Extensor Mechanism Reconstruction for Chronic Patellar Fracture

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abstract

Patients with displaced patellar fractures typically present with disruption to the extensor mechanism requiring acute surgical intervention. Chronic patellar fractures with disruption of the extensor mechanism are uncommon, and few surgical options are available. The authors present a patient who sustained a fracture to the inferior pole of the patella in Africa 5 years prior that was managed conservatively with bands and a brace. He decided to pursue surgical intervention because of difficulties with leg extension, weakness, and ambulation. The patient underwent a novel reconstruction of his chronic extensor mechanism loss with a combination of inferior pole patellar fracture excision, z-plasty and lengthening of the quadriceps tendon, and Achilles tendon reconstruction of the patellar tendon with both hamstring autograft and acellular human dermal matrix allograft augmentation of the entire reconstruction construct. At the final 2-year follow-up, the patient had restored active extension with no extensor lag and had returned to his preinjury activities, including running and playing soccer. [Orthopedics. 201x; xx(x):xx-xx.]

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Case Report

A 38-year-old African American man from Nigeria presented to the authors’ institution with difficulties extending his knee and ambulating since a fall approximately 5 years earlier in Africa during which he suffered a fracture of the inferior pole of the patella that was managed conservatively with bands and a brace. On initial presentation, he reported pain and weakness ascending and descending stairs. He reported having limited mobility and significant weakness with leg extension. The patient was unable to straighten his leg and limped on his knee. Prior to the injury, he played soccer recreationally. Since the injury, he had not been able to run or play soccer.

On examination, the patella was superiorly migrated (Figure 1). He was not able to perform a straight leg raise and had approximately 80° of extensor lag. He had full passive flexion and extension with no evidence of varus or valgus instability. Anterior–posterior drawer and Lachman tests yielded negative results. There was no joint line tenderness on either the medial or the lateral side. His preoperative International Knee Documentation Committee score was 20.7, modified Cincinnati Knee Rating System score was 23, Tegner Activity Level score was 21, and visual analog scale score was 7.

Radiographs showed a proximally migrated patella and distal sleeve inferior pole fracture (Figure 2A). Magnetic resonance imaging revealed scar tissue between the superior aspect of the patella and the inferior pole fracture with severe contraction of the patellar tendon (Figure 2B). The patient also had diffuse grade 4 cartilage loss on the underside of the patella, involving approximately half of the surface area (Figure 3A), and diffuse grade 3 cartilage loss on the trochlear groove (Figure 3B). There was no evidence of intra-articular pathology.

The patient underwent a right knee patellar tendon reconstruction with a non-irradiated Achilles allograft, quadriceps z-plasty lengthening with GraftJacket augmentation, further augmentation of both the patellar tendon reconstruction and the quadriceps tendon reconstruction with semitendinosus and gracilis hamstring autograft, extensive medial and lateral release, and excision of the inferior pole of the patellar fracture and patellar tendon. The residual inferior pole fracture of the patella and contracted patellar tendon were excised first (Figure 4). A z-plasty of the quadriceps tendon was then performed,
and there was a 3-cm residual defect after bringing the patella down to the groove. Thus, two No. 2 braided sutures were sutured into each end in a Krakow fashion. The residual sutures were tied together. A GraftJacket was then wrapped around the entire z-plasty to further augment it. This step brought the patella down to the groove anatomically. The bone block on the Achilles tendon was then shaped into a triangle measuring 15×30 mm. A similar size trough was made on the prior location of the distal patellar tendon. The bone block of the Achilles tendon was press fit into the trough and fixed with a 4.5-mm fully threaded screw using a lag technique (Figure 5). The Achilles tendon was fixed to the inferior patella with metal anchors (Healix Metal Titanium 5.5-mm anchors; DePuy Mitek, Raynham, Massachusetts) using sutures in a Krakow fashion (Figure 6A). The residual tendon from the Achilles graft was used to augment the quadriceps lengthening with interrupted No. 2 braided sutures (Figure 6B). The hamstring tendons were harvested with the insertion intact at the pes (Figure 6B). One limb was stapled on the lateral side and both limbs were wrapped around the entire construct into the proximal quadriceps tendon to augment the entire reconstruction (Figure 7). Medial and lateral retinacula were closed with interrupted sutures. Skin was closed with running nylon.

The patient tolerated the procedure well, and his knee was placed in a long cylinder cast in 20° of flexion for 2 weeks. He also was admitted for 2 days for intravenous antibiotics. At the 2-week postoperative visit, the wound was checked, the sutures were removed, and the knee was again placed in a long cylinder cast in 20° of flexion. Four weeks postoperatively, he was transitioned to a Bledsoe brace (Bledsoe, Carlsbad, California) locked in extension for 2 more weeks with partial weight bearing instructions. Six weeks postoperatively, physical therapy was initiated with the Bledsoe brace open from 0° to 60° of flexion, with a progression of 10° per week. The patient was transitioned from partial to full weight bearing between weeks 6 and 8.

Physical therapy interventions consisted of tibiofemoral joint mobilization to improve range of motion, functional knee strengthening, and active quadriceps control. Intermittent passive stretch and submaximal isometric contraction of the quadriceps was performed to promote a tissue-healing response to the tendon.

Twelve weeks postoperatively, the patient’s range of motion was 0° to 70°. He had active knee extension and was able to do a straight leg raise without extensor lag. The patient was switched to a Road-Runner brace (Breg, Inc, Carlsbad, California) and advanced to 90° of flexion in his physical therapy exercises to increase quadriceps strength. Four months postoperatively, the patient had improved range of motion (0° to 90°), and the knee was stable to both varus and valgus move-
ments. At 6-month follow-up, the patient reported that he was able to ascend and descend stairs without problems and jog without knee pain. His range of motion had improved to 0° to 100° with an intact extensor mechanism and a lag of approximately 5°. A physical therapy regimen to strengthen his quadriceps was continued, and his brace was discontinued. His International Knee Documentation Committee score was 66.4, and his modified Cincinnati Knee Rating System score was 67.

At his most recent follow-up, 2 years postoperatively, knee range of motion was 0° to 125° (20° less than the contralateral side), with 0° of extensor lag and active extension with contraction of his quadriceps muscle (Figure 8). Radiographs showed the patella in the anatomical location (Figure 9). His International Knee Documentation Committee score was 79.3, modified Cincinnati Knee Rating System score was 90, Tegner Activity Level score was 97, and visual analog scale score was 0. When preoperative dynamometry test results were compared with those at last follow-up, the patient had a 260% increase in quadriceps strength.

**Discussion**

Patellar fractures with loss of the extensor mechanism are associated with significant patient morbidity and functional deficits. Surgical treatment options depend on the severity of the fracture, location, and fracture pattern. These include open reduction and internal fixation with K-wires or screws and tension banding, plating, or a combination of both plate and screws. Each surgical method aims to reconstruct the extensor mechanism and return the patella to the anatomical location within the trochlear groove to restore active extension of the leg without lag signs. Chronic patellar fractures with severe quadriceps contracture and proximal migration of the patella along with the loss of the extensor mechanism are difficult situations with few surgical options. Furthermore, this presentation of chronic extensor mechanism disruption involving a patellar fracture that is managed conservatively is rare. On average, the senior author (X.L.) sees 1 or 2 patients per year with chronic disruption of the extensor mechanism due to either quadriceps or patellar tendon rupture. However, this is the first case of a patellar fracture managed conservatively with a chronic loss of
extensor mechanism seen at the authors’ academic center—a level I trauma center and one of the busiest tertiary referral centers in New England—by the senior author. Most of the literature has reported on the management of chronic quadriceps or patellar tendon rupture or the loss of the extensor mechanism in the elderly after total knee replacement.

The authors have presented a unique case of a chronic inferior pole patellar fracture with the loss of the extensor mechanism for more than 5 years. The patient underwent a combination of reconstruction techniques including z-plasty lengthening of the quadriceps tendon to bring the patella distal, Achilles tendon allograft reconstruction of the patellar tendon, medial and lateral release, and augmentation of the entire reconstruction with hamstring autograft and augmentation of the quadriceps z-plasty lengthening with GraftJacket.

Several key components ensure the success of this complex knee reconstruction procedure. First, in this patient, the patella was migrated to the midtigh with severe contraction of the quadriceps tendon. A z-plasty of the quadriceps tendon was essential and performed first to give the maximal lengthening. Depending on the severity of the contraction, the z-plasty lengthening can be sutured either using a sliding technique or end to end. However, in this case, the patella was severely migrated; with the z-plasty, there was a 3-cm defect to move the patella down to the anatomical location within the trochlear groove. Thus, the authors had to augment the lengthening with a GraftJacket wrapped around the quadriceps tendon to bridge the 3-cm defect. GraftJacket is an acellular dermal matrix with intact basement membrane complex, and preserved vascular channels allow for the infiltration of vascular tissue without a significant host inflammatory response.\(^5\)\(^6\)

The second key component is to address the contracted patellar tendon and the inferior pole of the patellar fracture. The only option is to excise the entire inferior pole fragment and the patellar tendon and reconstruct it with an Achilles tendon allograft. This was done with shaping of the bone block of the Achilles tendon. A trough of similar size was created where the patellar tendon was originally located, and the bone block was press fit into the trough and further secured with a 4.5-mm fully threaded screw using a lag technique. The senior author recommends making the bone block at least 15×30 mm for secure fixation. The Achilles tendon was then fixed to the inferior pole of the patella with metal suture anchors, and the residual graft was used to augment the quadriceps lengthening with interrupted No. 2 braided suture. Additionally, both medial and lateral sutures were needed to mobilize the patella down to the groove. The length of the reconstruction of the patellar tendon can be determined using the contralateral normal knee. This can be measured on a standard lateral radiograph. At this time, the surgeon will have the option to further use the hamstring tendon to augment the entire construct with autograft tissue. The authors decided to do this because of the patient’s young age and the chronicity of the injury. Thus, the gracilis and semitendinosus were harvested and used to augment the entire construct. With the above technique, this patient had full return of his extensor mechanism function at the final 2-year follow-up.

Some authors have proposed the use of patellar tendon or fascia lata autograft to reconstruct chronic patellar tendon ruptures.\(^7\) Siwek and Rao\(^8\) reported good outcomes of 31 patients with patellar tendon ruptures that were reconstructed using an autogenous graft of the fascia lata. Twenty-nine patients had good or excellent results, and acute reconstruction had a significantly better outcome than delayed reconstruction.\(^8\) Both approaches were protected using pins-and-plaster immobilization postoperatively. Recently, Wiegand et al\(^9\) described a patellar tendon reconstruction using a Y-shaped, folded back vastus lateralis fascia flap in 16 patients. Ultrasound monitoring and physical examination confirmed that all 16 tendons fully healed, and there was full quadriceps function restoration, anatomical positioning of the patella, and mobilization. These other autografts are additional options that could have been used with the current authors’ reconstruction technique. The disadvantage of harvesting graft from the contralateral knee or the fascia lata graft from the hip is further patient morbidity. Instead of using an internal wiring to augment the reconstruction during the healing time, the authors used the addition of the hamstring tendon, which provides both autograft tissue and more tendon tissue to assist the healing process to the final construct.

The use of hamstring autograft to repair or reconstruct patellar tendon ruptures was first described by Kelikian et al\(^10\) in 1957. It has emerged as a viable surgical approach\(^1\) for patients with chronic disruptions of the extensor mechanism, including elderly patients after total knee replacements, whose tissues may be devascularized, and patients with systemic diseases such as rheumatoid arthritis and lupus erythematosus.\(^11\) Ecker et al\(^12\) reported excellent outcomes and restoration of knee function in 4 patients who underwent delayed patellar tendon reconstruction via gracilis and semitendinosus tendon transfer, supplemented by a heavy-gauge encircling wire to bridge the gap. From the authors’ experience, hamstring tendons are stronger or more robust than fascial strips when reconstructing the patellar ligament.\(^12\) Gustilo and Thompson\(^13\) reported on 2 autograft reconstructions in patients undergoing total knee arthroplasty. A fascia lata autograft failed, while a semitendinosus autograft had a successful outcome. The authors concluded that semitendinosus augmentation provided a stronger repair for these complex chronic extensor tendon disruptions.\(^13\) Similarly, Chen et al\(^14\) described 2 patients who underwent a delayed patellar tendon reconstruction using the semitendinosus and
gracilis tendons combined with a tension-reducing wire. This technique corrected the patellar height to allow for maximal range of motion, and both patients had good results with no evidence of extensor lag.\textsuperscript{14} Cadambi et al\textsuperscript{11} reported the outcomes of 7 patients who received semitendinosus autografts to repair chronic patellar tendon ruptures following total knee arthroplasty. They concluded that the use of a semitendinosus tendon autograft restored both range of motion and quadriceps strength.\textsuperscript{11}

**CONCLUSION**

Chronic missed or mismanaged patellar fractures that result in the loss of active extension can be devastating for patients and their overall function. The surgical management of these patients is difficult and limited. The authors have reported the successful reconstruction of a patient’s chronic extensor mechanism loss with a combination of fracture excision, z-plasty and lengthening of the quadriceps tendon, and Achilles tendon reconstruction of the patellar tendon with both hamstring autograft and GraftJacket augmentation of the entire reconstruction construct. At the final 2-year follow-up, the patient had restored active extension and had returned to his preinjury activities, including running.

**REFERENCES**