Technical Note

Modified Grammont Soft-Tissue Distal Patellar Realignment and Medial Patellofemoral Ligament Reconstruction for Patellofemoral Instability in Pediatric Patients

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Abstract: Patellar dislocation is a relatively common pediatric injury, which often results in recurrent patellofemoral instability. An increased tibial tubercle—trochlear groove distance predisposes to patellofemoral instability and can be corrected with a distal realignment procedure. Soft-tissue distal realignment procedures must be used in the pediatric population to avoid the risks of premature physeal closure associated with tibial tubercle osteotomies. Several soft-tissue distal realignment procedures have been described, with no consensus as to the optimal technique. When combined with medial patellofemoral ligament reconstruction, distal realignment procedures can restore patellofemoral stability through the entire flexion arc. This article describes a modification of the Grammont distal patellar realignment procedure in conjunction with medial patellofemoral ligament reconstruction for the management of pediatric patellofemoral instability.

Patellofemoral instability is a relatively common pediatric issue, with acute dislocations occurring in approximately 30 to 40 per 100,000 children.[1,2] Recurrent dislocations and instability are concerns in this population and can occur in up to two-thirds of patients after patellar dislocation.[3,4]

Distal realignment procedures are indicated in patients with an increased tibial tubercle—trochlear groove (TT-TG) distance and improve patellar tracking within the trochlear groove after 30° of flexion. Several techniques have been described, including but not limited to the Maquet, Fulkerson, Elmslie-Trillat, Roux-Goldthwait, Nietosvaara, and Grammont procedures.[5] Techniques involving a tibial tubercle osteotomy, such as the Maquet, Fulkerson, and Elmslie-Trillat procedures, should be limited to those patients with closed or nearly closed proximal tibial physes to avoid premature physeal closure. Overall, there are several soft-tissue realignment procedures that may be used in children and adolescents for the surgical management of patellar instability. The success rates of these procedures vary widely, and none has been shown to be superior.[6]

Grammont et al.[7] in 1985 first described a soft-tissue procedure for the correction of patellar instability using a lateral release and medial fixation of the patellar tendon on the tibial tubercle in the setting of pediatric patients with congenital patellar dislocations; this procedure was performed simultaneously with the Langenskiöld procedure. Several modifications of this technique have since been described with reported favorable outcomes.[8-10] Nevertheless, there is no consensus on the preferred surgical technique for distal patellar realignment in the skeletally immature patient.

This article describes a modification of the procedure described by Grammont et al.[7] in conjunction with medial patellofemoral ligament (MPFL) reconstruction (as opposed to the Langenskiöld procedure) for patellar

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Fig 1. The patient is positioned supine on a standard operating room table.

instability in skeletally immature patients. A demonstration of the main surgical steps is provided in Video 1.

Surgical Technique

The patient is placed supine on a standard radiolucent operating room table and then induced under general anesthesia. A pneumatic tourniquet is placed high on the thigh, and a Bone Foam leg elevator (Corcoran, MN) is placed under the operative extremity. The leg is then prepared and draped in preparation for diagnostic arthroscopy (Figs 1 and 2). Preoperative landmarks are marked, including the medial border of the patella, tibial tubercle, and anteromedial and anterolateral arthroscopy portals, as well as the planned incision on the medial aspect of the patellar tendon (Fig 3). A diagnostic arthroscopy through a standard anterolateral portal is performed to assess and address any relevant intra-articular pathology. A lateral release can be performed if excessive patellar tilt is noted on diagnostic arthroscopy. A lateral retinacular release is performed arthroscopically with a radiofrequency electrode system in instances with patellar tilt greater than 20° or tightness of the lateral retinacular structures preventing passive centralization of the patella.

Fig 2. The left leg is prepared and draped in standard fashion for diagnostic arthroscopy.

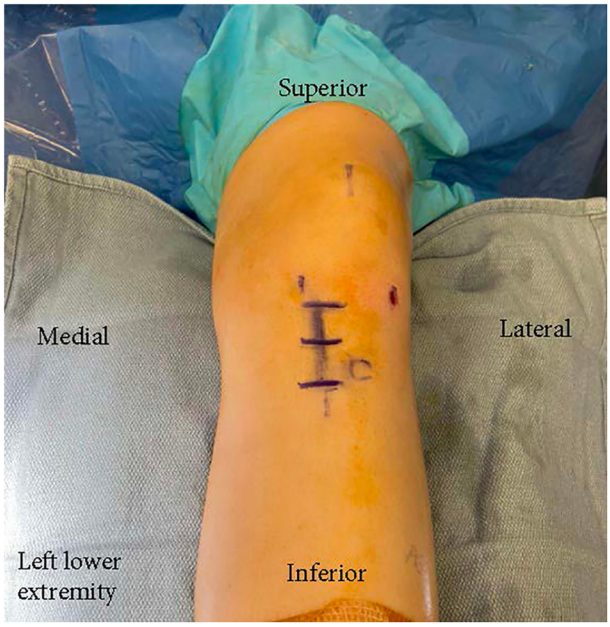

Fig 3. Preoperative landmarks are marked on the left knee, including medial and lateral arthroscopic portals, the medial border of the patella, the tibial tubercle, and the anticipated incision (dashes) on the medial aspect of the patellar tendon.

At the completion of the arthroscopic portion of the case, attention is turned to distal patellar realignment. A longitudinal incision is made over the medial border of the patellar tendon from the joint line to the distal tibial tubercle in line with the anteromedial arthroscopic portal. Dissection is continued to the level of the patellar tendon, and a lateral flap is raised to expose the lateral border of the tendon. With the medial and lateral borders of the tendon exposed, the undersurface of the tendon is dissected away from the underlying fat pad until the attachment at the tubercle is visible. By use of a combination of sharp dissection and

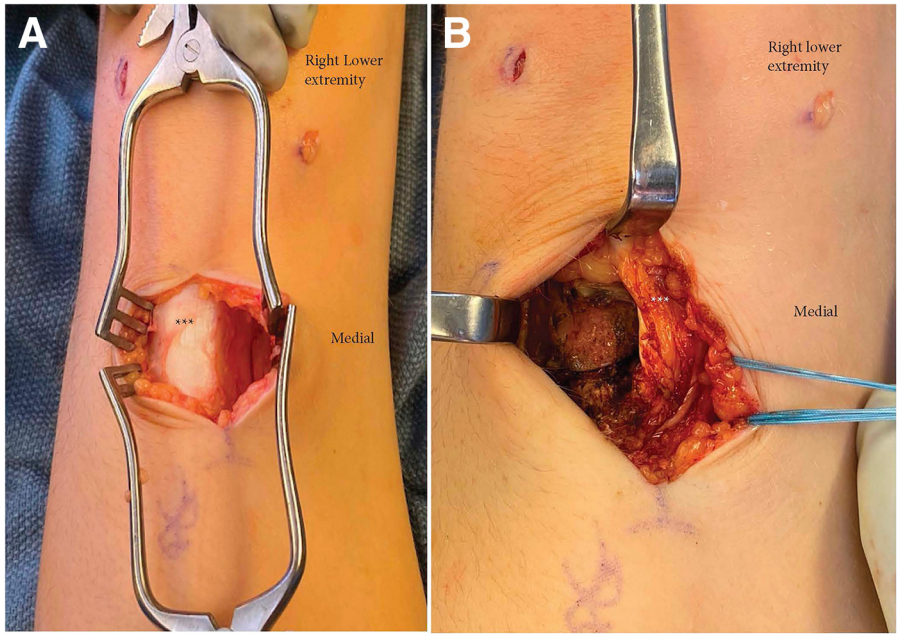

Fig 4. Intraoperative views of patellar tendon (asterisks) in right knee. (A) Relatively lateralized initial position of patellar tendon. (B) Adequate medial excursion of patellar tendon after suture placement and manual translation.

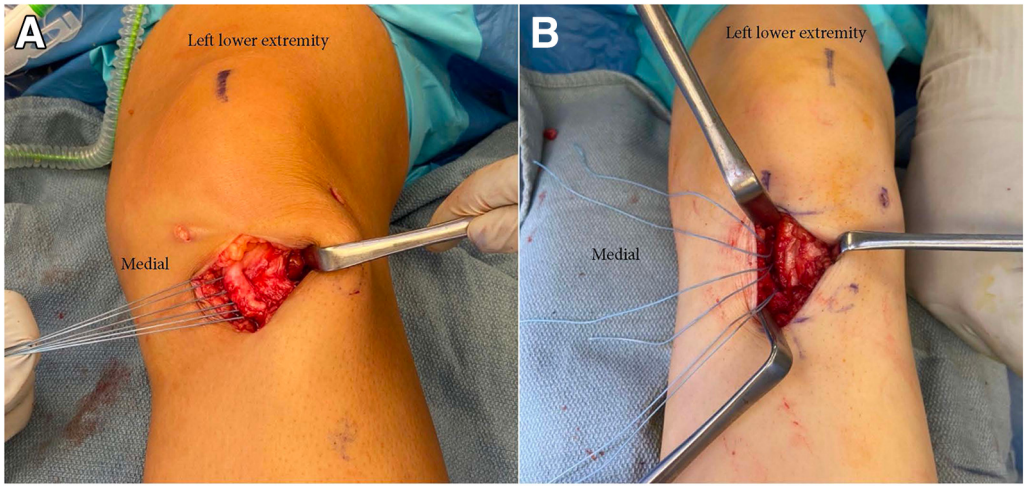

Fig 5. (A) Medial excursion of left patellar tendon with manual translation. (B) Patellar tendon resting in medialized position after sutures are secured to anteromedial tibia with 3 suture anchors to complete modified Grammont distal patellar realignment procedure.

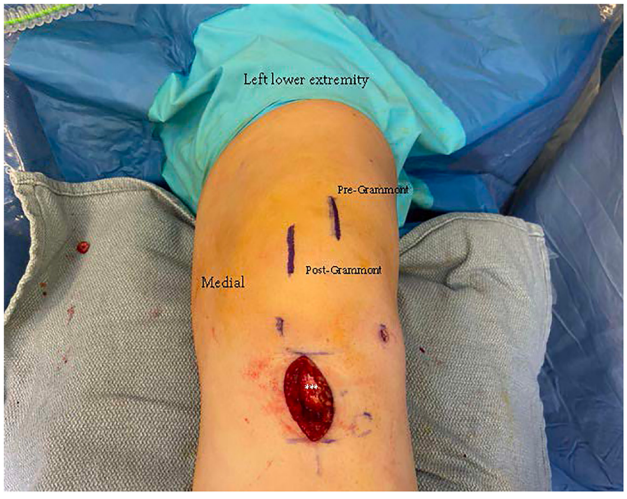

Fig 6. Marking the medial border of the patella preoperatively and after the modified Grammont procedure shows medial translation and slight distalization of the patella (left knee).

Fig 7. The C-arm should be positioned on the same side as the operative extremity to facilitate fluoroscopy during medial patellofemoral ligament reconstruction. The C-arm is positioned on the left side of the patient for medial patellofemoral ligament reconstruction in the left knee.

Fig 8. The surgeon should be positioned on the contralateral side of the operating room table to allow access to the medial knee for medial patellofemoral ligament reconstruction.

electrocautery, the tendon is elevated subperiosteally off the tubercle from proximal to distal until it is attached only at the distal-most aspect of the tubercle and the distal periosteum is left intact.

With the distal attachment left intact, the tendon is translated medially while patellar stability is manually assessed in about 20° of knee flexion to determine the final positioning of the tendon. Medial translation of the tendon is considered adequate when manual patellar translation does not exceed 1 quadrant. The desired new location of the tendon is marked on the tibia with a marking pen or with electrocautery. Three No. 2 FiberWire sutures (Arthrex, Naples, FL) are placed into the medial border of the patellar tendon in a modified Kessler fashion. The suture placement is tailored to allow for 3 points of fixation of the medial patellar tendon into the anteromedial aspect of the proximal tibia with suture anchors. The sutures are then pulled medially to test the suture purchase and to demonstrate medial excursion of the patellar tendon (Fig 4).

Three 3.9-mm SwiveLock suture anchors (Arthrex) are placed into the anteromedial tibia at the desired final position of the patellar tendon. The sutures within

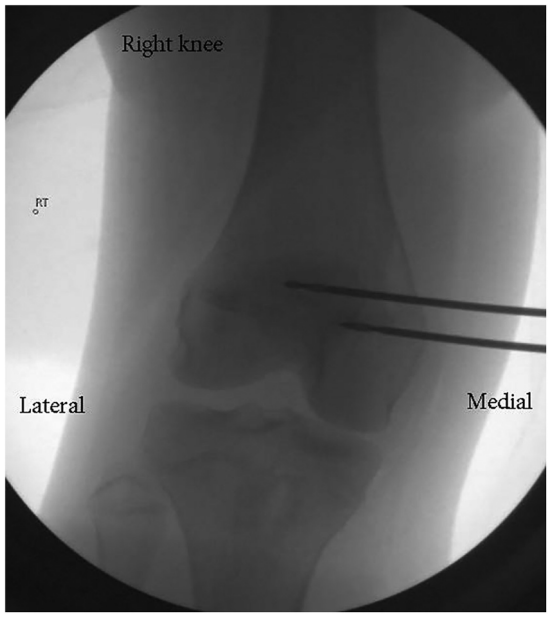

Fig 9. Intraoperative fluoroscopy is used during medial patellofemoral ligament reconstruction to ensure parallel placement of guidewires into the patella to mark the locations of the medial patellofemoral ligament patellar tunnels. (RT, right.)

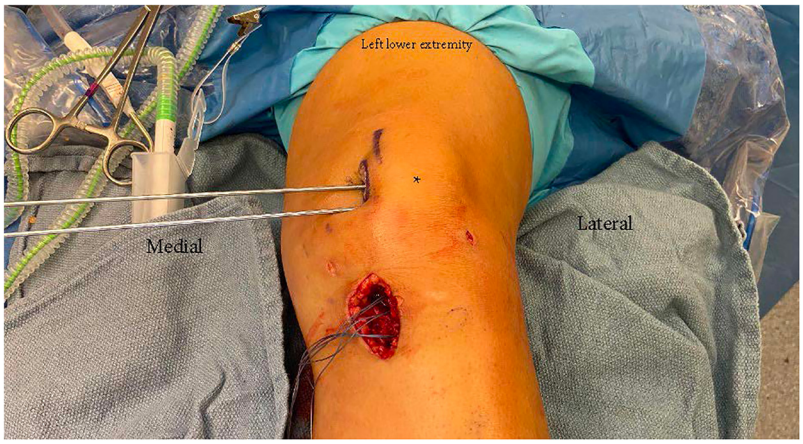

Fig 10. Two parallel guidewires are placed into the patella (star) under fluoroscopic guidance and are then over-drilled to create tunnels for graft fixation with suture anchors for medial patellofemoral ligament reconstruction (left knee).

the tendon are tensioned and fixed sequentially from proximal to distal (Fig 5). Examination of the patella should now show relative medialization, as well as improved stability with no more than 1 quadrant of lateral translation (Fig 6).

After the completion of the modified Grammont procedure, we proceed with the MPFL reconstruction. A skin incision is made over the medial border of the patella, and dissection is taken down through the subcutaneous tissue to expose the medial border of the patella. A rongeur is used to remove residual soft tissue and to create a shallow groove to facilitate the placement of patellar tunnels. A C-arm is positioned on the ipsilateral side of the operative extremity, and the surgeon is positioned on the contralateral side of the operating room table (Figs 7 and 8).

A hamstring tendon allograft is prepared with sutures at either end. Hamstring tendon autograft or other graft types can be used based on surgeon preference. Two parallel guidewires are inserted into the patella from medial to lateral under fluoroscopy, with care taken not to penetrate the articular surface (Figs 9 and 10). The guidewires are over-drilled with a 4.5-mm cannulated drill, and the 2 free ends of the graft are fixed to the patella using 4.75-mm SwiveLock suture anchors.

Soft-tissue dissection is then taken between layers 2 and 3 of the knee to the medial aspect of the distal femur to create a soft-tissue tunnel for the graft. Fluoroscopic guidance is used to identify the location of distal femoral graft fixation at the Schöttle point, distal to the distal femoral physis and anterior to the Blumensaat line (Fig 11). In a recent case series using

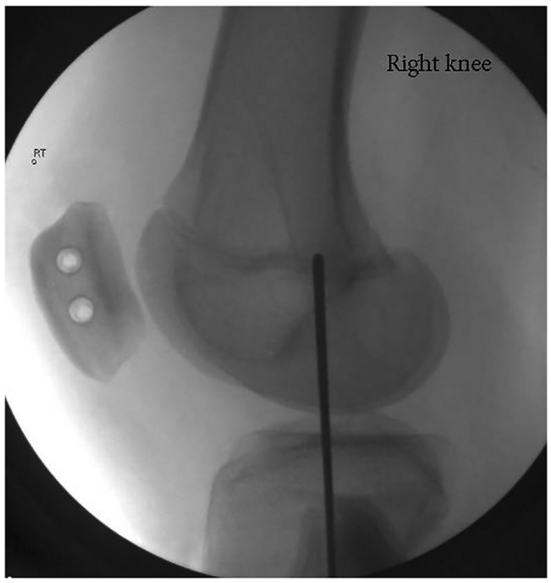

Fig 11. The Schöttle point is localized under fluoroscopy just anterior to the posterior femoral cortex, anterior to the Blumensaat line, and just distal to the distal femoral physis. This point marks the location of the femoral tunnel for medial patellofemoral ligament reconstruction. (RT, right.)

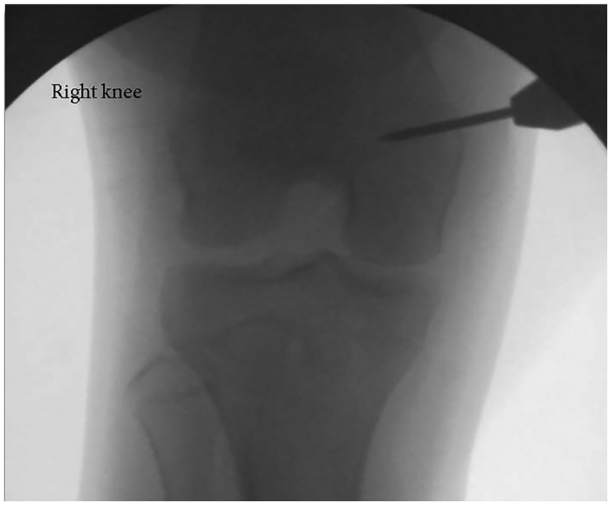

Fig 12. An intraoperative notch view is used during guide pin placement for the medial patellofemoral ligament femoral tunnel to ensure placement of the guide pin distal to the distal femoral physis and proximal to the intercondylar notch.

3-dimensional computed tomography imaging, it was determined that the Schöttle point was located 8.1 ± 0.2 mm (95% confidence interval, 7.7-8.5 mm) distal to the apex of the adductor tubercle and 8.0 ± 0.3 mm (95% confidence interval, 7.4-8.6 mm) anterior to the posterior edge of the femur.[11]

A 2.7-mm passing pin is placed at this point and advanced from medial to lateral through the far cortex and out of the skin with about 15° of inferior and anterior inclination to avoid the distal femoral physis and avoid penetrating the intercondylar notch (Fig 12). A small incision is made medially along the passing pin

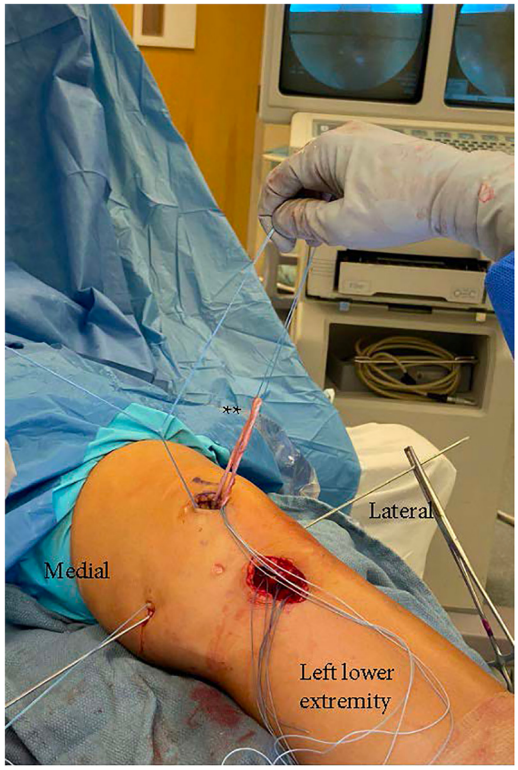

Fig 13. After the medial patellofemoral ligament graft (stars) is secured to the patella, a suture loop is passed between the limbs of the graft to facilitate shuttling the free end of the graft from the patella to the medial distal femur (left knee).

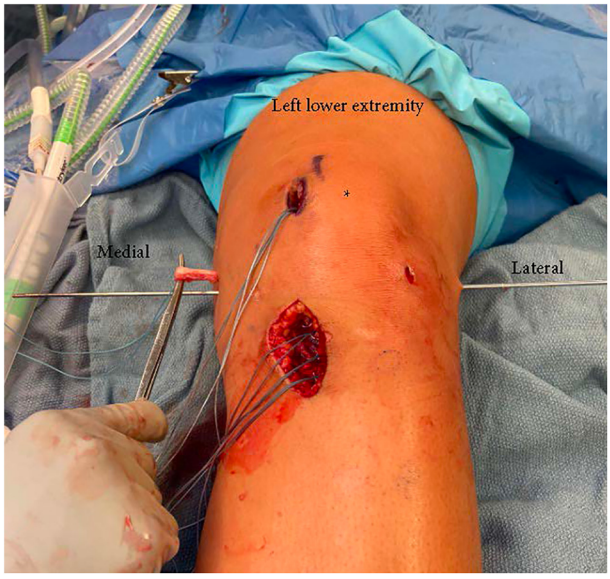

Fig 14. The free end of the medial patellofemoral ligament graft (star) is passed between layers 2 and 3 of the medial knee using a suture loop (left knee). The suture loop is then threaded into a passing pin in the distal femur, and the pin is pulled out of the lateral thigh to facilitate graft passage into the femoral tunnel.

to allow for over-drilling with a 7-mm cannulated drill that is taken about 75% across the distal femur to create a femoral tunnel for graft fixation. A suture loop is used to pass the graft through the soft-tissue tunnel between layers 2 and 3 of the medial knee (Figs 13 and 14). The suture ends are then threaded into the passing pin, which is pulled out of the lateral side of the knee.

The suture loop is used to tension the graft within the distal femoral tunnel. A nitinol guidewire is placed into the medial side of the femoral tunnel, and a 6-mm bioabsorbable interference screw is advanced over the guidewire to secure the graft within the tunnel with the knee held in approximately 20° of flexion. After fixation, the patella is stable throughout a full range of motion with no more than 1 quadrant of lateral translation with manual testing.

The incisions are closed and covered in sterile dressings. Postoperatively, patients are limited to toe-touch weight bearing for 6 weeks in a hinged knee brace with 0° to 40° of motion. Each week, an additional 10° of motion is allowed. After 6 weeks, range-of-motion and activity restrictions are removed.

Discussion

Recurrent patellar dislocations in the pediatric population can be effectively managed with a combination of a modified Grammont procedure with MPFL reconstruction. We believe the modified Grammont procedure may be beneficial relative to other soft-tissue procedures in that it maintains the integrity of the patellar tendon, re-creates more anatomic patellofemoral joint biomechanics, and is technically less demanding than other methods. When combined with MPFL reconstruction, this procedure both corrects the increased tibial tubercle–trochlear groove (TT-TG) distance and restores the medial checkrein for stability in the first 30° of flexion. Our modified Grammont technique combined with MPFL reconstruction has shown promising early clinical results. This technique can also be considered in patients approaching or at skeletal maturity and is advantageous over tibial tubercle osteotomies in that it avoids risk to the physis and leads to a quicker and less painful recovery. Additional long-term comparative studies are needed to determine the relative efficacy of the described soft-tissue distal patellar realignment procedures; however, the modified Grammont technique provides an alternative option for the management of pediatric and adolescent patellofemoral instability. Risk factors for patellar instability are presented in Table 1, and pearls and pitfalls of our technique are presented in Table 2.

Table 1. Risk Factors for Patellar Instability

Major
Trochlear dysplasia
Patellar tilt
Patella alta
Increased TT-TG distance
Minor
Young age
Ligamentous laxity
Genu valgum
Increased Q-angle (femoral anteversion and/or external tibial torsion)

TT-TG, tibial tubercle–trochlear groove.

Table 2. Pearls and Pitfalls of Modified Grammont Distal Patellar Realignment

Pearls
Adequate exposure of the medial and lateral borders of the patellar tendon should be obtained to minimize the risk of tendon injury.
The surgeon should take a full-thickness sleeve from the superior aspect of the tubercle to the level of the periosteum distal to the tubercle to allow for sufficient excursion of the tendon.
Patellar stability should be tested prior to fixation by manually translating the tendon medially until the desired tension and stability are obtained.
Weight bearing should be protected for 6 wk to avoid disruption of extensor mechanism fixation.
Pitfalls
Care must be taken to avoid excessive distalization of the patella when fixing the patellar tendon medially.
The MPFL femoral tunnel should start at the Schöttle point and be angled with about 15° of inferior and anterior inclination to avoid the distal femoral physis and the intercondylar notch.
Over-tightening the MPFL graft may lead to excessive medial restraint.

MPFL, medial patellofemoral ligament.

Table 3 describes the advantages and disadvantages of the modified Grammont technique relative to other distal patellar realignment procedures.

Table 3. Advantages and Disadvantages of Modified Grammont Procedure Relative to Other Distal Patellar Realignment Procedures

Advantages
Risk to the physis is minimized relative to tibial tubercle osteotomy.
This procedure avoids the iatrogenic patellar tilt produced by other all—soft tissue realignment procedures.
This procedure can be combined effectively with proximal realignment procedures including MPFL reconstruction.
This procedure is less technically demanding than other distal realignment procedures.
Disadvantages
This procedure can lead to increased patellofemoral joint contact pressures.
MPFL patellar tunnels can predispose to patellar fracture.
Arthrofibrosis is a potential complication leading to limited range of motion.
Prolonged protected weight bearing increases the risk of DVT formation.

DVT, deep venous thrombosis; MPFL, medial patellofemoral ligament.

References

1. Nietosvaara Y, Aalto K, Kallio PE. Acute patellar dislocation in children: Incidence and associated osteochondral fractures. *J Pediatr Orthop* 1994;14:513-515.
2. Fithian DC, Paxton EW, Stone ML, et al. Epidemiology and natural history of acute patellar dislocation. *Am J Sports Med* 2004;32:1114-1121.
3. Popkin CA, Bayomy AF, Trupia EP, Chan CM, Redler LH. Patellar instability in the skeletally immature. *Curr Rev Musculoskelet Med* 2018;11:172-181.
4. Palmu S, Kallio PE, Donell ST, Helenius I, Nietosvaara Y. Acute patellar dislocation in children and adolescents: A randomized clinical trial. *J Bone Joint Surg Am* 2008;90:463-470.
5. Longo UG, Rizzello G, Ciuffreda M, et al. Elmslie-Trillat, Maquet, Fulkerson, Roux Goldthwait, and other distal realignment procedures for the management of patellar dislocation: Systematic review and quantitative synthesis of the literature. *Arthroscopy* 2016;32:929-943.
6. Wilkens OE, Hannink G, van de Groes SAW. Recurrent patellofemoral instability rates after MPFL reconstruction techniques are in the range of instability rates after other soft tissue realignment techniques. *Knee Surg Sports Traumatol Arthrosc* 2020;28:1919-1931.
7. Grammont PM, Latune D, Lammaire IP. Die Behandlung der Subluxation und Luxation der Kniescheibe beim Kind. Technik von Elmslie mit beweglichem Weichteilstiel (8-Jahres-Ubersicht) [Treatment of subluxation and dislocation of the patella in the child. Elmslie technic with movable soft tissue pedicle (8 year review)]. *Orthopade* 1985;14:229-238 [in German].
8. Kraus T, Lidder S, Švehlík M, et al. Patella re-alignment in children with a modified Grammont technique. *Acta Orthop* 2012;83:504-510.
9. Musielak BJ, Premakumaran P, Janusz P, Dziurda M, Koch A, Walczak M. Good outcomes of modified Grammont and Langenskiöld technique in children with habitual patellar dislocation. *Knee Surg Sports Traumatol Arthrosc* 2021;29:1983-1989.
10. Mo Y, Jing Y, Wang D, Paley D, Ning B. Modified Langenskiöld procedure for congenital patella dislocations in pediatric patients. *BMC Musculoskelet Disord* 2022;23:241.
11. Wang HJ, Song YF, Yan X, et al. Using anatomic landmarks to locate Schöttle's point was accurate without fluoroscopy during medial patellofemoral ligament reconstruction. *Arthroscopy* 2021;37:1902-1908.