Chronic Patellar Tendon Rupture

Surgical Reconstruction Technique Using 2 Achilles Tendon Allografts

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ABSTRACT: Delayed reconstruction of chronic patellar tendon ruptures classically has yielded suboptimal results. Quadriceps contracture, distal patella mobilization, quadriceps lengthening (eg, V-Y lengthening), prolonged postoperative immobilization, residual quadriceps weakness, surgical macro failure, and loss of knee flexion are some of the complications associated with treatment for chronic patellar tendon rupture. Reinforcement hardware (eg, cerclage wire) may necessitate subsequent removal and the possibility of breaking with migration through the body. This article details the use and short-term success of a surgical technique using 2 Achilles tendon allografts for reconstruction of a chronic patellar tendon rupture.


INTRODUCTION

Late reconstruction of patellar tendon ruptures usually yields less favorable results than does immediate reconstruction.\textsuperscript{16} This disparity has been attributed to proximal patella migration, poor tissue quality, and quadriceps atrophy. Growing experience with soft-tissue manipulation through the use of autograft and allograft tissue has enabled results for the reconstruction of chronic ruptures to approach those seen with immediate repair.\textsuperscript{4,5,7,10,14}

This article describes a technique for repairing chronic patellar tendon ruptures and demonstrates its dramatic short-term clinical success. This technique avoids the use of reinforcing hardware for a chronic proximally migrated patella following patellar tendon rupture.

CASE REPORT

A 34-year-old man presented with difficulty ascending and descending stairs in a reciprocal fashion and the inability to actively extend his left knee. His symptoms began after sustaining a hyperflexion injury of the left leg while playing basketball 1.5 years prior to presentation. He had no history of knee problems before this injury, and he initially ignored the injury, thinking it was a muscle strain. With continued symptoms, he was referred to the senior author (B.R.B.) for operative treatment. Preoperative functional and subjective evaluations completed at the initial visit are summarized in the Table.

On physical examination, the patient was 6’5” tall and weighed 325 lb. He walked with a limited gait pattern and was able to comfortably bear weight on the injured extremity. Examination of his left lower extremity revealed marked patella alta that was displaced approximately 8 cm proximal to the joint line. Palpation of the knee demonstrated a palpable defect in the patellar tendon. There was no erythema and only limited swelling. Passive range of motion was nearly intact (0°/0°/120°); however, active range of motion was limited with a 45° extension lag. Manual quadriceps testing was 2/5. His ligamentous examination was normal and the leg was neurovascularly intact. The contralateral leg had full range of motion (0°/0°/125°) and normal strength.

Plain radiographs of the left knee demonstrated extreme patella alta with an Insall-Salvati ratio\textsuperscript{8} of >2.8 (normal, 1.0-1.2) (Fig-
**TABLE**

**FUNCTIONAL AND SUBJECTIVE OUTCOME SCORES**

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>6 Months Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>IKDC score(^1)</td>
<td>43</td>
<td>51</td>
</tr>
<tr>
<td>KOOS Score(^{15})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td>100</td>
<td>97</td>
</tr>
<tr>
<td>Symptoms</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Activities of daily living</td>
<td>76</td>
<td>97</td>
</tr>
<tr>
<td>Lysholm score(^{13})</td>
<td>70</td>
<td>91</td>
</tr>
<tr>
<td>SF-12 score(^{17})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental</td>
<td>55</td>
<td>62</td>
</tr>
<tr>
<td>Physical</td>
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<td>45</td>
</tr>
<tr>
<td>HSS knee score(^{18})</td>
<td>58</td>
<td>88</td>
</tr>
</tbody>
</table>

Abbreviations: IKDC=International Knee Documentation Committee, KOOS=Knee Injury and Osteoarthritis Outcomes, SF-12=Short Form-12, HSS=Hospital for Special Surgery.

...Magnetic resonance imaging showed a chronic rupture of the patellar tendon.

Initial surgical considerations included the use of an Ilizarov external fixation device to distract the patella to a more appropriate position to allow for reconstruction. However, concerns of infection related to the use of an external fixation device made this a less than desirable option. A decision was made to proceed with reconstruction of the extensor mechanism with 2 non-irradiated, fresh-frozen Achilles tendon allografts (AlloSource, Denver, Colo) without attempting to normalize the position of the patella. The use of a second allograft was unique and was indicated based on the patient's size and weight.

## SURGICAL TECHNIQUE

### Preoperative Evaluation

Preoperatively, lateral plain radiographs of both the injured and uninjured knees were obtained. The radiograph of the contralateral knee was used for appropriate measuring and for determining normal height alignment of the extensor mechanism reconstruction. A reconstruction that is too long will compromise the mechanical advantage of the extensor mechanism, and a reconstruction that is too short will limit flexion and may be more likely to re-rupture. Function and anatomical limitations were discussed with the patient to establish realistic postoperative goals and expectations. In this case, one goal was to add collagen (ie, Achilles tendon allograft) to replace missing tissue and restore active knee extension; however, during the preoperative discussion, the patient was made aware that restoration of normal, symmetric patellar tendon length was improbable.

### Patient Positioning

The patient was positioned supine with the operative leg draped at the proximal thigh in the standard fashion. A sterile tourniquet was applied and used as needed. General anesthesia was required for paralysis to achieve muscle relaxation. Preoperative antibiotics (ie, first-generation cephalosporin) were administered.

### Exposure

After injecting the skin with 1% lidocaine with epinephrine, a midline incision was made longitudinally from the patella proximally to the tibial tubercle distally. The dissection was carried down through the subcutaneous tissues to identify the defect and the patellar tendon pseudocapsule, which was incised and tagged to create medial and lateral flaps (Figure 2).
Figure 3. An anterior cruciate ligament tibial tunnel guide was used to drill the guide pin for the patellar tunnel for proximal fixation of the docking allograft.

Figure 4. With use of a 10-mm reamer, the tibial tunnels were drilled for distal allograft fixation.

Figure 5. The reinforcing allograft bone plug was fixed distally with a 9×25-mm interference screw.

Figure 6. The docking allograft bone plug was fixed proximally with a 7×25-mm interference screw.

Using an anterior cruciate ligament tibial tunnel guide system (Smith & Nephew, Andover, Mass), a 3/32-inch Steinmann pin was drilled longitudinally through the main body of the patella (Figure 3). This pin subsequently was overreamed with a 10-mm cannulated reamer. In a similar fashion, two oblique drill holes were made straddling the tibial tubercle medially and laterally. Each drill hole was reamed to a depth of 30 mm using a 10-mm reamer (Figure 4).

Allograft Preparation

The first Achilles tendon allograft (the docking allograft) was prepared to create a proximal bone plug and tubularized distal tendon. The bone plug of this allograft was secured into the distal pole of the patella and the tendon into the tibial tunnel. The bone plug was fashioned with an oscillating saw and rongeured to a size of approximately 10×25 mm. The distal end of the allograft then was prepared by running a baseball whipstitch with #2 FiberWire suture (Arthrex Inc, Naples, Fla) over 10 cm of the tendon.

The second allograft (the reinforcing allograft) was prepared to create a similar bone plug (as in the docking allograft) that would be fixed in the tibia. This allograft was fashioned to have a flat and broad free-tendon finish. This tendon matched the shape of the first Achilles allograft and was trimmed to match the fanning contour of the quadriceps tendon.

Fixation

The reinforcing allograft was placed in the proximal medial tibia and then fixed with a 9×25-mm soft-silk metal interference screw (Smith & Nephew) (Figure 5). In a similar fashion, the docking allograft was placed and fixed in the distal pole of the patella. This bone plug then was secured with a 7×25-mm metal interference screw (Smith & Nephew) (Figure 6). The size of these interference screws can be adjusted depending on the bone quality and the size and fit of the bone blocks.

To balance the reconstructed patellar tendon's pull and avoid patellar tilt, the tendons were overlapped slightly.
Then, with the knee in extension, multiple points of fixation were achieved with a #2 Ethibond suture between the length of the tendon allografts as well as the reinforcing free tendon to the quadriceps tendon proximal to the patella. Finally, the tubularized distal portion of the docking allograft was secured into the lateral tibial tunnel with a 9×25-mm Bio-Tenodesis screw (Arthrex Inc).

In this case, restoration of normal patellar height was not attempted; however, intraoperative fluoroscopy may be used to achieve this in some settings. Depending on surgeon preference, the tibial fixation points can be reversed, with the docking allograft secured medially and the reinforcing allograft secured laterally.

After freeing the infrapatellar scar tissue, the knee was easily flexed 45°. After verifying graft position, alignment, and fixation, attention then was turned to closure.

**Closure**

The medial and lateral retinaculum were closed with a pants-over-vest repair (Figure 7). The subcutaneous tissue was closed with inverted 2-0 polyglactin 910 sutures, and the skin was closed with staples. Finally, 0.25% bupivacaine was injected into the surgical wound region.

**Postoperative Rehabilitation**

The postoperative rehabilitation program balanced mobilization and protection of the allograft reconstruction. The patient was allowed protected weight bearing in a drop-lock range-of-motion brace for the first 6 weeks. Hamstring stretching exercises and progressive active flexion from 0° to 30° in the brace were initiated postoperatively. Range of motion was progressed in 30° increments at 2-week intervals. At 6 weeks postoperatively, the patient began supervised physical therapy 2 to 3 times per week for progressive weight bearing, closed chain exercises, and progression of range of motion >90°.

**CLINICAL RESULTS**

No complications occurred intraoperatively or postoperatively. Six months postoperatively, the patient had painless, active range of motion of 0°/0°/125° and no extension lag (Figure 8). He was able to perform straight-leg raises without any lag. Thigh girths were nearly symmetrical (left, 59 cm and right, 58.5 cm). Objective extension-strength testing with an Isobex Dynamometer (Cursor AG, Bern, Switzerland) demonstrated the surgical leg was 92% that of the contralateral leg at 60° flexion and 64% at full extension.

Radiographs demonstrated all screws were well fixed and in appropriate alignment and position. The patellar interference screw was slightly proud inferiorly on the lateral view; however, this was unchanged from postoperative radiographs (Figure 9). Ideally, this screw should be flush with the inferior margin of the patella.

The Insall-Salvati index was approximately 2, and there was no evidence of retropatellar osteoarthritis. The functional and subjective outcomes demonstrated dramatic improvement (Table). The patient had no patellar pain symptoms, was able to ascend and descend stairs in a reciprocal fashion, and walked with a normal gait pattern.
Figure 8. Photographs showing active extension in straight-leg raise (A) and flexion (B) at 6 months postoperatively.

Figure 9. AP (A) and lateral (B) plain radiographs at 6 months postoperatively showing screw positions.

DISCUSSION

Chronic patellar tendon rupture reconstructions are complex and technically demanding because of proximal patella migration, poor soft-tissue quality, and quadriceps atrophy. Proximal migration of the patella presents the surgeon with the challenging decision of providing external fixation for preoperative traction versus reconstruction without distal reapproximation. Skeletal traction requires extended bed rest and lengthy hospitalization and can threaten future graft incorporation by possibly seeding an infection. Moreover, skeletal traction has demonstrated inconsistent results. For these reasons, no attempt was made to normalize the patellar height in this patient. Similar to patients after patellectomy, it
was anticipated that the reconstruction would provide a functional extensor mechanism despite patella alta, and it was believed that attempts to restore normal patellar height would compromise the overall result.

Poor soft-tissue quality often precludes primary repair as well as the use of soft-tissue to soft-tissue reconstruction techniques in the setting of chronic patellar tendon rupture. The advantage provided by the Achilles tendon allograft was the ample bone stock available. In this case, tenuous soft-tissue repairs were avoided by the application of high-quality bone-to-bone healing as seen in other allograft procedures. Additionally, quadriiceps and hamstring muscle strengthening was initiated without fear of early failure because of the predictably stable bone-to-bone fixation.

There was little to be found in the literature for guidance regarding the issues faced with this patient. Specifically, there were no reports detailing the treatment of such a chronically neglected patellar tendon rupture with superior proximal patellar migration in a patient of this size.

The largest of the early case series of autologous tissue transfer was reported by Ecker et al. Despite persistent quadriiceps atrophy in 3 of the 4 cases and extensor lag in 1 case, all of their patients returned to preinjury functional levels. Expanding the use of a bone-patellar tendon-bone allograft from the total joint arthroplasty literature, Burks and Edelson repaired a patellar tendon rupture that occurred 6 weeks previously. One year postoperatively, the patient demonstrated dramatic results, with 0° to 130° flexion, no extensor lag, and full strength with no pain. Case reports by Falconiero and Pallis and McNally and Marcelli demonstrated similar success. In all of these reports, the reconstructions included reinforcing suprapatellar wires to distribute loading stresses on the allograft, and in each reconstruction, this hardware later required removal.

Our technique is unique in that it avoids any hardware implantation, thereby avoiding any need for a second procedure to remove reinforcing hardware. A recent report described migration of a broken cerclage wire into the heart. In our case, a second graft was placed to reinforce the docking allograft instead of hardware. The proximal portion of this reinforcing allograft was sutured broadly over the quadriiceps tendon. This broad fixation minimizes the stresses on the quadriiceps tendon and thus is less likely to be affected by poor soft-tissue quality. These results are comparable to those published for acute repair.

**CONCLUSION**

The use of allografts can allow for novel surgical reconstruction techniques. In this case, 2 Achilles tendon allografts were implanted for the reconstruction of a chronic patellar tendon rupture and have demonstrated dramatic short-term success.

**REFERENCES**