Technical Note

Open Patellar Tendon Tenotomy, Debridement, and Repair Technique Augmented With Platelet-Rich Plasma for Recalcitrant Patellar Tendinopathy

Bradley M. Kruckeberg, B.A., Jorge Chahla, M.D., Marcio B. Ferrari, M.D., George Sanchez, B.S., Gilbert Moatshe, M.D., and Robert F. LaPrade, M.D., Ph.D.

Abstract: Patellar tendinopathy is a disabling condition that frequently affects the athletic population, especially athletes undergoing repetitive impact forces as a result of jumping and landing activities. Most cases are initially treated conservatively, but if symptoms persist, surgical treatment is warranted. Options for surgical treatment include both arthroscopic and open techniques. The purpose of this technical note is to detail our open patellar tendon tenotomy, debridement, and repair technique augmented with platelet-rich plasma.

Patellar tendinopathy is a frequent pathology that affects up to 14% of the athletic population,[1] with some cases being particularly disabling because of symptomatology, prolonged rehabilitation, and the recalcitrant nature of the condition.[2-4] Histologically, patellar tendinopathy has been described as microscopic tears in combination with evidence of a failed healing response. This is more evident at the distal aspect of the patella, although it can be seen at any location of the tendon.[5,6] In addition, pseudocyst formation, disappearance of the tidemark, and fibrocartilage broadening and metaplasia can occur.[5,7] Once known as an inflammatory pathology, it is now widely accepted as a degenerative disease of the patellar tendon.[8]

Typically, a trial of conservative treatment lasting 3 to 6 months is preferred. A combination of conservative methods is used, including activity modification, relative rest (which is preferred over immobilization, given that inactivity may lead to further tendon and muscle atrophy),[9] nonsteroidal anti-inflammatory drugs, eccentric exercises, and cryotherapy.[3] Recently, biological approaches have been described as coadjuvant or sole treatments, including prolotherapy,[10] platelet-rich plasma (PRP),[11-13] and progenitor

From the Steadman Philippon Research Institute (B.M.K., J.C., M.B.F., G.S., G.M., R.F.L.) and The Steadman Clinic (R.F.L.), Vail, Colorado, U.S.A.; Oslo University Hospital and University of Oslo (G.M.), Oslo, Norway; and OSTRC, Norwegian School of Sports Sciences (G.M.), Oslo, Norway.

The authors report the following potential conflicts of interest or sources of funding: R.F.L. receives support from Smith & Nephew Endoscopy, personal fees and institutional support; Smith & Nephew, royalties and paid consultant; Ossur Americas, personal fees and institutional support; Ossur, paid consultant; Arthrex, personal fees, institutional support, royalties, and paid consultant; Siemens Medical Solutions USA, institutional support; Small Bone Innovations, institutional support; ConMed Linvatec, institutional support; Opedix, institutional support; Ossur, patent pending—unrelated to this work; and Smith & Nephew, patent pending—unrelated to this work. The Steadman Philippon Research Institute has received financial support not related to this research. R.F.L. is on the editorial/governing board for AJSM and KSSTA and has member/committee appointments with AOSSM, ISAKOS, AANA, and ESSKA.

Received October 11, 2016; accepted October 28, 2016.

Address correspondence to Robert F. LaPrade, M.D., Ph.D., Steadman Philippon Research Institute, The Steadman Clinic, 181 W Meadow Dr, Ste 400, Vail, CO 81657, U.S.A. E-mail: drlaprade@sprivail.org

2212-6287/16986/$36.00

http://dx.doi.org/10.1016/j.eats.2016.10.025

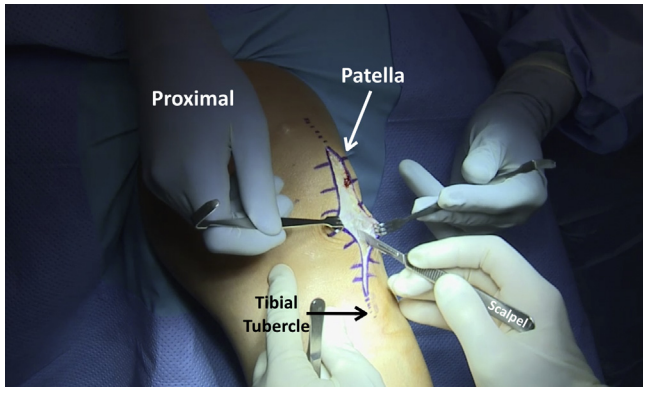

Fig 1. A midline skin incision is performed in a left knee centered at the patellar tendon and extending to the tibial tubercle to perform the patellar tendon debridement. The subcutaneous layer is sharply dissected medially and laterally to expose the whole patellar tendon. A careful incision along the paratenon is performed at the medial aspect of the tendon.

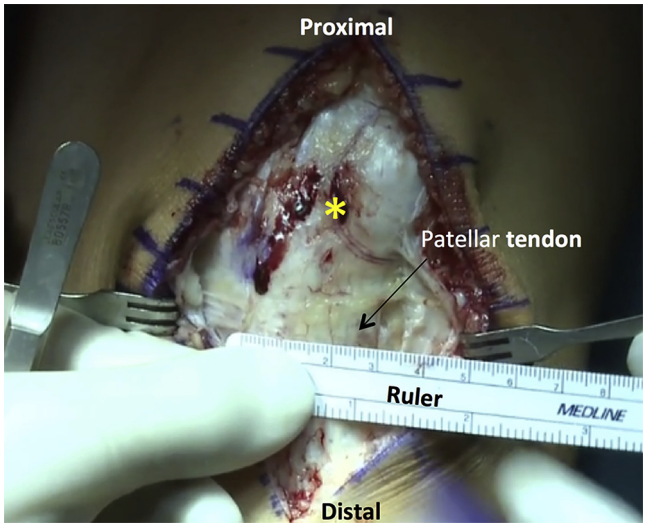

Fig 2. To access the degenerated tissue, which is located at the posterior portion of the tendon, a vertical incision is made at the middle aspect of the patellar tendon in the left knee. To ensure optimal positioning of the incision, a ruler is used to measure the width of the patellar tendon, and then previously acquired axial-view magnetic resonance imaging scans are used to locate the portion of degenerated tendon. The midpoint of the degenerative tendon is marked with a surgical pen. The tendon is opened with a longitudinal incision. The asterisk indicates the patella.

cell inoculation[14] to the diseased tendon. When nonoperative management fails or symptoms are not tolerable by the patient, a surgical approach is necessary.

Both arthroscopic and open techniques for treatment of this degenerative disease have been previously described. However, no consensus currently exists on the preferred approach.[3] Arthroscopically, debridement of the retropatellar tissues at the site of the attachment of the patellar tendon and partial resection of the distal pole of the patella can be performed.[15] Previously described open surgical techniques include partial removal of the affected patellar tendon; opening of the paratenon; drilling of the distal patellar pole; and tenotomy, debridement, and repair.[16] Because the latter is the most widely accepted form of treatment,[15] the purpose of this technical note is to describe our preferred approach for an open patellar tendon tenotomy, debridement, and repair technique augmented with PRP for treatment of recalcitrant patellar tendinopathy.

Patellar Tendinopathy Classification

Blazina et al.[6] described the most widely accepted classification of patellar tendinopathy. The degenerative disease has 4 phases: phase I is pain only after the activity; phase II, pain or discomfort during the activity that does not interfere with sports participation; phase III, pain both during and after participation that interferes with competition; and phase IV, complete tendon disruption.

Operative Indications

Surgical treatment is often warranted for patients with tendinopathy refractory to conservative treatment, resulting in persistent symptoms.[4,9,16-19] When surgical treatment is indicated, both arthroscopic and open techniques have been used. The most widely used approach for open surgical treatment is the approach described in this technical note, which involves debridement of the affected tissue.[9,17]

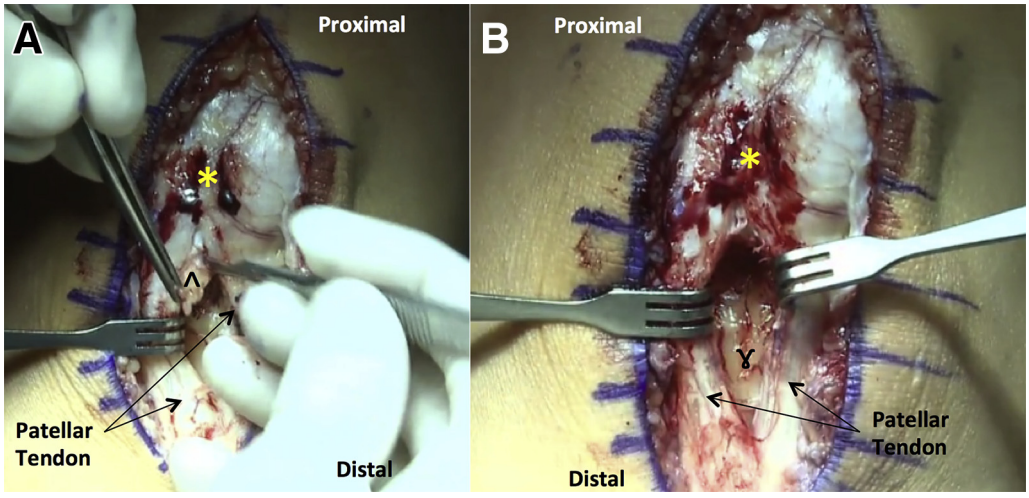

Fig 3. The degenerated part of the patellar tendon is located by palpation in the left knee, as well as noting differences in texture and color of the tissue. (A) Once identified, the degenerated tissue (carat mark) is excised with a No. 15 blade. (B) After excision of the tissue, careful palpation of the tendon is performed to ensure that all the degenerative tissue has been excised. The asterisks indicate the patella, and the gamma indicates the infrapatellar fat pad.

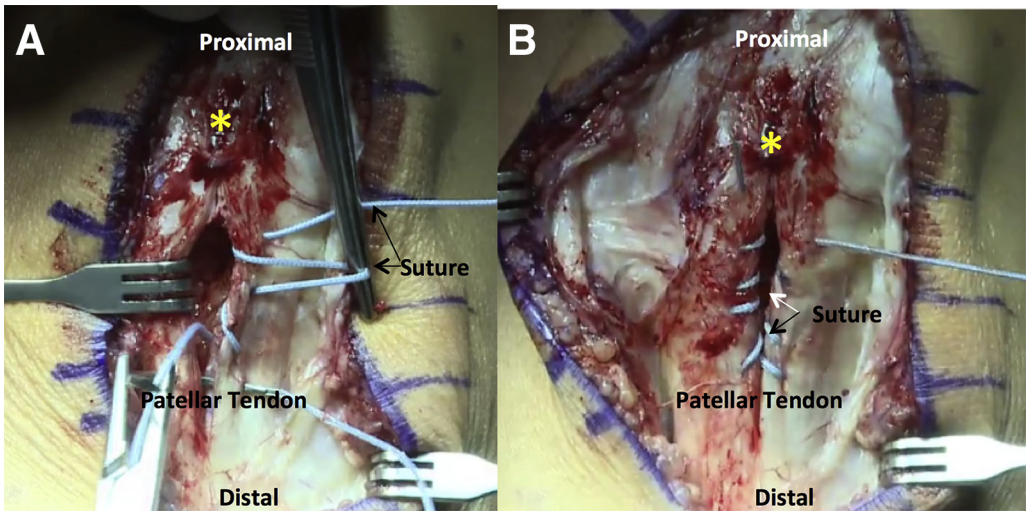

Fig 4. After complete excision of the degenerative tissue from the left knee, a No. 5 FiberWire is whipstitched along the medial and lateral sides of the patellar tendon, beginning at the proximal aspect of the lateral half of the tendon (A) and finishing at the proximal aspect of the medial half of the tendon (B). The distance between each suture is approximately 2 mm. The asterisks indicate the patella.

Patient Positioning and Anesthesia

The patient is placed in the supine position with the injured leg in a leg holder (Mizuho OSI, Union City, CA), with the nonsurgical leg flexed, abducted, and held in an abduction holder (Birkova Products, Gothenburg, NE) (Video 1). A well-padded thigh tourniquet (ATS 4000 Automatic Tourniquet System; Zimmer, Sävedalen, Sweden) is subsequently placed on the upper thigh of the operative leg to ensure a bloodless field. The surgical leg is prepared and draped in the usual sterile fashion, the leg exsanguinated, and the tourniquet inflated.

Surgical Technique

A midline skin incision centered on the patellar tendon is performed (Video 1, Fig 1). Sharp dissection is undertaken down to the paratenon. Dissection is then performed medially and laterally to expose the whole patellar tendon. For optimal placement of the incision, a ruler is used to measure the width of the patellar tendon. Moreover, axial-view magnetic resonance imaging scans are used to identify the portion of degenerated tendon. Afterward, the midpoint of the degenerative tendon is marked with a surgical pen (Fig 2). A longitudinal incision along the tendon fibers is performed with a No. 15 blade in the area of partial detachment and tendinopathy based on the axial images on preoperative magnetic resonance imaging. The necrotic area of the tendon is debrided (Fig 3), and a rongeur is used to decorticate the distal pole of the patella to arrive at fresh bone. Moreover, decortication of the distal pole enhances the healing potential of the tendon attachment after debridement.

A No. 5 FiberWire (Arthrex, Naples, FL) is whipstitched along the medial and lateral aspects of the patellar tendon (Fig 4). After this, an anterior cruciate ligament guide (Arthrex) is used to complete the repair by drilling an eyelet pin twice from the distal patellar pole to the proximal pole (Fig 5). The lateral limb of the

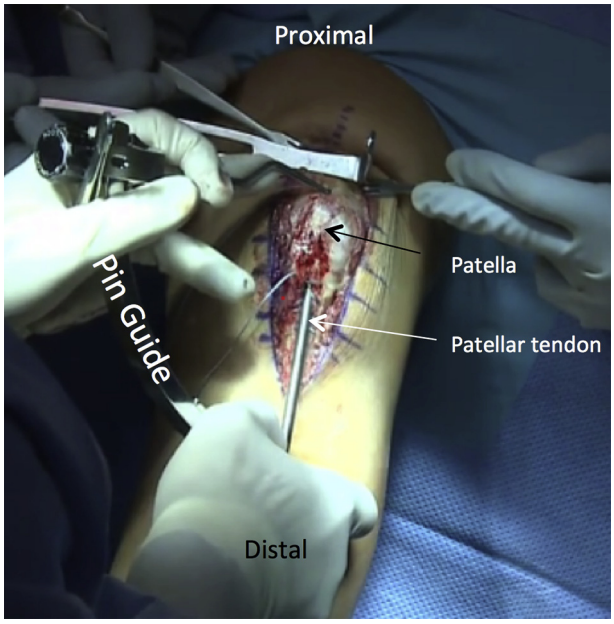

Fig 5. After the dissection of the degenerated tissue and whipstitching of each half of the remaining tendon in the left knee, an anterior cruciate ligament guide is used. A Beath pin is drilled from the distal patellar pole proximally toward the quadriceps tendon. Care should be taken to avoid bone spikes at the entrance and exit of the tunnels to avoid cutting the sutures during knee flexion.

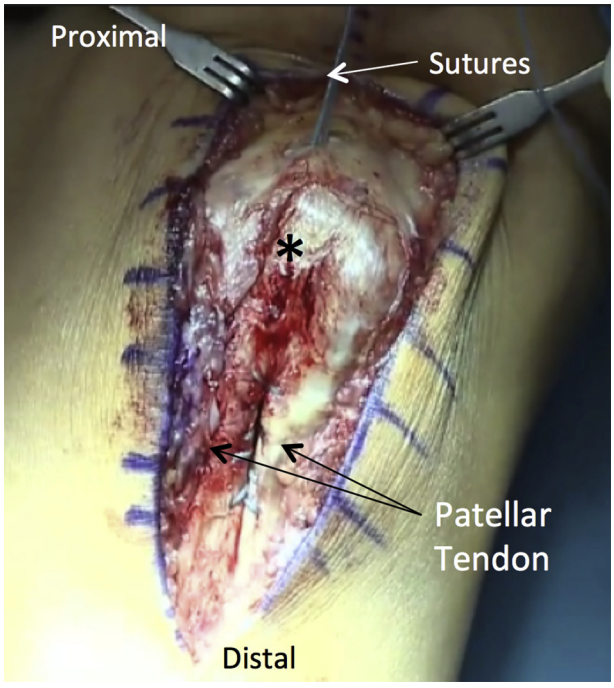

Fig 6. After whipstitching and tunnel placement in the left knee, both ends of the suture are passed through the tunnels. Then, with the knee flexed to 90°, the sutures are tied at the proximal pole of the patella. Care should be taken to avoid bone spikes at the entrance and exit of the tunnels to avoid cutting the sutures during knee flexion. The asterisk indicates the patella.

repair is then brought to the medial eyelet pin track. After this, the medial portion of the FiberWire suture is taken through the lateral eyelet pin track (Fig 6).

A diagnostic arthroscopy is performed by use of standard anterolateral and anteromedial portals. The menisci and cartilage are evaluated. The fluid is then withdrawn from the joint. With the knee flexed to 90°, the FiberWire sutures are tied at the proximal pole of the patella. The repair is then evaluated. After this, the knee is extended and a PRP membrane (Greyledge Technologies, Vail, CO) is placed under the tendon to stimulate further healing and a larger growth factor response (Fig 7). The patellar tendon is then sealed with No. 2 OrthoCord sutures (DePuy Synthes, West Chester, PA). After verification that the seal is watertight, PRP (Greyledge Technologies) is injected at the repair area to maximize the healing response (Fig 8). Specifically, leukocyte-rich PRP is recommended for this augmentation.

After PRP injection, the paratenon is closed. The deep tissue layer is then closed with No. 0 and No. 2-0 Vicryl (Ethicon, Somerville, NJ). The tourniquet is deflated and hemostasis control obtained. The skin layer is then closed with Monocryl (Ethicon). Once closure is complete, Steri-Strips (3M, St Paul, MN) and a sterile dressing are applied. The pearls and pitfalls of this technique are listed in Table 1, and the advantages and disadvantages are listed in Table 2.

Postoperative Rehabilitation

The limb is placed in a knee immobilizer in full extension for 6 to 8 weeks. Toe-touch weight bearing is allowed for the first 6 weeks after surgery. Range of motion from 0° to 90° is permitted during the first 2 weeks, with a gradual increase as tolerated after

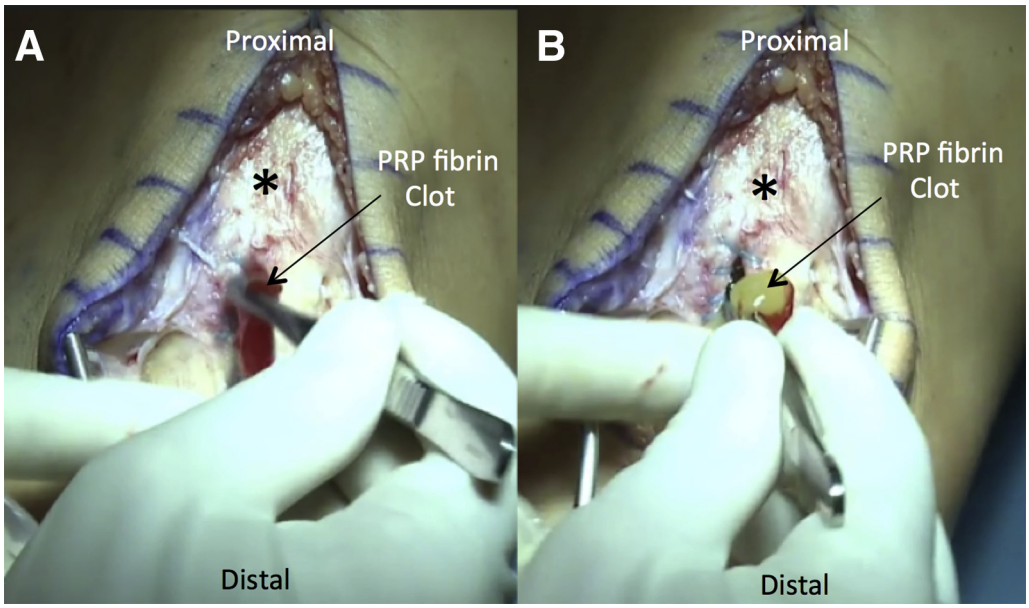

Fig 7. (A, B) To improve the healing potential at the site of the initial incision, a platelet-rich plasma (PRP) clot (or membrane) (Greyledge Technologies) is inserted at the site of the tenotomy in the left knee. After clot insertion, the tendon and paratenon are sealed with No. 2 OrthoCord sutures. The asterisks indicate the patella.

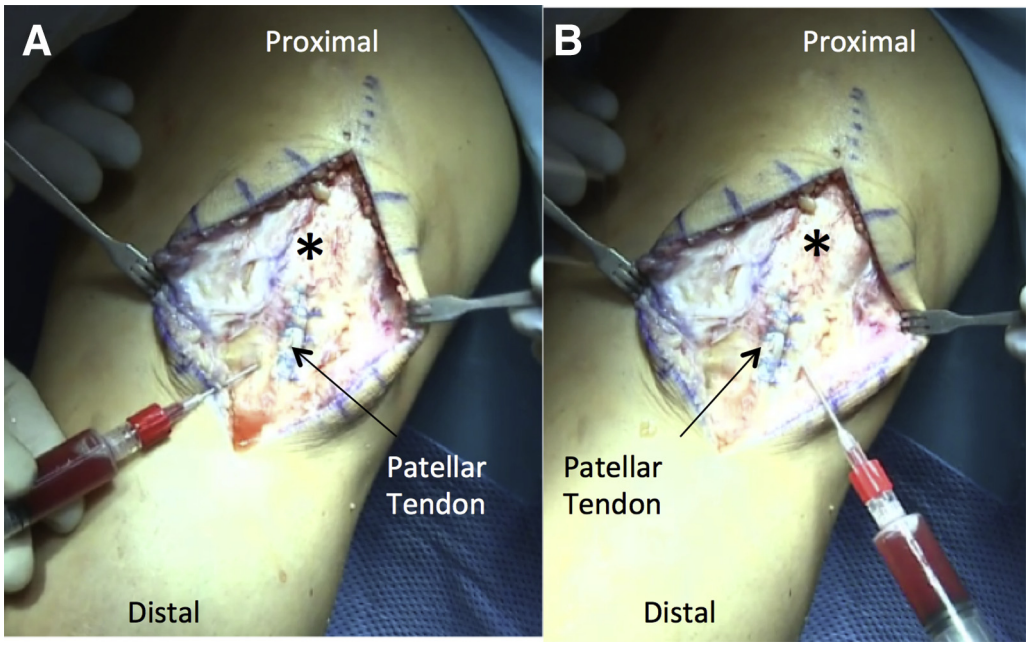

Fig 8. Once the suture ends are tied and the patellar tendon and paratenon are secured, platelet-rich plasma is injected at the medial (A) and lateral (B) halves of the incised tendon in the left knee to maximize healing potential and increase the number of growth factors in the healing environment. Of note, leukocyte-rich platelet-rich plasma is recommended. The asterisks indicate the patella.

2 weeks. The immobilizer is taken off during range-of-motion exercises. However, straight-leg raises are performed with the knee immobilizer worn. At 6 weeks, use of the knee immobilizer is discontinued and partial protective weight bearing is initiated. At this point, the patient is instructed to use crutches. The patient is weaned from using crutches once he or she is able to ambulate without a limp. Squats and lunges should be avoided during the first 16 weeks after surgery to allow for ample healing time.

Discussion

This technical note describes our preferred surgical technique for treatment of insertional patellar tendinopathy in patients who did not respond to initial conservative treatment. Given that this degenerative disease is highly symptomatic and typically seen in young, active patients, the correct treatment of choice is key to alleviate anterior knee pain and reduce the probability of progression toward a more debilitating condition.[20]

Patellar tendinopathy is most commonly seen in athletes in combination with swelling, pain, and decreased athletic performance.[21] Although it may ultimately limit performance in various sports, it is especially restrictive in activities with excessive jumping, landing, and cutting.[22] If left untreated for a prolonged period, the symptoms may be severe with considerable pain and warrant surgical treatment to allow for return to sports. However, even with improvement in symptoms after surgery, many patients may not be able to return to the same level of sport activities.[23]

Several techniques have been described as alternative options to treat this pathology, including minimally invasive treatments such as a local steroidal injection[24-26]

Table 1. Pearls and Pitfalls

Pearls
An anterior cruciate ligament guide should be used to ensure optimal transpatellar suture placement.
The sutures should be secured with the knee at 90° of flexion to avoid overtightening the repair or postoperative stiffness.
No squats or lunges should be performed during the initial 16 weeks after surgery to maintain an intact repair.
Pitfalls
Incomplete excision of degenerative patellar tendon tissue may result in recurrence of patellar tendinopathy.
Inaccurate placement of tunnels may lead to patellar fracture or cartilage damage.
Tying sutures with the knee in extension may result in postoperative complications including loss of flexion and failure of the repair.

Table 2. Advantages and Disadvantages

Advantages
Drilling of tunnels and decortication of the distal patellar pole increase healing potential and maximize the strength of reattachment.
Application of platelet-rich plasma increases healing potential and the number of growth factors.
Securing the crossing sutures at the proximal pole of the patella strengthens the repair.
Disadvantages
If the technique is performed incorrectly, patellar cartilage damage is possible.
Whipstitches on the medial and lateral borders of the patella may compromise blood supply.

and sclerosing treatment[27]; each is associated with positive treatment outcomes. For severe and recalcitrant cases, open[28,29] or arthroscopic[3,30] procedures have been reported as effective treatment options. Regardless of the surgical technique undertaken, excision of all macroscopic degenerated tissue is emphasized.[23] Moreover, decortication at the distal pole of the patella has been previously described to maximize healing potential.[18,31,32] Marcheggiani Muccioli et al.[32] evaluated open and arthroscopic techniques previously described for treatment of chronic patellar tendinopathy. No statistically significant differences were found regarding return to sports and surgical success rates between the arthroscopic and open procedures after review of 21 studies.

Another possible treatment, which can be performed in isolation or as an adjunct to open or arthroscopic surgical treatment, is PRP injection. The application of PRP has been associated with tendon healing and remodeling as a result of growth factors that lead to matrix production and heightened tenocyte activity.[33] Several studies have shown symptomatic improvement and/or evidence of improvement on imaging in patients with patellar insertional tendinopathy after application of PRP.[34-36] Furthermore, a recent meta-analysis of randomized controlled clinical trials showed that leukocyte-rich PRP improves outcomes for patients with tendinopathy.[37] Leukocytes are considered beneficial in the chronic setting because of their capacity to reset the healing process by promoting an inflammatory reaction.[38,39] Our technique combines the excision of the degenerated tendon tissue along with decortication of the distal pole of the patella and application of leukocyte-rich PRP. Furthermore, the use of arthroscopy in our procedure allows for a thorough evaluation of the proximal insertion of the patellar tendon and patellar cartilage and evaluation and possible treatment of any concomitant pathology.

In conclusion, in accordance with positive clinical outcomes reported in the literature, we recommend our described technique for treatment of patellar tendinopathy. Nevertheless, future long-term studies with large sample sizes are needed to further assess the efficacy of this procedure.

References

1. Lian OB, Engebretsen L, Bahr R. Prevalence of jumper's knee among elite athletes from different sports: A cross-sectional study. *Am J Sports Med* 2005;33:561-567.
2. Cassel M, Baur H, Hirschmuller A, Carlsohn A, Frohlich K, Mayer F. Prevalence of Achilles and patellar tendinopathy and their association to intratendinous changes in adolescent athletes. *Scand J Med Sci Sports* 2015;25:e310-e318.
3. Pascarella A, Alam M, Pascarella F, Latte C, Di Salvatore MG, Maffulli N. Arthroscopic management of chronic patellar tendinopathy. *Am J Sports Med* 2011;39:1975-1983.
4. Popp JE, Yu JS, Kaeding CC. Recalcitrant patellar tendinitis. Magnetic resonance imaging, histologic evaluation, and surgical treatment. *Am J Sports Med* 1997;25:218-222.
5. Khan KM, Bonar F, Desmond PM, et al. Patellar tendinosis (jumper's knee): Findings at histopathologic examination, US, and MR imaging. Victorian Institute of Sport Tendon Study Group. *Radiology* 1996;200:821-827.
6. Blazina ME, Kerlan RK, Jobe FW, Carter VS, Carlson GJ. Jumper's knee. *Orthop Clin North Am* 1973;4:665-678.
7. Ferretti A, Puddu G, Mariani PP, Neri M. The natural history of jumper's knee. Patellar or quadriceps tendonitis. *Int Orthop* 1985;8:239-242.
8. Zhang B, Qu TB, Pan J, et al. Open patellar tendon tenotomy and debridement combined with suture-bridging double-row technique for severe patellar tendinopathy. *Orthop Surg* 2016;8:51-59.
9. Peers KH, Lysens RJ. Patellar tendinopathy in athletes: Current diagnostic and therapeutic recommendations. *Sports Med* 2005;35:71-87.
10. Freeman JW, Empson YM, Ekwueme EC, Paynter DM, Brolinson PG. Effect of prolotherapy on cellular proliferation and collagen deposition in MC3T3-E1 and patellar tendon fibroblast populations. *Transl Res* 2011;158:132-139.
11. Zhou Y, Zhang J, Wu H, Hogan MV, Wang JH. The differential effects of leukocyte-containing and pure platelet-rich plasma (PRP) on tendon stem/progenitor cells—Implications of PRP application for the clinical treatment of tendon injuries. *Stem Cell Res Ther* 2015;6:173.
12. Zayni R, Thaunat M, Fayard JM, et al. Platelet-rich plasma as a treatment for chronic patellar tendinopathy: Comparison of a single versus two consecutive injections. *Muscles Ligaments Tendons J* 2015;5:92-98.
13. Kaux JF, Bruyere O, Croisier JL, Forthomme B, Le Goff C, Crielaard JM. One-year follow-up of platelet-rich plasma infiltration to treat chronic proximal patellar tendinopathies. *Acta Orthop Belg* 2015;81:251-256.
14. Pascual-Garrido C, Rolon A, Makino A. Treatment of chronic patellar tendinopathy with autologous bone marrow stem cells: A 5-year-followup. *Stem Cells Int* 2012;2012:953510.
15. Schwartz A, Watson JN, Hutchinson MR. Patellar tendinopathy. *Sports Health* 2015;7:415-420.
16. Griffiths GP, Selesnick FH. Operative treatment and arthroscopic findings in chronic patellar tendinitis. *Arthroscopy* 1998;14:836-839.
17. Ferretti A, Conteduca F, Camerucci E, Morelli F. Patellar tendinosis: A follow-up study of surgical treatment. *J Bone Joint Surg Am* 2002;84:2179-2185.
18. Lorbach O, Diamantopoulos A, Paessler HH. Arthroscopic resection of the lower patellar pole in patients with chronic patellar tendinosis. *Arthroscopy* 2008;24:167-173.
19. Maier D, Bornebusch L, Salzmann GM, Sudkamp NP, Ogon P. Mid- and long-term efficacy of the arthroscopic patellar release for treatment of patellar tendinopathy unresponsive to nonoperative management. *Arthroscopy* 2013;29:1338-1345.
20. Cook JL, Khan KM, Harcourt PR, Grant M, Young DA, Bonar SF. A cross sectional study of 100 athletes with

jumper's knee managed conservatively and surgically. The Victorian Institute of Sport Tendon Study Group. *Br J Sports Med* 1997;31:332-336.
21. Morrey ME, Dean BJF, Carr AJ, Morrey BF. Tendinopathy: Same disease different results—Why? *Oper Tech Orthop* 2013;23:39-49.
22. Santander J, Zarba E, Iraporda H, Puleo S. Can arthroscopically assisted treatment of chronic patellar tendinopathy reduce pain and restore function? *Clin Orthop Relat Res* 2012;470:993-997.
23. Coleman BD, Khan KM, Kiss ZS, Bartlett J, Young DA, Wark JD. Open and arthroscopic patellar tenotomy for chronic patellar tendinopathy. A retrospective outcome study. Victorian Institute of Sport Tendon Study Group. *Am J Sports Med* 2000;28:183-190.
24. Fredberg U, Bolvig L, Pfeiffer-Jensen M, Clemmensen D, Jakobsen BW, Stengaard-Pedersen K. Ultrasonography as a tool for diagnosis, guidance of local steroid injection and, together with pressure algometry, monitoring of the treatment of athletes with chronic jumper's knee and Achilles tendinitis: A randomized, double-blind, placebo-controlled study. *Scand J Rheumatol* 2004;33:94-101.
25. Capasso G, Testa V, Maffulli N, Bifulco G. Aprotinin, corticosteroids and normosaline in the management of patellar tendinopathy in athletes: A prospective randomized study. *Sports Exerc Inj* 1997;3:111-115.
26. Kongsgaard M, Kovanen V, Aagaard P, et al. Corticosteroid injections, eccentric decline squat training and heavy slow resistance training in patellar tendinopathy. *Scand J Med Sci Sports* 2009;19:790-802.
27. Alfredson H, Ohberg L. Neovascularisation in chronic painful patellar tendinosis—Promising results after sclerosing neovessels outside the tendon challenge the need for surgery. *Knee Surg Sports Traumatol Arthrosc* 2005;13:74-80.
28. Al-Duri ZA, Aichroth PM. Surgical aspects of patellar tendonitis: Technique and results. *Am J Sports Med* 2001;14:43-50.
29. Shelbourne KD, Henne TD, Gray T. Recalcitrant patellar tendinosis in elite athletes: Surgical treatment in conjunction with aggressive postoperative rehabilitation. *Am J Sports Med* 2006;34:1141-1146.
30. Ogon P, Maier D, Jaeger A, Suedkamp NP. Arthroscopic patellar release for the treatment of chronic patellar tendinopathy. *Arthroscopy* 2006;22:462.e461-462.e465.
31. Pierets K, Verdonk R, De Muynck M, Lagast J. Jumper's knee: Postoperative assessment. A retrospective clinical study. *Knee Surg Sports Traumatol Arthrosc* 1999;7:239-242.
32. Marcheggiani Muccioli GM, Zaffagnini S, Tsapralis K, et al. Open versus arthroscopic surgical treatment of chronic proximal patellar tendinopathy. A systematic review. *Knee Surg Sports Traumatol Arthrosc* 2013;21:351-357.
33. Nourissat G, Ornetti P, Berenbaum F, Sellam J, Richette P, Chevalier X. Does platelet-rich plasma deserve a role in the treatment of tendinopathy? *Joint Bone Spine* 2015;82:230-234.
34. Kon E, Filardo G, Delcogliano M, et al. Platelet-rich plasma: New clinical application: A pilot study for treatment of jumper's knee. *Injury* 2009;40:598-603.
35. Filardo G, Kon E, Della Villa S, Vincentelli F, Fornasari PM, Marcacci M. Use of platelet-rich plasma for the treatment of refractory jumper's knee. *Int Orthop* 2010;34:909-915.
36. Smith J, Sellon JL. Comparing PRP injections with ESWT for athletes with chronic patellar tendinopathy. *Clin J Sport Med* 2014;24:88-89.
37. Fitzpatrick J, Bulsara M, Zheng MH. The effectiveness of platelet-rich plasma in the treatment of tendinopathy. *Am J Sports Med* 2017;45:226-233.
38. Bielecki T, Dohan Ehrenfest DM, Everts PA, Wiczkowski A. The role of leukocytes from L-PRP/L-PRF in wound healing and immune defense: New perspectives. *Curr Pharm Biotechnol* 2012;13:1153-1162.
39. Dohan Ehrenfest DM, Bielecki T, Jimbo R, et al. Do the fibrin architecture and leukocyte content influence the growth factor release of platelet concentrates? An evidence-based answer comparing a pure platelet-rich plasma (P-PRP) gel and a leukocyte- and platelet-rich fibrin (L-PRF). *Curr Pharm Biotechnol* 2012;13:1145-1152.