Patellar Tendon Imbrication for Patella Alta

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Abstract: Patella alta is a significant contributor to patellar instability. Historically, distalizing tibial tubercle osteotomy has been recommended for this problem; however, complications such as nonunion, fracture and hardware irritation are concerning. Additionally, the procedure cannot be performed on skeletally immature patients without violation of the proximal tibial physis. The authors describe a technique of patellar tendon imbrication that does not involve hardware or osteotomy. This technique allows for reliable correction of patella alta and provides patellar stability without the complications associated with osteotomy.

Introduction

Patella alta is a known anatomic risk factor for patellar instability.1,2 Dejour et al. noted that patella alta was one of the four major reasons for recurrent patellar instability.3 Patella alta is also a known risk factor for recurrent instability following isolated MPFL reconstruction.4,5 Treatment for patella alta has historically used a distalizing tibial tubercle osteotomy.6 Although effective, this technique is associated with complications such as nonunion and hardware irritation.7 Additionally, this procedure cannot be performed on skeletally immature patients without violation of proximal tibial physis. In 2007, Andrish et al. described a novel method of patellar tendon imbrication for patella alta, which avoided the need for osteotomy.8 The purpose of this technical note is to describe this procedure in more detail, given the recent publication of favorable results.9

Surgical Technique

The presented surgical technique was adapted from Andrish’s described technique in 2007.8 Indications include symptomatic patella alta with an abnormal patella height index or recurrent instability with patella alta. Although there is no gold imaging standard for determining pathologic patella alta, a CD ratio >1.3-1.4 has been cited as a reasonable indicator for patellar distalization.10 Additionally, the patellar trochlear index (PTI) has been described11 to determine patellar height. While a PTI <.20-25 has been determined to be 2 standard deviations below the mean, it is not known if this is an indicator of symptomatic alta. Unpublished expert opinion would consider distalization with a PTI <.20-.25.

Complete surgical technique is demonstrated in Video 1. Prior to surgery, the amount of shortening of the patellar tendon to normalize the patella height ratio is determined. The patient is positioned supine on the operating room table with a tourniquet positioned high on the thigh. Following a standard surgical prep and draping, the limb is exsanguinated using an Esmarch, and the tourniquet is inflated to 250 mmHg. The leg is...
positioned on a radiolucent triangle to optimize exposure and tension on the tendon (Fig 1). The inferior pole of the patella, the tibial tubercle, as well as the palpable borders of the patella tendon are marked. Using a 15 blade, a 7-10-cm incision is made on the lateral aspect of the patella to just proximal of the tibial tubercle. The location of the incision is surgeon dependent, but one of the authors (J.L.P.) prefers this approach to allow for concomitant lateral retinacular lengthening (LRL) when performing this in the setting of patellar stabilization to include LRL and medial patellofemoral ligament (MPFL) reconstruction. Further, this laterally based incision is better tolerated in a young population with regard to kneeling after surgery. Sharp dissection is carried through skin and subcutaneous tissue. If a LRL is performed, it will be done at this point prior to the imbrication. The paratenon is split longitudinally in the midportion of the patellar tendon, or it can be elevated from lateral to medial (often helpful when a LRL is performed in conjunction) to expose the patellar tendon. The tendon is elevated off the underlying fat pad.

With the tendon exposed, a broad, typically 1-inch osteotome is placed behind the tendon to give a stable surface to perform the imbrication. In the central aspect of the tendon, lines are drawn on the tendon to indicate the amount of anticipated shortening. The most common amount of shortening to perform is 1 cm. Another line is drawn more proximal, which is half the length of the anticipated shortening (Fig 2). This represents an anchor point for the posterior pleat of the imbrication. From the most distal marking, a sharp 15 blade is used to elevate the anterior half of the thickness of the tendon extending proximal to the anticipated shortening. Care must be taken to maintain 50% thickness and not completely transect the tendon. Performing this dissection with the knee flexed allows for easier incision and division of the patellar tendon in the coronal plane. With a marking pen, create an additional horizontal mark on the intact posterior tendon that is midway between the site of initial tendon elevation and the proximal terminus of the elevation (Fig 3). This represents the leading area where the tendon will be pleated on the posterior aspect to assist in the imbrication.

Using 0-Vicryl suture (Ethicon, Bridgewater, NJ), begin at the proximal line representing the anchor point of the posterior pleat, pass it completely through to the posterior aspect of the tendon and have it re-merge distally at the horizontal line that is present in

Fig 1. Patient is positioned supine with leg on radiolucent triangle in approximately 45° of flexion. Note the planned lateral para patellar incision.

Fig 2. After exposing the patella tendon, lines are drawn to demarcate the anticipated shortening. The most distal line is where the anterior tendon elevation will begin. The next line proximal is where the anterior flap elevation will end. In this example, this distance is 1 cm. The most proximal line is where the anchor point for the posterior pleat will be. That distance is half of the total length of the imbrication, which in this example is 5 mm.
sutures are placed in this fashion. Clamp the sutures ends for organization.

Remove the triangle and let the knee come into full extension. Pull the Vicryl sutures proximally and the nonabsorbable sutures distally to effect and evaluate the imbrication (Fig 6). Once adequate shortening is confirmed, begin by sequentially tying the Vicryl sutures while maintaining a provisional reduction of the imbrication by keeping tension on the rest of the sutures. Next, sequentially tie the distal row of nonabsorbable sutures. Use another 0-Vicryl suture to secure the distal free edge of the partial thickness flap down to the tendon. This will stabilize the flap and maximize the

Fig 4. Using 0-Vicryl suture (shown here in purple), a full-thickness pass is made through the proximal line and emerging at the midpoint of the intact posterior half of the tendon. A rip stop Mason-Allen type configuration is used distally before completing the mattress stitch. Not pictured here is the use of a broad osteotome that is used to stabilize the tendon and prevent inadvertent passage of sutures through the fat pad posterior to the tendon.

Fig 3. The anterior 50% of the patellar tendon has been elevated. A fourth mark is now created on the intact posterior half of the tendon that is midway between the initiation and proximal terminus of flap elevation. Solid white line indicates the remaining posterior 50% of the patellar tendon.

the intact posterior half of the tendon. The suture is passed back through the tendon in a horizontal fashion at this level to create a Mason-Allen rip stop configuration to minimize suture cut through on the tendon. The suture is then passed from anterior to posterior through the tendon and then finally passed from posterior to anterior at the level of the proximal pleat anchor point several millimeters away from the original entry point of the suture (Fig 4). Typically, four sutures are passed in this fashion. These sutures are clamped independently for later tying.

Next, use #2 high-strength nonabsorbable suture (FiberWire, Arthrex, Naples, FL) to create a similar rip-stop mattress suture configuration. This is accomplished by starting proximally at the apex of the flap and ending distally at the original beginning of the flap (Fig 5). However, these sutures are passed through the base of the elevated flap but are not passed deep to the posterior aspect of the intact tendon. Typically, 3
healing surface. Under direct visualization, evaluate the imbrication through a range of motion up to 90°, paying particular attention to the integrity of the sutures. Once confirmed, cut excess suture tails (Fig 7). For the free edge, we use an 0- Vicryl to suture down the free edge to secure the flap and maximize the healing surface. At this point, other procedures such as an MPFL reconstruction can be performed.

For closure, the peritenon is repaired with either 0- or 2-0-Vicryl suture. If a LRL was performed, it is typically

Fig 5. Nonabsorbable high-strength suture is then used to pass a mattress stich starting at the proximal end of the flap and ending at the beginning of flap elevation. A rip-stop configuration is used here as well, and it should be noted that this suture is kept anterior to the intact posterior half of the tendon when passing from proximal to distal. In this picture, an Army-Navy retractor (solid white arrow) is used to keep tension on the tendon to aid in suture passage, but it is now the author’s preference to use a broad osteotome deep into the tendon.

Fig 6. Once all sutures are passed but untied, tension is placed on the sutures, pulling the 0-Vicryl sutures (purple) proximally and the nonabsorbable sutures distally to approximate the imbrication.

Fig 7. Sutures are tied sequentially beginning with the 0-Vicryl sutures (purple) first followed by the nonabsorbable sutures. Imbrication is evaluated for stability through 90° of motion.
closed in lengthened fashion at this point (Fig 8). The dermal layer is closed with buried 2-0 PDS suture, and the subcuticular layer is closed with a running subcuticular 3-0 Monocryl.

Postoperatively, patients are allowed to weight bear as tolerated with a hinged knee brace locked in extension. Early range of motion will be to achieve 0°-90° by 6 weeks, and this can be pursued with graduated motion in the brace over the 6-week course, or the patient can be allowed immediate flexion to 90° when not ambulating. After that, the brace is discontinued and the range of motion is advanced. If rehab proceeds accordingly, the patient may begin impact activities at 3-6 months postoperatively.

Discussion

Patella alta is a known anatomic risk factor for patellar instability. Historically, a distalizing tibial tubercle osteotomy has been the preferred treatment to correct this. However, this technique is associated with several complications, including nonunion, fracture, and hardware irritation. Additionally, a distalizing tibial tubercle osteotomy cannot be performed on skeletally immature patients due to the violation of the proximal tibia physis. In this technique, the authors describe patellar tendon imbrication that does not involve osteotomy or use of hardware. This obviates the potential for complications such as nonunion and hardware irritation and can be performed on skeletally immature patients without concern for proximal tibia physis disruption. Further, because patella alta is due to a long patellar tendon and not to a pathologically proximal tibial tubercle, this procedure provides a direct treatment of the problem. This is in contradistinction from what a distalizing tibial tubercle osteotomy does, which is compensated for by the long tendon. Lastly, one of the authors (J.L.P.) performs this as his procedure of choice for all patients (excluding comorbid factors that could impair healing) with pathological patella alta, regardless of age or physeal status. It should be acknowledged that this procedure is indicated in young, healthy patients and should be looked at with caution in older patients with comorbidities that could impair healing. A list of advantages and disadvantages can be found in Table 1, and a list of pearls and pitfalls can be found in Table 2.

Table 1. Advantages and Disadvantages

| Advantages                                                                 | Disadvantages                                                                 |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Able to correct patellar height without need for osteotomy               | Poor tissue quality could contraindicate procedure.                          |
| Can perform safely on skeletally immature patients without violating proximal tibia physis | Potential for stretching of the tendon over time (not shown in recent study). |
| No risk for fracture, nonunion, delayed union, or hardware complications  | The thin patellar tendon is at risk of being completely transected if care is not taken during anterior flap elevation. |
|                                                                             | Lacks long term studies for range of motion and patient reported outcomes    |

Table 2. Pearls and Pitfalls

| Pearls | Pitfalls |
|--------|----------|
| Preoperative evaluation to determine the amount of shortening is paramount to success of the procedure. | Tendon transection: Care must be taken to elevate only 50% of the tendon |
| Having the knee flexed over a sturdy object such as a tibial triangle will optimize exposure and tension on the tendon during suture passage. | Under or overcorrection: Preoperative measurements as well as intraoperative measurements can be helpful in ensuring accurate correction. |
| Place the knee in full extension when provisionally reducing the imbrication. This will minimize any suture cut through on the tendon. | Failure to mobilize the tendon from the infrapatellar fat pad may cause tethering. |
| Carefully dissect peritenon on surgical approach in order to optimize closure. | Inadvertent suture passage into the fat pad could also cause abnormal tethering. |

Fig 8. The laterally based elevation of the peritenon is closed over the imbricated tendon. In this picture, the lateral retinaculum was also closed in a lengthened fashion.
Distalizing tibial tubercle osteotomy is an effective surgical procedure for patella alta in the setting of patellar instability. However, reports of complications are concerning. Complications associated with distalizing tibial tubercle osteotomy include nonunion, delayed union, proximal tibial fracture, hardware irritation, and difficulty with revision surgery. In fact, a recent systematic review identified the complication rate following tibial tubercle osteotomy to be 4.6%; this increases to 10.7% when the osteotomy is completely detached, as done for a distalizing procedure. When performing tibial tubercle osteotomy for distalization, the hardware removal rate has been reported to be 48.3%. Another study reported that tibial tubercle osteotomy for patella alta had a reoperation rate of 14.3%. Tibial tubercle osteotomy is an effective procedure for patella alta; however, the complication rate reported in the literature is concerning.

In 2007, Andrish et al. published a comprehensive review of patellar instability and included a technique for patellar tendon imbrication. Though outcomes were not published at that time, this technique was certainly of interest to surgeons wary of complications associated with tibial tubercle osteotomy and surgeons who treat skeletally immature patients with patella alta. In 2020, Patel et al. published results of patellar tendon imbrication for patella alta. They reported results on 27 patients (32 knees) with a minimum 2-year follow-up. They noted maintained correction at 2 years with no complications directly related to the technique. They conclude that patellar tendon imbrication is safe and effective for the correction of patella alta.

In conclusion, patella alta can be effectively treated with a patellar tendon imbrication, as described here. This technique obviates the need for osteotomy and its associated complications and can be performed on skeletally immature or mature patients.

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