	31.33 (21, 38)	40.70 (34, 53)	**<.01***
	Average power (W)	27.48 (20, 38)	26.46 (25, 37)	.60	32.13 (22, 47)	37.63 (32, 48)	**.04***
Ankle dorsiflexion	Peak (Nm)	21.48 (19, 26)	22.74 (19, 31)	.06	15.69 (14, 20)	16.54 (15, 21)	.16
	Average power (W)	14.56 (14, 20)	15.01 (13, 22)	.83	13.87 (10, 24)	13.18 (9, 20)	.60

[a]Median (25th percentile, 75th percentile) values for torque (Nm) and power (W) outputs. *P* values reflect the results of a comparison between operative and nonoperative outputs.
[*]Boldface indicates statistical significance, $P < .05$, when comparing operative versus nonoperative side.

Significant pre- to postoperative improvement was detected for every PROMIS domain except for Global Mental Health and for Depression. Patient-reported outcomes are reported in Table 6.

Satisfaction Survey

Twenty of the 30 patients who returned for strength testing completed a satisfaction survey. Eight of these cases involved gracilis autograft alone; 4 gracilis and semitendinosus; and 8 gracilis, semitendinosus, and FHL. Of these patients, 18 (90%) were either satisfied or very satisfied with the results of surgery. One patient (5%) was neither satisfied nor dissatisfied, and 1 (5%) was dissatisfied. Nineteen patients (95%) indicated that they would recommend the surgery to someone else with a comparable injury. No patient had undergone or scheduled a revision procedure at the time of follow-up. Four patients (20%) experienced pain or discomfort at the knee, where the autograft tendons were harvested. Most of these cases resolved

Table 4. Relative Knee and Ankle Strength: Extension vs Flexion.[a]

	180 degrees/s			300 degrees/s		
Output	Flexion	Extension	*P* Value	Flexion	Extension	*P* Value
Peak, %	101.37 (84, 103)	103.06 (91, 97)	.77	94.37 (79, 101)	95.92 (93, 101)	>.99
30 degrees, %	136 (83, 120)	101.4 (77, 100)	<**.01***	126.03 (81, 142)	102.33 (92, 115)	.28
70 degrees, %	97.78 (78, 94)	115.96 (91, 96)	.73	97.33 (76, 112)	102.26 (93, 108)	.44
90 degrees, %	107.62 (53, 91)	107.48 (87, 101)	.34	99.99 (44, 100)	102.78 (86, 104)	.23
Average power, %	111.67 (76, 94)	107.88 (88, 102)	.32	100.53 (80, 116)	102.30 (94, 104)	.83

[a]Median values (25th percentile, 75th percentile) for relative torque and power when measuring the operative side against the nonoperative side. *P* values reflect the results of a comparison between flexion and extension.
*Boldface indicates statistical significance, $P < .05$.

Table 5. Relative Knee and Ankle Strength: Plantarflexion vs Dorsiflexion.[a]

	60 degrees/s			120 degrees/s		
Output	Plantarflexion	Dorsiflexion	*P* Value	Plantarflexion	Dorsiflexion	*P* Value
Peak, %	86.49 (63, 102)	95.46 (86, 100)	.15	80.16 (62, 80)	96.01 (82, 103)	**.03***
Average power, %	134.8 (73, 118)	101.25 (83, 112)	.35	89.39 (62, 106)	100.82 (82, 125)	.12

[a]Median values (25th percentile, 75th percentile) for relative torque and power when measuring the operative side against the nonoperative side. *P* values reflect the results of a comparison between plantarflexion and dorsiflexion.
*Boldface indicates statistical significance, $P < .05$.

Table 6. Pre- and Postoperative FAOS and PROMIS Scores.

	Mean Preoperative	Mean Postoperative	*P* Value
FAOS Pain	47.62	80.55	**.025***
FAOS Symptoms	59.69	75.71	.104
FAOS ADL	59.66	92.65	**.016***
FAOS Sports	31.43	63	**.034***
FAOS QoL	11.90	50.63	<**.01***
PROMIS Physical Function	38.96	54.6	<**.01***
PROMIS Pain Interference	60.52	46.71	<**.01***
PROMIS Pain Intensity	49.04	37.18	<**.01***
PROMIS Global Physical Health	42.95	56.55	<**.01***
PROMIS Global Mental Health	50.16	56.11	.58
PROMIS Depression	49.53	45.98	.95

Abbreviations: FAOS, Foot and Ankle Outcome Score; PROMIS, Patient-Reported Outcomes Measurement Information System.
*Boldface indicates statistical significance, $P < .05$.

over time. This did not hamper patient-reported activity level at the time of follow-up. The remaining 16 patients (80%) reported no symptoms at the site of the hamstring harvest or limitations in activity. Of the 23 patients we received follow-up from, 14 (60.8%) were able to toe walk by 3 months postoperatively, 19 (82.6%) were able to toe walk at 6 months postoperatively, and 21 (91.3%) were able to toe walk by 1 year postoperatively.

Complications

Two patients developed a postoperative infection that was successfully treated with irrigation and debridement and intravenous antibiotics. One patient was indicated for Achilles debridement and repair due to chronic insertional tendinopathy, performed 10 months after the index procedure. One patient experienced deep vein thrombosis 4 weeks postoperation and was treated with Xarelto. There have been no other serious complications to date.

Discussion

Patients did demonstrate a slight deficit in calf strength on the operative side, as represented by a significant decrease in peak torque generated by the operative leg at both testing speeds. At 13.51% on the slow test and 19.84% on the fast test, these median deficits in calf strength were substantial but not unexpected. Notably, despite approximately 80% peak torque on the operative side, all patients could get on their tiptoes for gait. Furthermore, patient-reported outcome scores indicated that individuals did not tend to experience disability or loss of function as a result of this strength deficit; patients largely were satisfied with the result of their surgery and would recommend the surgery to a patient with a comparable injury. Physical function and activity scores were consistently high at the time of follow-up, whereas pain and symptoms were low. Functionally, their conditions were significantly improved as measured by ability to walk on their toes. However, we did not achieve complete restoration of strength, which is a concern particularly for highly active patients and athletes. Although we did not specifically inquire about return to sport, many of our patients, particularly the younger patients, did return to athletic activities at final clinical follow-up.

Achilles tendon reconstruction using a hamstring autograft has been described previously for the management of severe Achilles pathology.[5,6,16,21] Although positive outcomes have previously been demonstrated in the form of survey scores, there is a lack of objective outcomes such as isokinetic strength testing results in the current literature. El Shazly et al do report isokinetic testing outcomes 2 years after reconstruction using their minimally invasive method. Their results show very small deficits in ankle plantarflexion strength relative to the nonoperative leg that were consistently less than 5% and thus considered insignificant. It should be noted that the patients included in their study all experienced acute ruptures that were not repaired in the initial 6 weeks. This was in contrast to our study, which included pathology ranging from infection to misdiagnosed acute ruptures to chronic Achilles tendinopathy that caused large gaps in healthy tissue. El Shazly et al did not assess knee flexion and extension strength postoperatively.

Past studies involving larger cohorts have found minimal impairment in knee flexion strength after hamstring autograft harvest.[3,7,14,23]Any deficits that are detected tend to appear when assessing torque generated at higher degrees of knee flexion.[3] The results shown in the present study are largely in line with past findings, as we did not observe any significant deficits in knee flexion strength in neither slower nor faster test. High ultimate knee function was supported by functional outcomes, as PROMIS Physical Function and FAOS Sports and Daily Activities subscales were all high postoperatively, and only 4 patients reported any pain or discomfort at the knee postoperatively. Functional outcomes following hamstring tendon harvest have likewise been positive in past studies.[5,6,25]

The significant deficit observed on the operative side during the faster test appeared only during extension, where the hamstrings are not engaged. Although this result was statistically significant, the clinical significance is uncertain. During the slower test alone, relative flexion torque as a percentage of the nonoperative leg was significantly greater than relative extension torque as a percentage of the nonoperative leg. However, this difference only occurred at lower angles of knee flexion and extension, where the hamstrings are typically least engaged.[19] This outcome may also be a result of increased postoperative rehabilitation on the operative side compared to the nonoperative side, as well as increased rehabilitation of the hamstrings relative to the quadriceps, or atrophy from leg underuse.

Achilles reconstruction surgery remains challenging. The calf muscle is a major source of propulsion, and in chronic rupture cases, the muscle retracts and assumes a new position on the tension-length curve, which may have deleterious effects. We do not advocate for the V-Y plasty or gastrocnemius recession, which can ultimately exacerbate these biomechanical shortcomings. Although FHL transfer theoretically may decrease big toe push-off strength, in our cohort of 12 FHL transfers all patients maintained the ability to walk on their toes. Our findings suggest that concomitant FHL transfer for patients with inadequate strength with hamstring graft alone may be a good option to gain strength of the reconstruction without significantly compromising functional status with regard to push-off of the big toe. This is in line with past studies that have found loss of great toe push-off strength with FHL transfer to be clinically insignificant.[24]

The decision to harvest both hamstring tendons is made based on the severity of Achilles pathology present, and it may have implications for knee strength. Prior investigation suggests that patients undergoing harvest of both tendons generated less flexion torque at high degrees of flexion compared to patients who had a single tendon harvested.[3] However, no difference was detected in peak torque or torque at angles less than 90 degrees. We declined to analyze these subgroups in the present study because of inadequate sample size, though the question does merit further consideration, in order to make informed decisions about the effect of harvesting both tendons on knee function.

The single-surgeon nature of this study limits its generalizability. This study also faced limitations regarding its small sample size. We reserve Achilles reconstruction with a hamstring graft for cases of severe Achilles pathology that results in a significant gap in healthy tissue. Therefore, the available pool of patients was small, and may have limited our ability to detect small differences between operative and nonoperative sides. Because of the small sample size, we included 12 patients who underwent FHL transfer at the time of hamstring autograft reconstruction, though we believe that functionally these patients did not differ significantly from the group who did not undergo FHL transfer; all patients were able to walk on tiptoes postoperatively. We did find statistically significant findings, such as the deficit in calf strength at higher speeds, although it remains unclear if these findings on Biodex strength testing translate to a clinically significant difference for patients. Furthermore, this study was not comparative in nature, and further studies are needed to compare this technique to other alternatives, such as allograft reconstruction.

A further limitation resulted from our departmental switch from administering FAOS to PROMIS survey, which left the cohort split in terms of available surveys. Postoperative surveys were available for most patients, so we were ultimately able to account for the patient-reported outcomes of nearly all patients.

Conclusion

Achilles reconstruction with a hamstring autograft allowed patients with severe Achilles pathology to return to good function, as evidenced by patient-reported outcomes and statistically significant but modest calf strength deficit in an analysis of short-term outcomes. Furthermore, overall knee flexion strength was not impaired. These results suggest that hamstring autograft reconstruction is a viable method to treat these complex cases involving a lack of healthy tissue, allowing patients to return to symptom-free physical function and athletic activity. Further investigations into long-term outcomes of this procedure and the relative benefits of auto- and allograft for Achilles reconstruction are warranted.

Ethical Approval

Ethical approval was received: IRB# 2016-130.

Declaration of Conflicting Interests

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Supplemental Material

A supplemental video for this article is available online.

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