

# Patellar Tendon Lengthening: Rescue Procedure for Patella Baja



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**Abstract:** Patella baja is a challenging pathologic condition that causes pain and functional restrictions and can even lead to premature osteoarthritis—even more so in cases of patella infera or cases associated with degeneration of the patellar tendon in which simple conservative treatment frequently is not resolute. Several surgical options have been described for symptomatic patella baja: excision of the lower third of the patella, lengthening of the patellar tendon, reconstruction of the patellar tendon with allograft, and proximalization of the tibial tubercle. A combination of 2 or more of these treatments may be recommended in cases of significant patella baja. We present a simple and reproducible technique to address patella baja that combines a partial transposition of the tibial tubercle and patellar tendon lengthening using a subperiosteal patellar flap in continuity with the patellar tendon.

**P**atella baja is defined as an abnormal low-lying patella that remains distal in relation to the femoral trochlea. It can affect patellofemoral tracking. To evaluate patellar height, different techniques and measuring classifications are available.<sup>1-4</sup>

When patella baja occurs, a shortening of the patellar tendon might be detected. This condition can be either congenital<sup>5</sup> or acquired. The latter can be due to direct

patellar trauma, fractures around the knee,<sup>6</sup> a chronic quadriceps tear,<sup>7</sup> paralysis of the quadriceps, quadriceps dysfunction after poliomyelitis, or complex regional pain syndrome.<sup>8,9</sup> Furthermore, this condition can be observed as an iatrogenic consequence of surgical procedures such as osteotomy,<sup>2,3</sup> anterior cruciate ligament reconstruction, or total knee arthroplasty.<sup>10-14</sup> Postoperative patella baja is frequently associated with arthrofibrosis in the context of infrapatellar contracture syndrome.<sup>13,15</sup> The resultant shortening of the tendon might be due to either shrinkage of the tendon's fibers or a mechanical adherence between the inner surface of the tendon and the anterosuperior aspect of the tibia.<sup>10-15</sup>

As a result of this pathologic condition, patients may complain of chronic anterior knee pain,<sup>4,16</sup> weakness of the extensor apparatus,<sup>2,3</sup> and restricted range of motion.<sup>4,14,16</sup> If this mechanically unfavorable condition is not properly addressed, a greater risk of development of premature osteoarthritis has also been observed.<sup>4,14</sup>

Conservative treatments of this pathologic condition include physiotherapy, systemic steroids, extracorporeal shock wave therapy, and dry needling. Conservative treatments do not usually produce good responses, especially in chronic cases. When conservative treatment fails, surgical revision may be indicated. Several surgical options have been described for symptomatic patella baja. They include excision of the lower third of the patella,<sup>10</sup> lengthening of the patellar tendon,<sup>16-20</sup>

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reconstruction of the patellar tendon with allograft,<sup>11,18</sup> and proximalization of the tibial tubercle.<sup>2,20</sup> A combination of 2 or more of these treatments may be recommended in cases of significant patella baja (e.g. Insall-Salvati index <0.5) or for relapse after primary treatment.

Regarding patellar tendon lengthening, many techniques have been described. The superiority of one over another has never been shown in terms of safety or clinical outcomes. In every case, the technique to be used should be technically easy, should be reproducible, and should allow for early postoperative mobilization to prevent joint stiffness and recurrence.<sup>21</sup> The aim of this study was to present a simple and reproducible way to correct patella baja by means of a technique that combines a partial transposition of the tibial tubercle and patellar tendon lengthening using a subperiosteal patellar flap in continuity with the patellar tendon.

### Indication and Preoperative Planning

Patella baja is defined by an Insall-Salvati index of less than 0.8 or a difference in the length of greater than 15% in comparison to the contralateral side.<sup>2</sup> A lengthening of the patellar tendon is indicated in patients with symptomatic patella baja not responsive to conservative treatment for more than 3 months (Fig 1).

Contraindications are active infections, locally aggressive rheumatic disease, and pathologic conditions that could negatively affect the healing of the tendon such as inadequately compensated diabetes or vasculitis. Smoking can also produce alterations in the microvascularization processes. Therefore, patients should



**Fig 1.** Intraoperative fluoroscopic evaluation of left knee with patient in supine position. A patellar lengthening procedure was performed for symptomatic patella baja not responsive to conservative treatment.

stop smoking for at least 6 months after surgery. In addition, in the case of collagenopathy, chronic steroid therapy, or hormonal alterations that can affect the tendon's tissue quality, augmentation by means of an allograft should be considered.

Preoperative evaluation should comprise magnetic resonance imaging to assess tendon dimension and quality as well as a lateral-view radiograph of both knees to calculate the patellar height of the affected knee to compare it with the unaffected side. A computed tomography scan could be requested for proper preoperative planning in cases of post-traumatic or congenital deformity of the inferior pole of the patella or the anterior tibial tuberosity. Preoperative planning should give us a precise idea of about how many centimeters we should proximalize the patella.

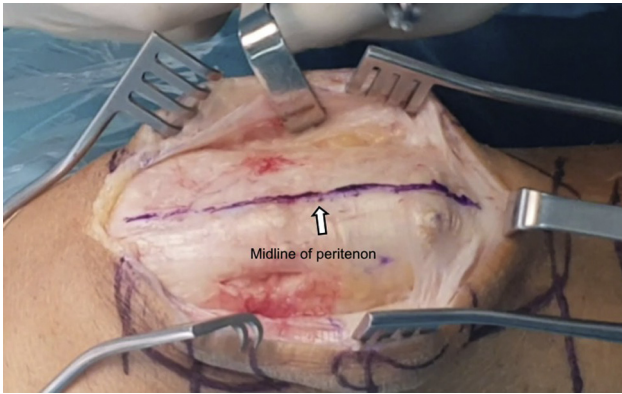
### Surgical Technique

The patient is positioned supine, with a tourniquet inflated at the proximal third of the thigh. Lateral support is put in place, and a distal stop is used to hold the lower extremity at 90° of flexion. An arthroscopic evaluation of all the knee's compartments is performed to establish whether any intra-articular problems contribute to lack of flexion and eventually to arthroscopically ablate fibrous scars. An anterior knee approach is subsequently performed from the proximal pole of the patella to the center of the tibial tubercle. The peritenon is sharply incised in its midline, creating flaps that should be closed at the end of the procedure. After complete mobilization of the patellar tendon, it is sized on the coronal plane and split into 2 halves equal in width, from the inferior pole of the patella to the anterior tibial tuberosity (Fig 2).

The lateral half is released proximally from the inferior pole of the patella, detaching the patellar periosteum with an electric scalpel. Thus, a continuum of the patellar periosteum is created with the lateral bundle of the tendon, leaving its insertion at the tibial tuberosity intact. The lateral rein is then created (Fig 3).

In the same way, the medial half is released from its distal insertion. In this case, the insertion of the tendon should be left intact, and a bone plug comprising all its fibers is harvested (Fig 4). On average, to achieve complete preservation of the enthesis, a bone plug of roughly 1 × 1.5 × 2 cm is created. First, the plug to be harvested is demarcated with an electric scalpel. Then, a hole is made in the center of the bone block with a 2.8-mm drill bit. Using an electric saw, we can start cutting over the previously marked border and finish detaching the bone plug with a chisel, avoiding fracturing both the harvested tissue and the anterior tuberosity.

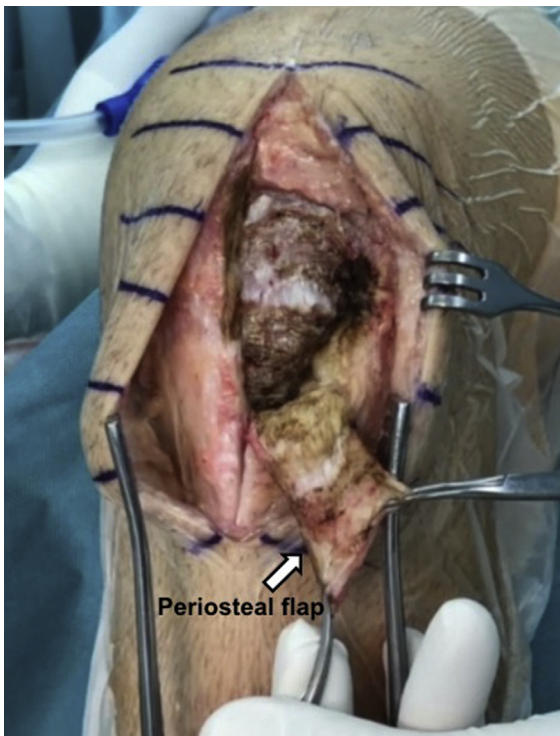
Once the bone plug is free, the proximal part of the medial rein is completely released from the medial, lateral, and deep adhesions, leaving its insertion intact at the inferior pole of the patella. Osteophytes at the



**Fig 2.** Left knee in extension, viewed from above, with patient in supine position. The peritenon of the patellar tendon is incised in its midline, creating 2 flaps, and the tendon is split into 2 halves equal in width, from the inferior pole of the patella to the anterior tibial tuberosity.

inferior pole of the patella might be found. Careful and thorough removal is required before proceeding to the next steps. Doing so will facilitate subsequent tendon reinsertion thanks to decortication of this area.

In accordance with our preoperative planning, we can now proceed to lengthening the tendon: The medial rein is moved proximally and the lateral one is moved distally, both the same distance (Fig 5). Once the



**Fig 3.** Left knee flexed 90°, frontal view, with the patient in the supine position. The lateral rein includes the lateral half of the patellar tendon in continuum with a periosteal flap obtained from the lateral half of the patella.

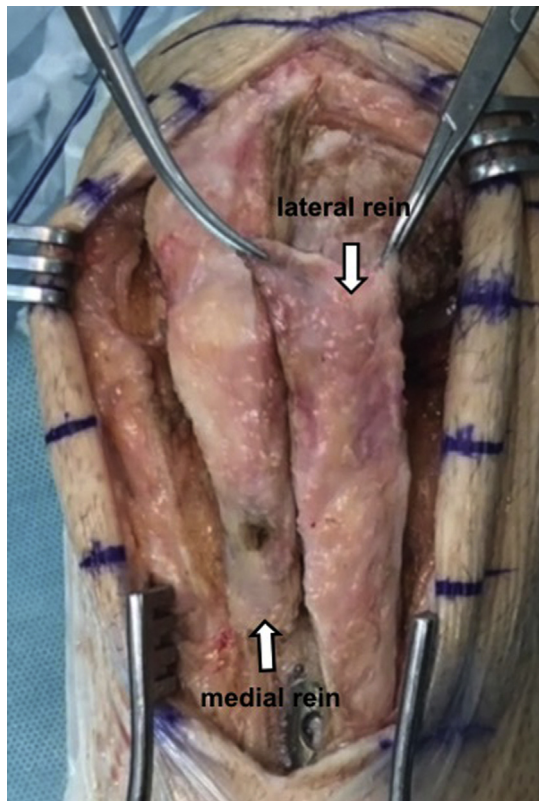
desired patellar height is seen to have been reached, lateral-view fluoroscopy with the knee in 90° of flexion should be performed to be sure that the right position has been achieved. A 2.8-mm drill bit is placed in the previously drilled hole, and it is drilled deeper into the tibia to mark its position. Decortication of the tibia around this hole is performed to a depth equal in size to the bone plug. The block is then fixed with a 3.5-mm cortical screw (Small Fragment System; DePuy Synthes) (Fig 6).

Two convergent suture anchors (Osteoraptor, 2.9 mm; Smith & Nephew) are placed in the lower pole of the patella on its lateral side (Fig 7). A backstitch-style Krackow suture is made to fix the lateral rein at this level, with care taken to create a large contact area between the periosteal flap and bleeding cancellous bone.

Both the medial and lateral reins should be fixed with the knee in 90° of flexion. Afterward, a fine adaptation at the center of the tendon is performed with resorbable No. 2-0 interrupted suture (Vicryl; Ethicon) to join the 2 reins together (Fig 8). Range of motion is then verified under fluoroscopy prior to closure. If adequate tension and complete range of motion are achieved, the



**Fig 4.** Left knee flexed 90°, frontal view, with patient in supine position. The medial rein includes the medial half of the patellar tendon and a bone block of at least 1 × 1.5 × 2 cm harvested in continuum with the patellar tendon from its insertion at the anterior tibial tuberosity.



**Fig 5.** Left knee flexed 90°, frontal view, with patient in supine position. In accordance with our preoperative planning, the medial rein of the patellar tendon is moved proximally and the lateral one is moved distally, both the same distance to lengthen the tendon symmetrically.

peritoneum is closed with a No. 4-0 continuous suture (Vicryl). A drain is left in place, and suturing of the wound is carried out.

In case of a high risk of recurrence or poor-quality soft tissues, an allograft can be used for biological augmentation. Achilles tendon is suggested in these cases. A bone block is obtained that is sized to precisely fit and fill the bone gap left from the proximal translation of the tibial bone block. The bone block of the allograft is inserted in a press-fit manner in the aforementioned defect and further blocked with a malleolar screw (Compact Ankle Fracture System; DePuy Synthes) (Fig 9). The soft part of the Achilles tendon is then fixed with a No. 0 absorbable suture (Vicryl) over the lengthened patellar tendon up to the quadriceps tendon while maintaining it in tension. The knee is finally immobilized in a brace locked in full extension.

A step-by-step summary of the technique is shown in Table 1. Table 2 provides pearls and pitfalls for performing this surgical procedure. The whole technique is described in detail in Video 1.

### Rehabilitation Protocol

Controlled continuous passive motion is started within the first few hours after the intervention. If

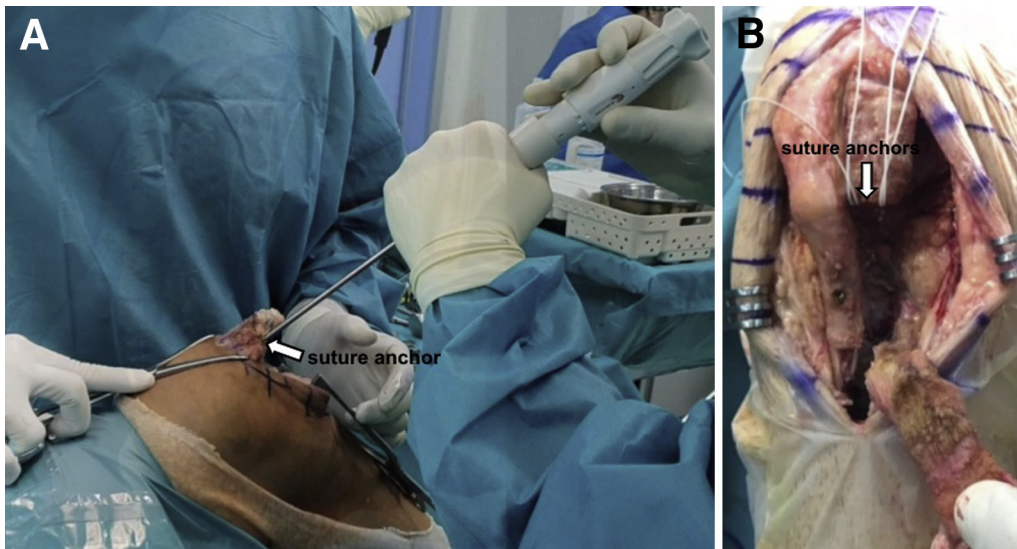
chronic (>1 year) lack of flexion is present, we suggest starting with continuous passive motion while keeping a peridural catheter in place for the first 48 hours to manage the pain and the reflex contraction. Limited range of motion between 0° and 90° is allowed for the first 2 weeks after the intervention. Isometric strengthening of the quadriceps and hamstring muscles is also recommended starting in the first few days after the procedure. Full weight bearing is allowed but only with a brace locked in full extension. We recommend leaving the same brace on overnight for the first 2 weeks after surgery to achieve better pain management and avoid sudden movements during sleep. The brace for weight bearing can be discontinued after 4 weeks if good muscular control has developed. After the first month, rehabilitation focuses on restoring full range of motion and strengthening the lower-limb musculature. Pivoting and strenuous activities are not recommended for the first 3 months. Moreover, athletic activity should be limited to light sports until 6 months postoperatively.

### Discussion

Patella baja is a challenging pathologic condition that causes pain and functional restrictions and can even lead to premature osteoarthritis.<sup>4,14,16</sup> So far, a gold



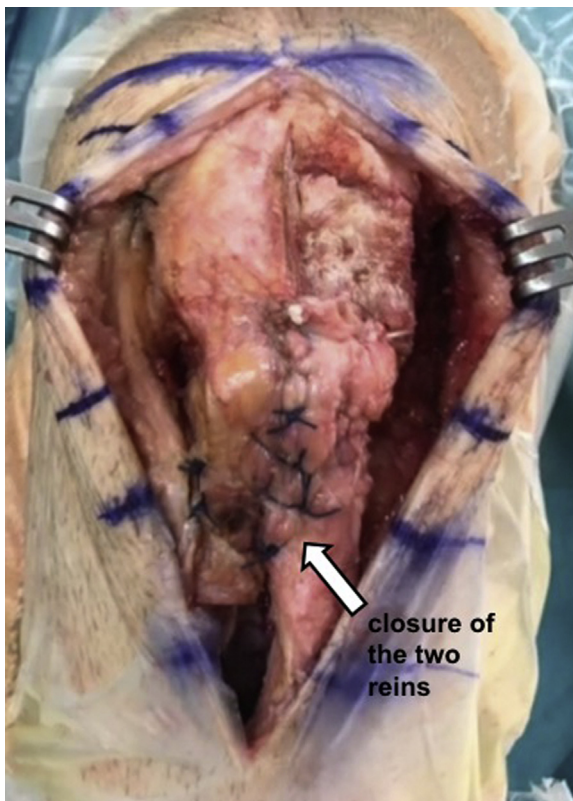
**Fig 6.** Right knee flexed 90°, anterolateral view, with patient in supine position. The bone block of the medial rein of the patellar tendon is fixed with a 3.5-mm cortical screw.



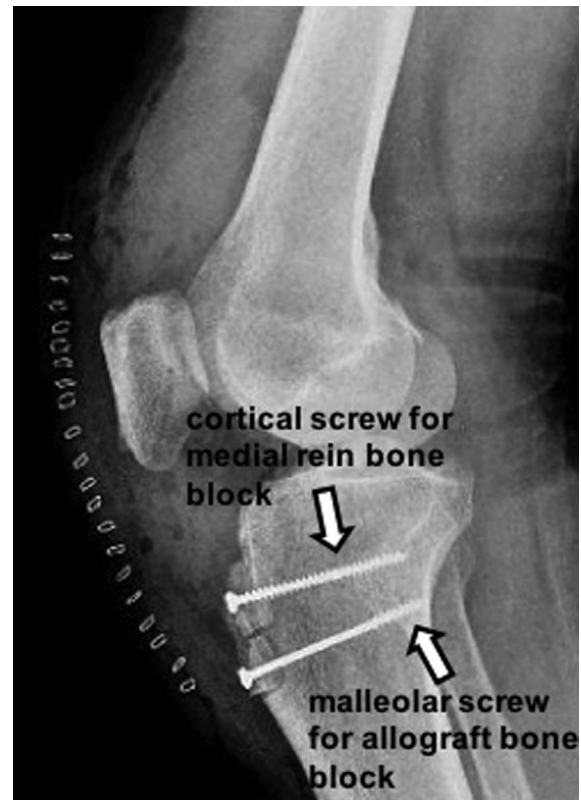
**Fig 7.** (A, B) Left knee flexed 90°, medial view, with the patient in the supine position. Two convergent suture anchors are placed in the lower pole of the patella on its lateral side to strongly fix the lateral rein.

standard for surgical treatment of this pathologic condition does not exist, but multiple techniques have been described in the literature. Excision of the lower third of the patella, lengthening of the patellar

tendon, reconstruction of the patellar tendon with allograft or autograft, and transposition of the tibial tubercle are among them.<sup>2,11,20</sup> Sometimes,



**Fig 8.** Left knee flexed 90°, frontal view, with patient in supine position. A fine adaptation at the center of the tendon is performed with resorbable No. 2-0 interrupted suture to join the 2 reins together.



**Fig 9.** Lateral-view radiograph of right knee postoperatively. When augmentation with allograft is performed, the bone block of the allograft is inserted in a press-fit manner in the bone defect remaining after harvesting of the bone block of the medial rein. The bone block of the allograft is further blocked with a malleolar screw.

**Table 1.** Step-by Step Patellar Tendon Lengthening

Step	Description
1	The patient is positioned supine on the operating table, with 90° of knee flexion, using a distal foot support and a lateral support for the thigh.
2	An arthroscopic evaluation of the knee is performed to establish whether any intra-articular problems contribute to lack of flexion and eventually to arthroscopically ablate fibrous scars.
3	An anterior knee approach is performed from the proximal pole of the patella to the center of the tibial tubercle.
4	The peritenon is sharply incised in its midline, creating flaps that should be closed at the end of the procedure.
5	The tendon is split into 2 halves on the coronal plane equal in width.
6	The lateral half is released proximally from the inferior pole of the patella, detaching the patellar periosteum with an electric scalpel and leaving its insertion at the tibial tuberosity intact.
7	The medial half is released from its distal insertion, harvesting a bone block of roughly 1 × 1.5 × 2 cm, leaving its insertion at the inferior pole of the patella intact.
8	Osteophytes at the inferior pole of the patella should be removed, achieving complete decortication of this area.
9	In accordance with our preoperative planning, we can length the tendon: The medial rein is moved proximally and the lateral one is moved distally, both the same distance.
10	The bone block of the medial rein is fixed with a 3.5-mm cortical screw after decortication of the area.
11	Two convergent suture anchors are placed in the lower pole of the patella on its lateral side to fix the lateral rein.
12	A fine adaptation at the center of the tendon is performed with resorbable No. 2-0 interrupted suture to join the 2 reins together.
13	If adequate tension and complete range of motion are achieved, the peritenon is closed with No. 4-0 Vicryl suture and the approach is closed in the usual manner.

a combination of several of the aforementioned techniques is required.

Our technique is a valid option to exploit both the advantages of tendon lengthening and the transposition of the tibial insertion of the tendon itself. Doing so, we can take advantage of the full length of the patellar periosteal flap that makes it possible for us to increase the patellar tendon height up to 3 cm. At the same time, we can produce the same amount of proximalization of half of the tibial anterior tuberosity using a bone block that leaves the new insertion on the tibial side very solid.

The weak point of the technique could be the reinsertion at the inferior pole of the patella, made by suture anchors. Attention should be paid to the direction of the anchors inserted. They should be convergent and have an adequate bone bridge in between. The

periosteal flap—cancellous bone contact point should be wide and bleeding. Thus, we are able to minimize the possibility of failure of the reinserted rail.

One advantage of our technique is that by leaving both the proximal and distal insertions of the tendon partially intact, the construct is solid and well vascularized. For this reason, the healing process is safe and quick. It even allows for immediate movement of the knee and load bearing as tolerated. Moreover, in that way, we do not change the Q angle at all, which is also important in patellofemoral tracking.<sup>22</sup> These points could be issues with other techniques such as complete osteotomy of the anterior tibial tubercle that presents the possibility of nonunion or an iatrogenic change in the Q angle.<sup>23</sup> Furthermore, our technique does not require any autografts and needs few and inexpensive devices to fix the tendon.

**Table 2.** Pearls, Pitfalls, and Risks

#### Pearls

Preoperative evaluation should comprise MRI to assess tendon dimension and quality as well as a lateral-view radiograph of both knees to calculate the patellar height of the affected knee in comparison to the unaffected side.

Once the desired patellar height is seen to have been reached, lateral-view fluoroscopy with the knee in 90° of flexion should be performed to prove it.

Both the medial and lateral reins should be fixed with the knee in 90° of flexion to avoid any hypertension.

If chronic lack of flexion is present, we suggest starting with continuous passive motion while keeping a peridural catheter in place for the first 48 hours.

#### Pitfalls and risks

Smoking can produce alterations in the micro-vascularization processes. Therefore, patients should stop smoking for at least 6 mo after surgery.

The anchors implanted in the patella can fail if not correctly placed. They should be convergent and with an adequate bone bridge in between. The periosteal flap—cancellous bone contact point should be wide and bleeding.

The surgeon should pay attention to harvesting a sufficient bone block from the anterior tibial tuberosity to maintain all the fibers of the medial rein of the tendon intact.

Pivoting and strenuous activities are not recommended for the first 3 mo. Athletic activity should be limited to light sports until 6 mo postoperatively.

MRI, magnetic resonance imaging.

**Table 3.** Advantages and Limitations**Advantages**

- The solid fixations allow early postoperative mobilization to prevent joint stiffness and recurrence.
- The healing process is safe and quick because of the solid and well-vascularized structure achieved.
- In case of collagenopathy, chronic steroid therapy, or hormonal alterations that can affect the tendon's tissue quality, augmentation with an Achilles tendon allograft could be performed.
- The Q angle is not changed. This guarantees good patellofemoral tracking.
- The diameter of the tendon does not decrease significantly.
- It is easy to precisely calculate the amount of proximalization, and it is possible to increase the patellar height up to 3 cm.
- Both the proximal and distal insertions of the tendon are left partially intact.

**Limitations**

- Only patients with severe pain and limitation of range of motion with no improvement during 3 mo of nonsurgical treatment are candidates for the described treatment.
- Aggressive rheumatic diseases, decompensated diabetes or vasculitis, and heavy smoking are not suitable indications.
- The surgical approach over the patellar tendon may lead to scar tissue formation between the subcutaneous tissue and the tendon itself.
- If augmentation with an allograft is performed, the cost of the technique increases.

Moreover, differently from other techniques, the final diameter of the tendon does not decrease significantly in comparison with the preoperative one and the incision of the tendon we suggest is in line with the direction of the fibers themselves. These points also guarantee good mechanical capacity of the newly built tendon.

Finally, given that the aim of the surgical procedure is to return the patella to its normal height, this technique makes it possible for the surgeon to easily calculate the amount of proximalization to be carried out intraoperatively to restore patellofemoral tracking and knee range of motion. The main advantages and disadvantages of the described technique are listed in Table 3.

In conclusion, the described technique is a valid option for anterior knee pain and decreased range of motion due to patella baja. Although the technique is not technically demanding, all steps should be carefully performed to avoid any risk of failure.

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