Technical Note

Extensor Mechanism Reconstruction Using Achilles Tendon Allograft With Suture Tape Augmentation

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Abstract: The management of chronic extensor mechanism injuries represents a significant challenge for orthopaedic surgeons, with numerous options for graft choice and fixation construct, but no clear consensus on which technique achieves optimal outcomes. Although there is little published data regarding outcomes of different fixation methods, small case series have demonstrated modest success using Achilles tendon bone block allografts and transverse patellar screw fixation. In this technical note, we describe a surgical technique for the treatment of a chronic inferior pole patella fracture, with extensor mechanism reconstruction using an Achilles tendon allograft with suture tape augmentation. Our technique describes the use of vertical cannulated screws in the patella for passing tape augmentation sutures, increased construct security by suturing of the Achilles graft directly to the quadriceps tendon, and the use of a post screw in the proximal tibia for suture tape augmentation.

Introduction

Although excellent results have been described for acute repair of extensor mechanism injuries, chronic injuries are more challenging to manage because of retraction, scar tissue formation, and decreased healing potential.[1-3] Thus, there remains no consensus for surgical management of chronic injuries.[4-6] Multiple options exist regarding graft choice and fixation for reconstruction. Techniques using autologous tissue and synthetic grafts have been described.[7,8] Additionally, allografts from a number of different sources, including Achilles tendon and entire extensor mechanism, have been described.[9] However, these techniques may be challenging in patients with poor bone quality or limited bone stock. We describe a surgical technique for extensor mechanism reconstruction using an Achilles tendon bone block allograft supplemented with suture tape augmentation through vertical screws in the patella, which is effective in restoring extensor mechanism function.

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Surgical Technique

Indications

This procedure is indicated for patients with chronic extensor mechanism disruption, including those with chronic patellar tendon rupture and is safe and effective for those with osteopenia or poor patellar bone quality.

Preoperative Assessment

Preoperative assessment should include documentation of gait, active and passive knee range of motion, degree of extensor lag, and ligamentous exam. Preoperative imaging includes radiographs and measurement of patellar height to determine the degree of patella alta. Magnetic resonance imaging of the knee is helpful to assess quality of the remaining tendon and rule of concomitant injuries. Fig 1 demonstrates chronic patellar tendon rupture and patella alta.

Positioning and Exposure

The surgical procedure is demonstrated in Video 1. The patient is placed supine, and general anesthesia is induced. Examination under anesthesia is performed, noting the passive range of motion of the knee and position of the patella, which may be retracted into the distal thigh. Perfect lateral fluoroscopic images of the

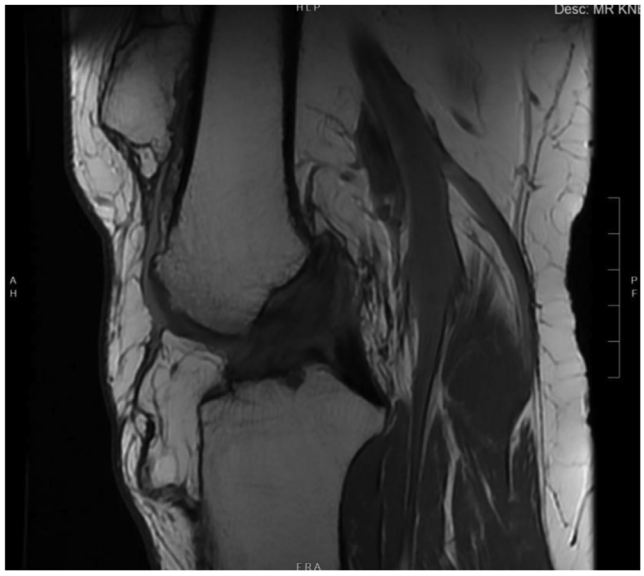

Fig 1. Sagittal magnetic resonance image demonstrating patella alta and chronic extensor mechanism disruption.

contralateral knee are obtained prior to draping to determine normal patellar height for later comparison. The operative limb should be draped out to the proximal thigh in order to allow for adequate exposure. A midline longitudinal incision is made from several centimeters distal to the tibial tubercle extending proximally to the quadriceps tendon to expose the entire extensor mechanism (Figs 2 and 3).

Mobilization of Extensor Mechanism

Traction sutures are placed in the remnant patellar tendon in order to provide distal traction. Adhesions should be released circumferentially from the quadriceps muscle and quadriceps tendon. This will allow for mobilization and inferior excursion of the proximal extensor mechanism. With the knee in full extension, the patellar height is evaluated. This can be confirmed using fluoroscopy to compare to the contralateral knee. If the patella remains proximal to its normal position, a quadricepsplasty may be performed. A fractional lengthening of the quadriceps tendon using Bovie cautery is performed to achieve partial-thickness chevron-shaped releases (Fig 4). Traction is pulled distally, and the patellar height is reevaluated and confirmed to be restored using fluoroscopy.

Patellar Screw Placement

Two 4.5-mm fully threaded cannulated screws are placed longitudinally through the patella from the distal to proximal end. These screws are used to protect the patella from fracture, as does the longitudinal configuration. FiberTape (Arthrex, Naples, FL) will be passed through these screws eventually for suture tape augmentation.

Achilles Allograft Preparation and Fixation in the Tibial Tubercle

The Achilles allograft is thawed on the back table. The calcaneal bone block is trimmed to measure 2.5 cm long by 2 cm deep and 2 cm wide (Fig 5). The tendon is left attached to the calcaneus. On the tibia, a sagittal saw is used to excise an equal size bone block at the tibial tubercle, in line with the trochlea. The Achilles allograft bone block is then tamped into this space (Fig 6) and secured with two 4.5-mm fully threaded cannulated screws with washers from the anterior to posterior

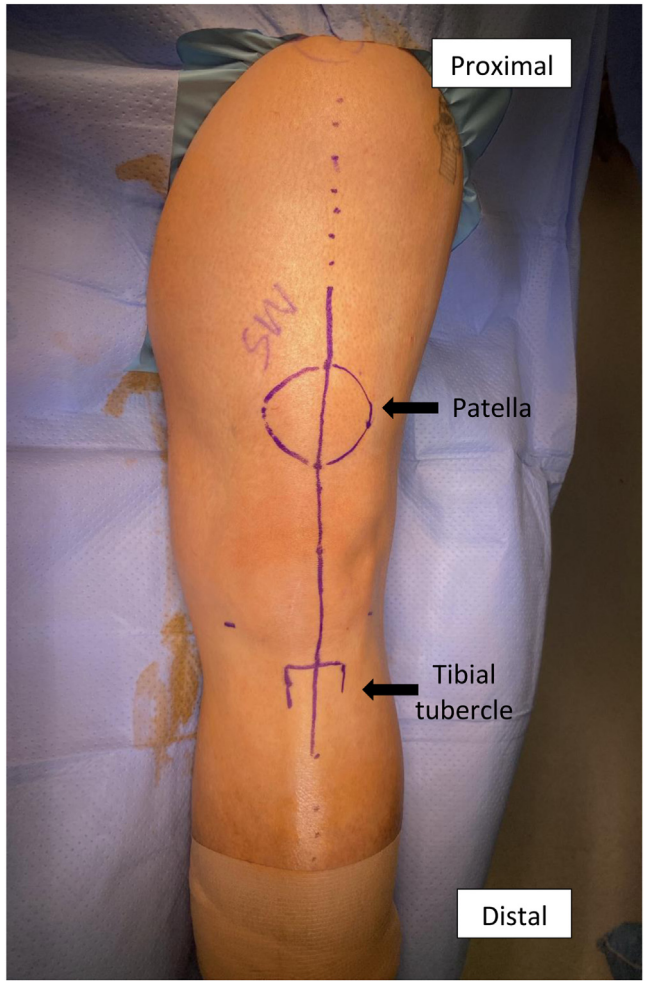

Fig 2. The patient is placed supine on the operating table, and the left lower extremity is prepped and draped in routine fashion. Care is taken to drape out to the proximal thigh to allow adequate exposure. A midline longitudinal incision is planned from several centimeters distal to the tibial tubercle extending proximally to the quadriceps tendon to expose the entire extensor mechanism.

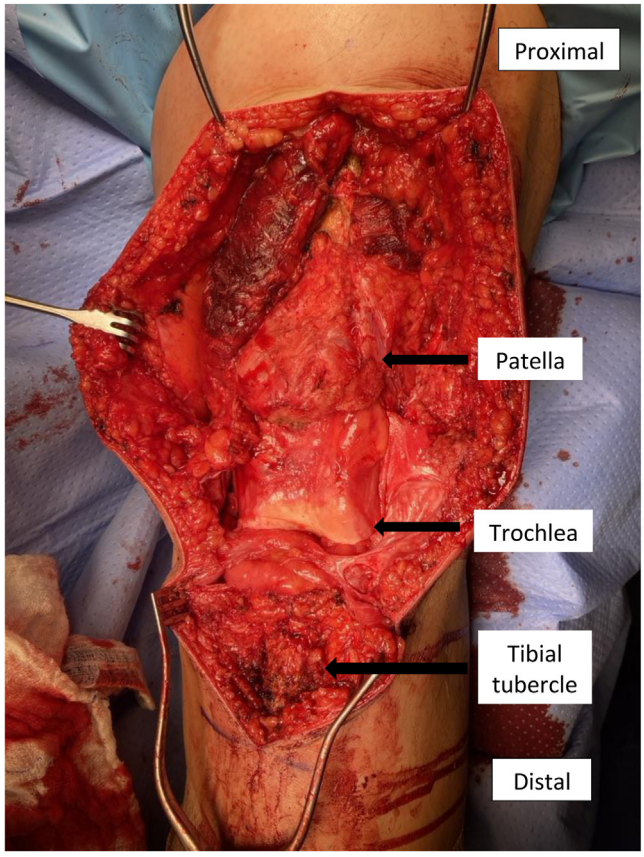

Fig 3. Extensive exposure of extensor mechanism with significant patella alta.

direction in lag fashion (Fig 7). One additional bicortical screw with a washer is placed just distal to this bone block in the native tibia to act as a post for suture tape augmentation (Fig 7).

Extensor Mechanism Reconstruction Construct

Figure 8 shows the completed reconstruction. The midportion of the FiberTape is wrapped around the post and the most proximal screw. The two free limbs of the FiberTape are then passed up through the tendinous portion of the Achilles allograft, so that they are superficial to the construct. The FiberTape is passed through the graft tendon once more from the anterior to posterior side, just before each limb was passed through the cannulated screws, previously placed in the patella. At the proximal end of the patella, the FiberTape ends are then passed from deep to superficial areas back up through the graft, where they were tied over the patella with the knee in full extension. The patella should be manually reduced distally using two Kocher clamps, while the FiberTape sutures are tied. The Achilles allograft itself is then secured to the native quadriceps tendon with multiple #2 FiberWire (Arthrex) sutures in figure-of-eight fashion (Fig 8). Finally, the retinaculum is closed over the graft with size 0 absorbable suture. The wound can then be closed in layers in standard fashion.

Postoperative Management and Rehabilitation Protocol

The knee should be immobilized in a hinged knee brace locked in extension for 6 to 8 weeks, with no range of motion. Weight bearing, as tolerated, is permitted. Then progressive knee flexion is initiated with physical therapy, in addition to a standard strengthening and proprioceptive program. The brace is discontinued once good quadriceps control is achieved, typically around 3 months postoperatively. At postoperative visits, gait, range of motion, and ability to perform straight leg raise should be assessed. A successful outcome generally consists of ability to ambulate without a brace, functional arc of flexion (at least 90°), and straight leg raise without lag (Fig 9). Radiographs should be obtained at each postoperative visit, assessing for stability of implants and measuring patellar height. Fig 10 shows the completed constructed with normal Caton-Deschamps index (CDI) of 1.11 at 13 months after surgery, improved from 2.35 preoperatively.

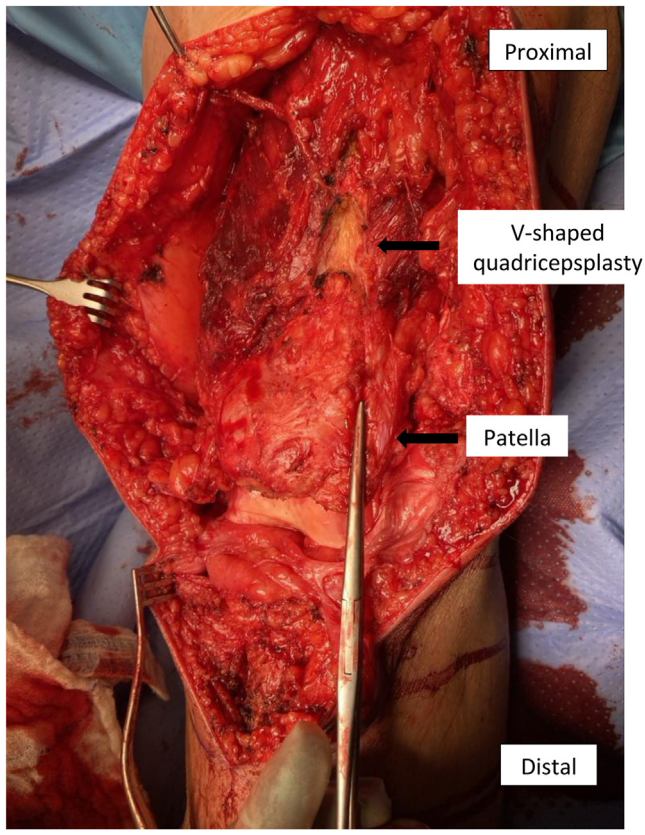

Fig 4. Improved distal excursion of patella after release of adhesions and fractional lengthening with V-shaped quadricepsplasty.

Fig 5. The Achilles allograft is thawed, and then the bone block is cut down, sized to 2.5 cm long by 2 cm deep and 2 cm wide.

Discussion

This surgical technique is effective for treating chronic extensor mechanism ruptures. Although Achilles tendon bone block allograft has been described for extensor mechanism reconstruction, the advantages of this technique include: 1) vertical cannulated screws in

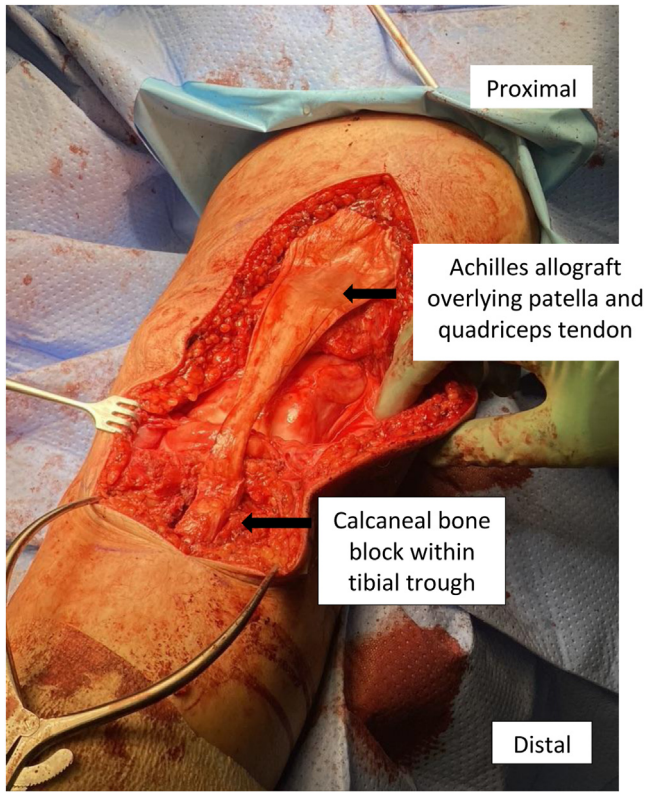

Fig 6. A matching tibial trough is created in the tibial tubercle using a saw and osteotomes. The Achilles allograft bone block is placed into this tibia trough. The soft tissue portion of the Achilles allograft is placed proximally to reconstruct the patellar tendon.

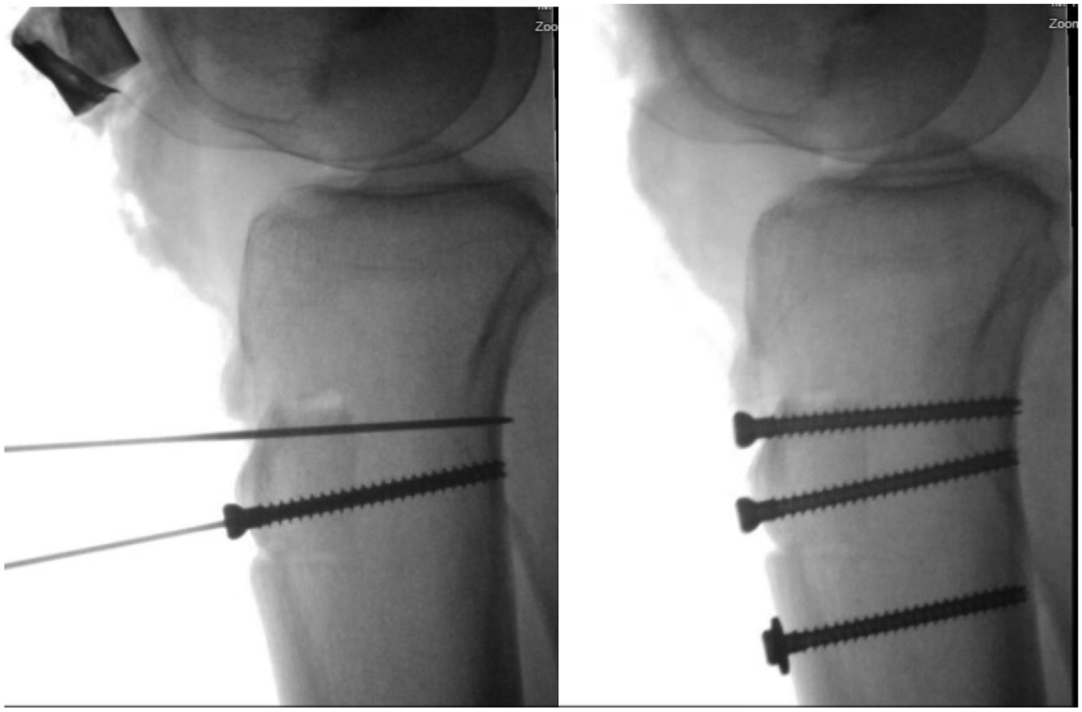

Fig 7. Intraoperative fluoroscopy (lateral of the knee) demonstrating fixation of the calcaneal bone block within the tibial trough using bicortical cannulated screws, 2 in the bone block, and 1 placed distal into native tibia to serve as a post for the suture tape.

the patella for passing tape augmentation sutures, 2) additional construct security and load sharing by suturing of the Achilles graft directly to the quadriceps tendon, and 3) an additional screw placed distal to the bone block in the tibia to serve as a post for suture tape augmentation. The advantages and limitations of this

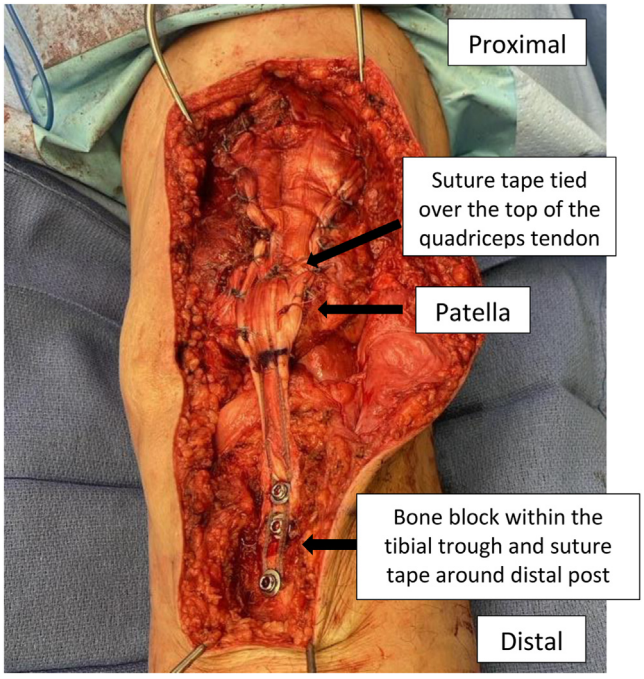

Fig 8. Final reconstruction completed with bone block secured into tibial trough, suture tape looped around the distal-most screw, which is used as a post. The suture tape is placed superficially to the Achilles tendon, then passed deep into the tendon and each limb, and passed up through the vertical cannulated screws in the patella. The suture tape is then passed up through the intact quadriceps tendon and Achilles allograft and tied over the top. The Achilles graft is sutured in multiple locations to the quadriceps tendon and patellar retinaculum.

Fig 9. Clinical photographs at 10-month postoperative follow-up showing extensor mechanism reconstruction with ability to perform straight leg raise without lag and functional degree of knee flexion.

technique are listed in Table 1, and technical pearls and pitfalls can be found in Table 2.

Treatment of chronic extensor mechanism disruptions is challenging. There is a paucity of data concerning outcomes of these cases. Murgier et al. demonstrated modest outcomes in their case series of 4 patients that were reconstructed using extensor mechanism allografts.[10] All patients were able to achieve active extension with a mean extensor deficit of 6.25°. Mean patellar height based on CDI was normal at 1.02 (0.4−1.8), but note the wide range in individual values ranging from low to high. Karas et al. published their results on 15 knees treated over a 17-year period using either Achilles tendon or whole extensor mechanism allograft. All patients were able to perform a straight leg raise postoperatively, and only 5 patients were noted to have an extensor lag, averaging 8° (3−18°). They also noted no postoperative reruptures.[11]

Prior techniques have been advocated for placing transverse screws across the patella. In this patient, transverse patellar screws were avoided given osteoporotic bone quality and bone loss. Drilling a 4.5-mm hole transversely in a patient with a typical patella (thickness of 22.4 mm) would result in a functional loss of 20% patellar thickness orthogonal to the main force vector of the extensor mechanism,[12] potentially decreasing strain to failure. While biomechanical data on screw configuration in the setting of patella tendon repair are limited, transverse patella fractures, especially at the inferior pole, become increasingly common in populations with poor bone quality.[13] Our technique involves vertically oriented drill holes with the patella, further protected by cannulated screws, which may reduce the risk of patella fracture. To further minimize tensile stress on the patella, direct fixation of the graft to the quadriceps tendon leads to load sharing in flexion.

Other graft options besides the Achilles tendon allograft include whole extensor mechanism grafting and synthetic grafting.[7,8,14] Modern synthetic grafts have been studied for patellar mechanism failures after total knee arthroplasty.[15] Retrospective data suggest these grafts may be less expensive and have biomechanical advantages over allograft options.[16] However, prospective data are limited, especially in the setting of chronic patellar ruptures in native knees. In this case, the ability to use a calcaneal bone block for reliable bone-to-bone healing in the tibia was one advantage of an Achilles allograft over soft tissue only or synthetic graft. Full extensor mechanism allograft reconstruction has also been described and could be considered an option in cases with severe patellar fragmentation, heterotopic ossification, or arthrofibrosis.[17]

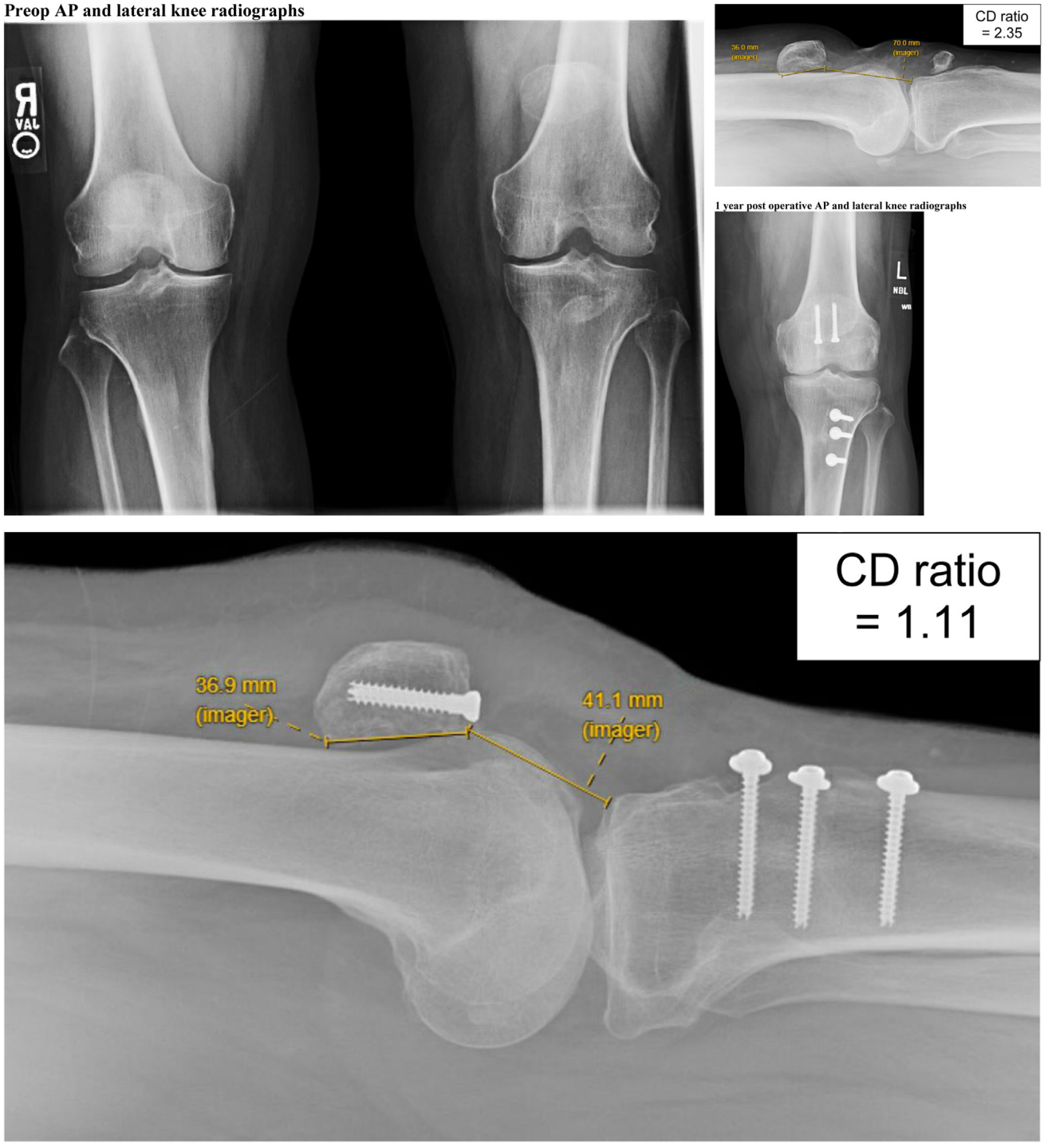

Fig 10. Preoperative and 1-year postoperative radiographs demonstrating Caton-Deschamps Index of 2.35 (patella alta) and 1.11 (normal), respectively. The postoperative radiographs show the final extensor mechanism reconstruction with vertical screws through the patella and fixation of the bone block within the tibial tubercle.

One limitation of this technique is that it requires an intact patella. Those with deficient patellar bone stock (i.e., prior patella excision or irreparable fracture) may benefit from full extensor mechanism allograft reconstruction. An additional limitation is that this technique cannot be used for extensor mechanism failure after total knee arthroplasty.

In summary, we present a technique for extensor mechanism reconstruction using an Achilles allograft with suture tape augmentation through vertical

Table 1. Advantages and Limitations of Technique

Advantages
The technique is safe and reproducible.
Vertical patellar screws limit the risk of fracture, especially in osteopenic bone and allow passage of suture tape.
Load sharing is improved by suturing the Achilles allograft directly to quadriceps tendon.
Bone-to-bone healing of the calcaneal bone block to the native tibia is reliable.
Ability to secure the suture tape to a post in the tibia.
Limitations
The chronic, and often retracted, nature of these injuries requires extensive exposure.
Quadricepsplasty can result in extensor lag.
Extended period of immobilization required to ensure construct integrity can result in stiffness in knee flexion.
Cannot be used in cases of total knee arthroplasty or with deficient patella bone.

cannulated screws with excellent clinical and radiographic outcome over 1 year. This technique warrants further investigation in larger groups of patients in the treatment of chronic inferior patellar pole fractures and chronic patellar tendon ruptures.

Table 2. Pearls and Pitfalls

Pearls
Use fluoroscopy to obtain contralateral knee perfect lateral images prior to draping.
Ensure that adequate exposure is possible by including the entire thigh in surgical field and using extensile incision.
Depending on retraction of the patella, releases can be performed sequentially, starting with release of adhesions around the quadriceps tendon and muscle, and then progressing to fractional lengthening of the quadriceps tendon, if necessary.
Keeping the patellar screw length slightly shorter than the length of the patella can help prevent cutting of the suture tape material proximally.
When creating the trough in the tibial tubercle for the calcaneal bone block, removal of the native tibial bone can be facilitated by cutting the bone into sections to be removed piecemeal and using an osteotome to lever them out of the trough.
A bolster under the heel to maintain full extension of the knee and traction sutures on the patellar tendon remnant can optimize patellar position, while the final construct is secured.
Pitfalls
Limited exposure can lead to difficulty in visualizing and mobilizing quadriceps tendon.
There is a risk of intraarticular penetration with patellar screws.
The tibial trough may need to be gradually expanded to allow the calcaneal bone block to fit flush with the anterior cortex of the tibia.
Prolonged postoperative immobilization can lead to knee flexion stiffness.
In some cases, quadriceps activation may be difficult to restore given chronicity of injury and may result in persistent extensor lag despite intact reconstruction and appropriate patellar height.

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