Technical Note

Surgical Technique for Obligate Flexion Patellar Dislocation: Medial Patellofemoral Ligament Reconstruction, Distal Femoral Osteotomy, Quadricepsplasty, and Lateral Retinacular Reconstruction with Dermal Allograft

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Abstract: Lateral patellar dislocation is a relatively common pathology that can be surgically treated with a medial patellofemoral ligament reconstruction. In rare occurrences patients can present with patellar maltracking that results in obligate patellar instability in flexion but central tracking in extension. This presentation can be much more complicated to treat surgically and may require a combination of multiple patellofemoral procedures. In this technique we describe a four-pronged treatment approach for improving patellar tracking in a patient with obligate flexion patellar dislocation and valgus malalignment including VY quadricepsplasty, distal femoral osteotomy, medial patellofemoral ligament reconstruction, and lateral retinacular and capsular reconstruction with a dermal allograft.

Patellar subluxation or dislocation that occurs in flexion and resolves in extension, flexion dislocation, is a devastating, rare subtype of patellar instability. This type of patellar instability is relatively poorly understood, but its cause is likely due to the aberrant interplay of dynamic and static patellar stabilizers with possible additional pathoanatomical factors present.[1] These patients may have aberrant lower extremity version or mechanical alignment, such as excessive femoral anteversion, external tibial torsion, or genu valgum. In many of these cases there is an underlying contracture or overtensioning of the vastus lateralis (VL) that contributes to lateralization of the patella in flexion.[2-5] The lateral retinaculum may also be excessively tight, further contributing to patellar lateralization. Finally, symptoms of lateral patellar subluxations or dislocations can suggest concomitant medial patellofemoral ligament (MPFL) insufficiency.

The goal of this article is to describe a 4-pronged technique that can ultimately be used in patients with severe obligate flexion patellar dislocation and valgus malalignment. The decision to combine all of the procedures included in this technique is often made intraoperatively on the basis of symptom severity; a quadricepsplasty may not always be indicated if a lateral lengthening and MPFL reconstruction resolve the patellar maltracking. In this technique we present the senior author's approach to a distal femoral osteotomy (DFO), VY quadricepsplasty, MPFL reconstruction, lateral retinacular release, and lateral retinacular and capsular reconstruction with dermal allograft augmentation to treat a patient with obligate flexion patellar dislocations, patellar maltracking, and valgus malalignment.

Technique

The patient is positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in lithotomy position. The operative thigh is placed in a circumferential leg holder and a pneumatic leg positioner is placed on the distal extremity. General

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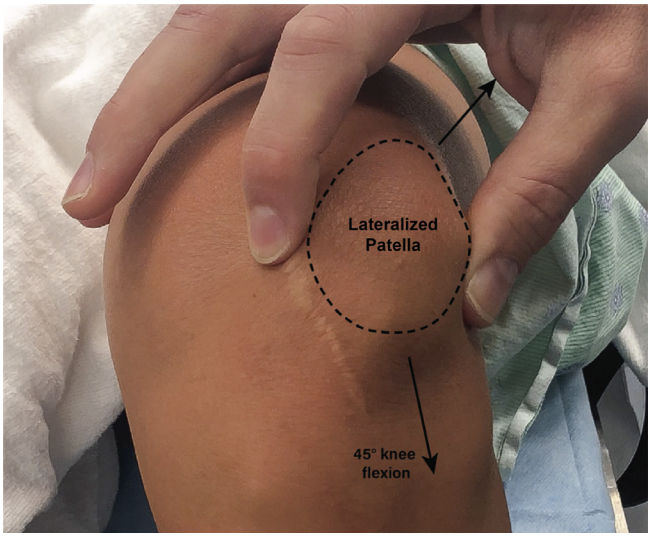

Fig 1. Intraoperative image of the left knee during the examination with the patient under anesthesia. The patient is positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in the lithotomy position. Dislocation of the patella (indicated by dashed line) was observed at 45° of knee flexion. An examination with the patient under anesthesia, including an assessment of medial and lateral patellar translation, patellar tilt, patellar tracking, passive internal and external rotation of the hip, and degree of knee flexion at which patellar instability appears should be performed before the procedure is begun.

anesthesia is induced, and an examination is performed. A thorough examination with the patient under anesthesia should be performed and may be significantly different from what is observed before surgery in the clinical setting. This should include an assessment of medial and lateral patellar translation, patellar tilt, an assessment of patellar tracking, and passive internal and external rotation of the hip. In addition, the senior author recommends assessing the degrees of flexion at which patellar instability appears and disappears and to evaluate for the presence of obligate patellar flexion dislocation (Fig 1, Video 1). It can usually be noted that when flexion dislocation occurs the quadriceps tendon can be palpated on the lateral aspect of the femur. The marked operative site is then sterilely prepared and draped appropriately.

A longitudinal incision using a 15-blade approximately 5 cm in length is made along the lateral aspect of the patella. A lateral lengthening procedure may be attempted (Fig 2). In this case, the oblique and transverse fibers of the retinaculum are separated, and the distal ends of the oblique layer and transverse layers are then sutured together (Fig 3). However, if this is not possible, a lateral release can be performed, and a dermal allograft can be used, as described later in the technique, to limit lateral patellar translation, prevent the risk of iatrogenic medial patellar dislocation after surgery, and provide an additional subcutaneous layer of tissue superficial to the osteotomy plate. Once this is complete, manual reduction should be attempted to see if centralization of the patella is possible. In patients with distal femoral valgus, the osseous lateral column is short, which can significantly contribute to the lateral maltracking. On the basis of this finding, a vastus lateralis release can be performed first if the need for osteotomy is still in question. If tracking is still not improved, then typically the distal femoral osteotomy is performed as the next step.

Distal Femoral Osteotomy

In the presence of continued severe flexion dislocation despite releasing the lateral retinaculum and VL, an opening-wedge DFO can be utilized. A ContourLock plate (Arthrex Inc., Naples, FL) can be placed in the desired osteotomy location. Further dissection can then be performed as needed and the plate can be fixed to the femur using 2 guide pins in a free hand manner (Fig 4). A retractor is then placed to allow adequate visualization and an oscillating saw followed by an osteotome is used to cut the lateral cortex. The medial cortex is left intact to act as a hinge and to minimize postoperative nonunion and fracture. Two wedged tricortical crest allografts are prepared with an oscillating saw on the back table based on degree of correction needed. The amount of correction is determined using calibrated preoperative radiographs. The grafts are then placed at the osteotomy site, and the plate is placed flush with the bone ensuring that the plate is not anterior to the trochlea. The plate is then fixed to the

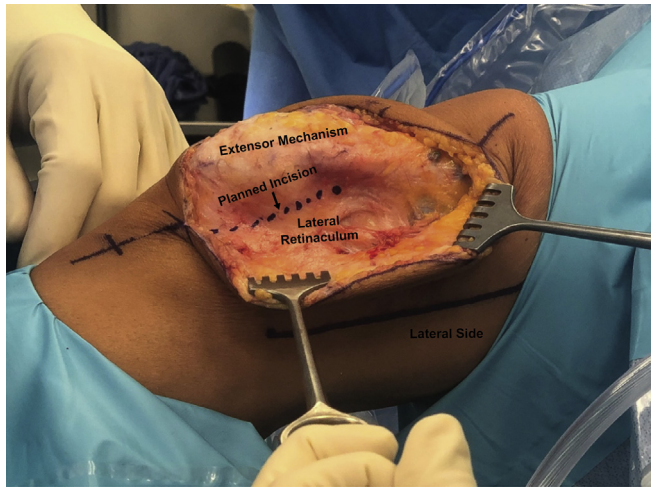

Fig 2. Intraoperative image of the left knee of the patient positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in lithotomy position. A longitudinal incision using a 15-blade approximately 5 cm in length is made along the lateral aspect of the patella revealing the lateral retinaculum. A lateral lengthening can then be attempted along the dashed line.

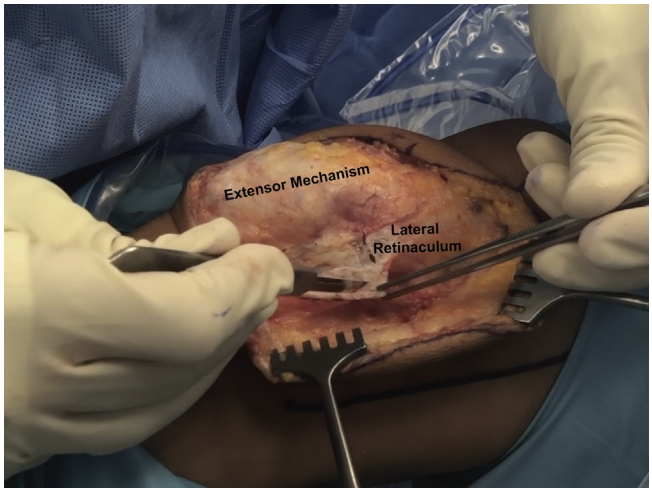

Fig 3. Intraoperative image of the left knee of the patient positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in lithotomy position. A lateral retinacular lengthening can be attempted by separating the oblique and transverse fibers of the lateral retinaculum. The distal ends of the oblique layer and transverse layers are then sutured together.

bone with 3 unicortical cancellous screws distally and 2 to 4 bicortical screws proximally.

Quadricepsplasty

In the presence of an excessively tight extensor mechanism, a quadricepsplasty may be considered as excessive tension may result in patellar maltracking or restricted flexion. In this setting, a VY lengthening of the vastus medialis (VM) and VL can be performed after the DFO and lateral release (Fig 5). To perform this, an approximately 5 cm incision is made along the lateral and medial aspects of the quadricep tendon, creating an inverted "V." The quadriceps tendon can then be relocated distally on the basis of the degree of quadricep tensioning desired. We suggest that the tendon be moved distally such that the knee can easily bend though high degrees of flexion (110°-120°). However, care must be taken because excessive distalization of the quadriceps tendon can result in a postoperative extensor lag. Once this location is identified, the quadriceps tendon is then sutured to itself with the knee in 90° of flexion using a no. 5 Ethibond (Ethicon,

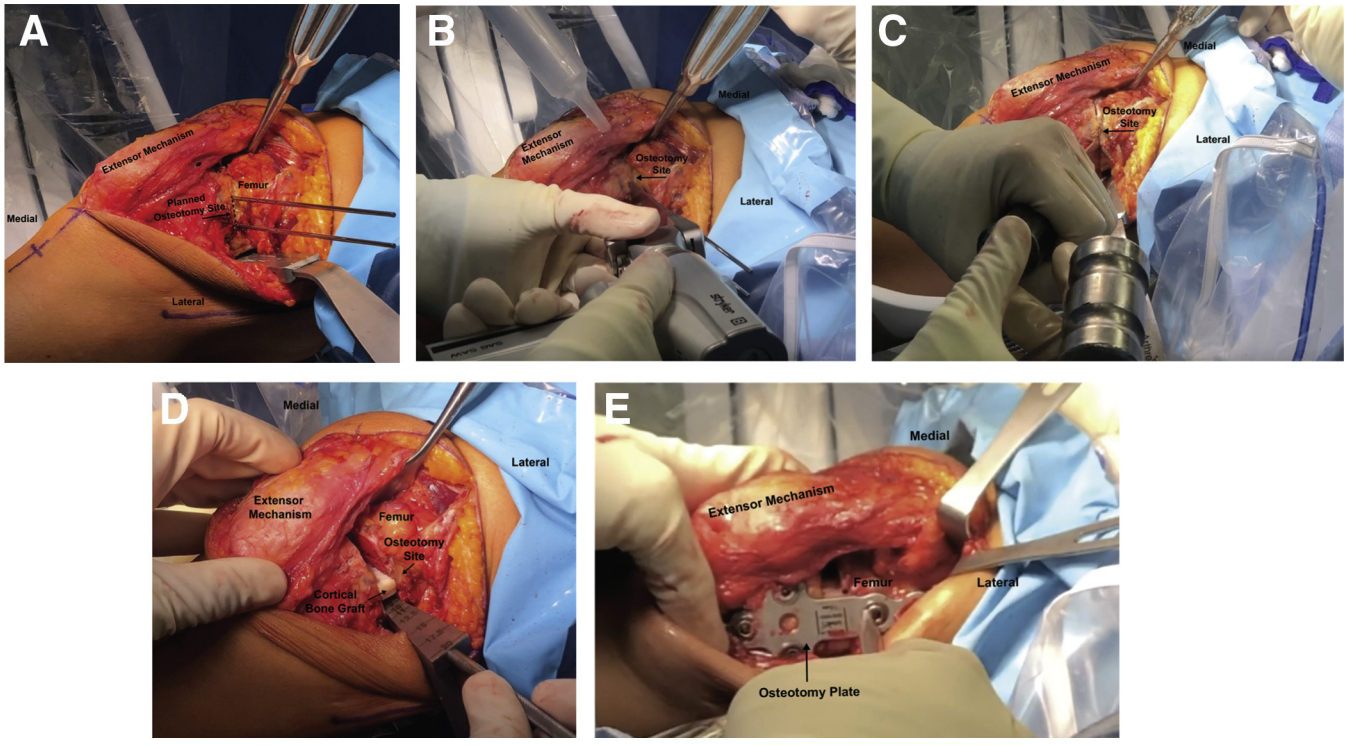

Fig 4. Intraoperative image of the left knee of the patient positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in lithotomy position. An opening-wedge distal femoral osteotomy can be used in the presence of continued flexion dislocation after lateral retinaculum and vastus lateralis release. A retractor is placed to allow for adequate visualization. (A) Using the plate as a guide, 2 osteotomy pins are inserted into the distal femur in preparation for the osteotomy cut, ensuring the cut stays proximal to the proximal trochlea, and then (B) the cut is made using an oscillating saw (C) followed by an osteotome. (D) A tricortical bone graft is prepared based on the amount of correction required and placed at the osteotomy side, and (E) the plate is placed and fixed to the bone with 3 unicortical cancellous screws distally and 2 to 4 bicortical screws proximally.

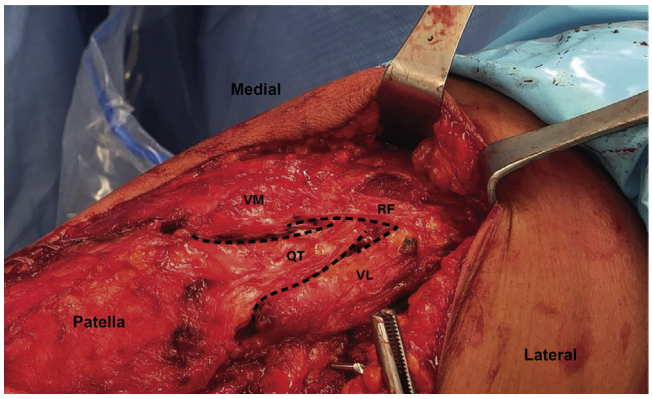

Fig 5. Intraoperative image of the left knee of the patient positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in lithotomy position. A quadricepsplasty can be performed via a V-Y technique: a 5 cm incision is made along the lateral and medial aspects of the quadricep tendon, creating an inverted "V" and the quadriceps tendon is then relocated distally based on the degree of quadricep tensioning desired and sutured to itself in 90° of flexion. (QT, quadriceps tendon; VL, vastus lateralis; VM, vastus medialis; RF, rectus femoris.)

Inc, Somerville, NJ) in an interrupted figure-of-8 fashion to secure this position.

Medial Patellofemoral Ligament Reconstruction

The MPFL reconstruction is typically performed after the patellar tracking has been normalized with any concomitant osteotomy or soft tissue release. The DFO fixation can reliably be avoided when performing the femoral tunnel for the MPFL reconstruction. The semitendinosus graft is prepared at the back table and is whipstitched on both ends. Two 3-0 PEEK knotless SutureTak (Arthrex Inc.) anchors are placed in the patella, 1 at the midbody of the patella and 1 at the superomedial aspect. The medial epicondyle and adductor tubercle are palpated on the medial femoral condyle and fluoroscopy is then used to identify Schottle's point (Fig 6).[6] A 3-cm incision is made at this location, and then blunt dissection is performed until the adductor tubercle is identified. The guide pin is then placed temporarily based on these anatomic and radiographic landmarks. The knee is then taken through its full range of motion, and the length changes between the guide pin and patellar anchors through flexion is assessed. Ideally, this value would be between 0 and 10 mm. The guide pin is overreamed with a reamer that is 1 mm larger than the graft diameter. The senior author typically uses a 6 mm hamstring graft and a 7 mm tunnel. The center of the hamstring graft is sutured down to the knotless anchors in a simple suture configuration (Fig 7). With the knee in full extension, the whipstitched ends of the graft are tunneled under the retinaculum with a hemostat, superficial to the capsule, and are then sequentially inserted into the femoral tunnel so that each limb can have its length set individually (Fig 8). The knee is then taken through a full range of motion to ensure that the graft reaches the "lowest common denominator" for length to avoid any over-constraint. The graft is fixed with a 7 × 23 mm PEEK (polyether ether ketone) interference screw and range of motion of the knee, patellar tracking, and medial and lateral patellar translation are assessed.

Lateral Retinacular and Capsular Reconstruction with Dermal Allograft Augmentation

In situations when a lateral lengthening is not possible, either because of poor tissue quality or because of the large degree of lengthening that is needed for proper patellar tracking, a reconstruction with a dermal allograft can be performed. When using a dermal allograft, the graft is trimmed to the appropriate size and sutured to the lateral retinaculum with no. 5 Ethibond in an interrupted figure-of-8 fashion (Fig 9). The knee should then be taken through a full range of motion after fixation to make sure there is no constraint from this reconstruction. The wound is then closed and dressed appropriately.

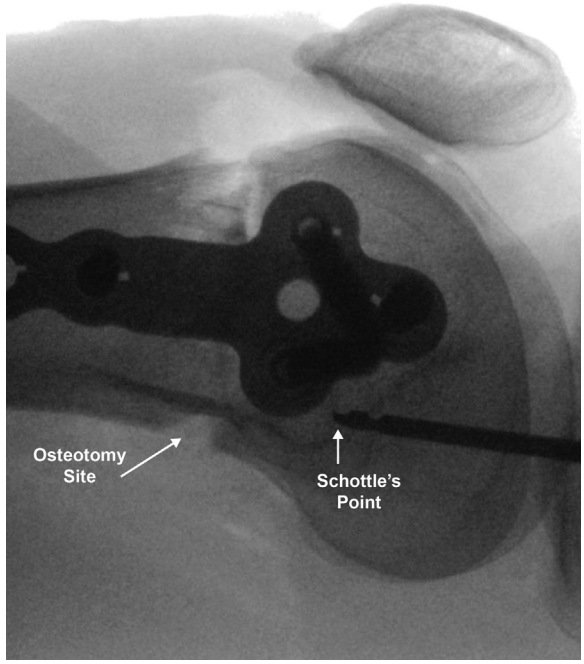

Fig 6. Intraoperative lateral radiograph of the left knee of the patient positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in the lithotomy position. This radiograph is used to identify Schottle's point after the distal femoral osteotomy is performed. Schottle's point is used as the radiographic surrogate for the femoral insertion site of the medial patellofemoral ligament (MPFL) when performing an MPFL reconstruction.

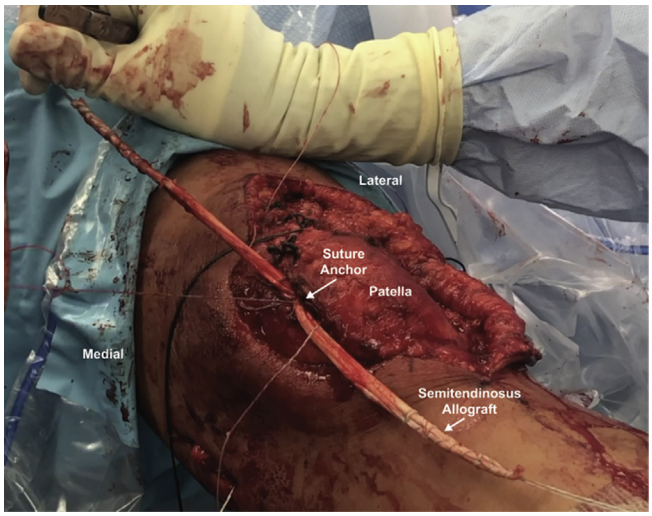

Fig 7. Intraoperative image of the left knee of the patient positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in lithotomy position. Two knotless SutureTak (Arthrex Inc., Naples, FL) anchors are placed in the patella, 1 at the midbody of the patella and 1 at the superomedial aspect. The medial patellofemoral ligament (MPFL) semitendinosus graft is prepared and whipstitched at both ends. Then, the MPFL graft is sutured to the 2 patellar knotless suture anchors using a simple suture configuration.

Rehabilitation

A standardized rehabilitation protocol is followed. Because of the DFO, the patient is limited to heel touch weightbearing (10%-20% body weight) with a hinged brace locked in extension with crutches as needed for support for the first 6 weeks. Range of motion is pushed as tolerated starting 2 weeks after surgery with no restrictions under the guidance of a physical therapist. After 6 weeks, the brace and crutches are discontinued when a full straight leg raise can be performed independently, and closed chain strengthening is initiated. Progressive strengthening, stability, and sport-specific exercises are introduced after 4 months, and the osteotomy is healed.

Discussion

This technique article presents a 4-pronged approach—VY quadricepsplasty, DFO, MPFL reconstruction, and lateral retinacular reconstruction with a dermal allograft—for treating a patient with obligate flexion patellar dislocation, significant maltracking and genu valgum (Table 1). Few comprehensive techniques have been described for treatment of a complex flexion dislocator. Furthermore, to our knowledge, this is the first description in the literature of using a dermal allograft to reconstruct the lateral retinaculum.

Lateral lengthening procedures are favored over lateral release procedures because the latter have been demonstrated to result in high rates—up to 57% of lateral releases—of iatrogenic medial instability.[7] In addition, biomechanical studies have demonstrated the importance of the lateral retinacular structures in preventing increases in medial and lateral patellar translation and alterations of patellar tracking.[8-11] Because of the importance of the lateral retinaculum, we do not recommend performing lateral release procedures and instead suggest performing lateral lengthenings to preserve the overall integrity of the lateral structures.[12-14] As described in this technique, it may be difficult to perform a lateral lengthening because of either poor tissue quality or the significant extent to which a lengthening would need to be performed. In this case, we recommend using a dermal allograft. This not only minimizes the risk of medial patellar instability but also provides an additional layer to minimize hardware prominence (Table 2).

Multiple lateral retinaculum plasty and reconstruction procedures have been described. Liu et al.,[15] for example, reported on a lateral retinaculum plasty procedure where a diagonal section of the lateral retinaculum and tensor fascia lata is grafted to the patella. In an outcome study of this approach with an MPFL reconstruction, Liu et al.[15] demonstrated significantly higher Kujala scores and lower patellar tilt angles compared to patients who underwent an MPFL with lateral release. In patients who have had prior lateral releases, multiple reconstructive techniques have been described, which could perhaps be utilized in place of a dermal allograft. For example, Sanchis-Alfonso et al.[16,17] described performing a deep transverse lateral retinaculum reconstruction using an anterior strip of the iliotibial band for patients with medial

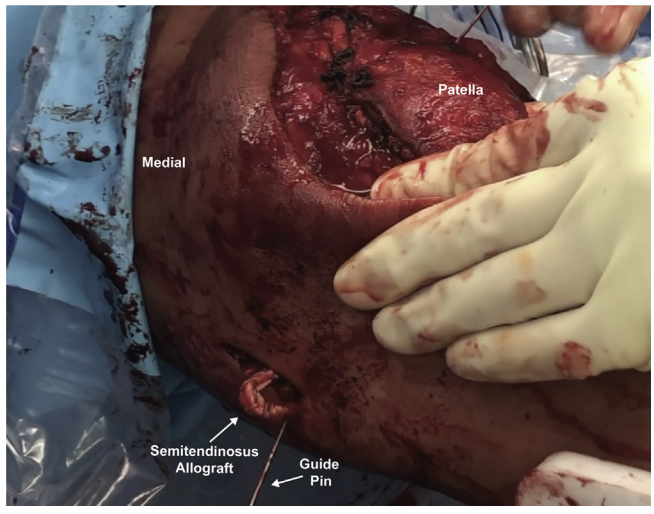

Fig 8. Intraoperative image of the left knee of the patient positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in lithotomy position. The medial patellofemoral ligament graft is then shuttled with a hemostat under the retinaculum and sequentially inserted into the femoral tunnel that was created at Schottle's point using a guide pin followed by a reamer that is 1 mm in diameter larger than the graft diameter.

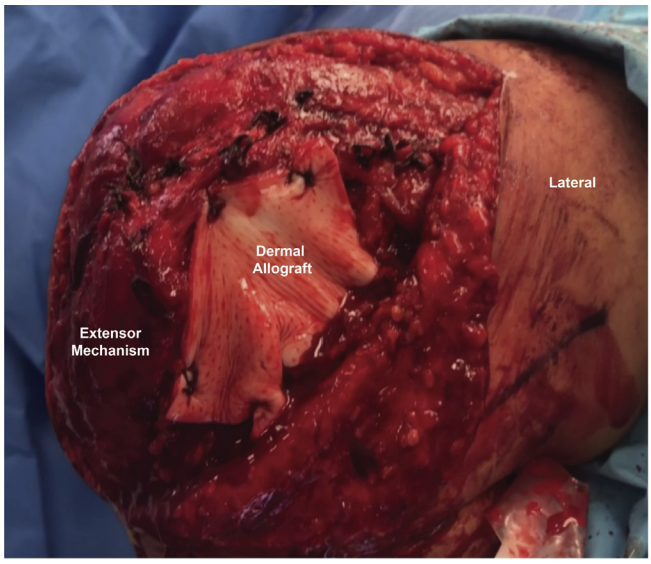

Fig 9. Intraoperative image of the left knee of the patient positioned supine on the operating table with the foot of the bed lowered and the nonoperative extremity in lithotomy position. When a lateral retinacular lengthening procedure cannot be performed, we recommend augmentation with a dermal allograft. The dermal allograft is trimmed appropriately to size and sutured to the medial and lateral aspects of the incised lateral retinaculum in an interrupted figure-of-8 fashion.

patellar instability. Whichever approach is selected, the lateral retinaculum should be maintained or reconstructed when it is compromised.

In addition to the lateral retinaculum, the quadriceps muscle plays a significant role in stabilizing and maintaining proper tracking of the patella.[18-20] Pathology of the quadriceps, including contracture or iatrogenic fibrosis of the VL or iliotibial band, can also contribute to flexion dislocation of the patella and patellar maltracking.[21,22] Different approaches have been described to treat this component of obligate flexion patellar dislocation, including quadricepsplasty (e.g., Judet quadricepsplasty), proximal rectus femoris release, and the VY quadriceps tendon lengthening procedure.[2-5] For example, Hung et al.[23] described performing a capsulorrhaphy, quadricepsplasty, and VM transfer. In this approach, they detach the insertion of the VL and VM from the patella and perform a tenotomy of the vastus intermedius, which is then sutured to the RF. The authors also report good outcomes using this approach. VY quadricepsplasty, specifically, has been described in multiple settings including total knee arthroplasty and patellar instability.[24] However, complications, mainly arthrofibrosis and stiffness that may necessitate a subsequent manipulation under anesthesia or lysis or adhesions, can occur. Some have suggested using an osseous approach, a tibial tubercle proximalization, instead of a quadricepsplasty to limit scar tissue formation and allow for rigid fixation, enabling early postoperative rehabilitation.[25,26] However, this approach can be accompanied by complications and can further disrupt the delicate balance of patellofemoral forces and alternative anatomy, such as increasing patella alta, which can increase the risk of postoperative instability. Because of these risks, soft tissue reconstruction may be preferred.

DFOs have been described in the literature to treat patients with flexion dislocations who have significant valgus deformities.[27-29] The goal of this component of the procedure is to improve patellofemoral congruity and remove one of the anatomic abnormalities contributing to patellar maltracking. This technique is supported by the literature. For example, a case series on 20 knees reported by Frings et al.[28] who underwent DFO with concomitant MPFL reconstruction

Table 1. Pearls and Pitfalls

Pearls
Patients presenting with obligate flexion patellar dislocation have complex anatomic considerations to be considered preoperatively, including lower extremity version and mechanical axis abnormalities (femoral anteversion, external tibial torsion, genu valgum), trochlear dysplasia, acquired vastus lateralis and lateral retinaculum contractures, and MPFL insufficiency
For these patients with genu valgum and laterally based contractures, the first operative procedures to be considered are lateral lengthening and MPFL reconstruction with subsequent assessment of patellar tracking throughout range of motion, as well as medial and lateral patellar translation
When lateral release and medial stabilization fail to address patellar maltracking in the presence of significant femoral valgus, a subsequent lateral opening distal femoral osteotomy should be performed
Extensor mechanism tightness can be effectively managed with VY quadricepsplasty
Subsequent MPFL reconstruction should be performed, taking care to ensure the graft length changes less than 1 cm between the guide pin in Schottle's point and the patellar anchors throughout range of motion to ensure maximal isometry of the graft
Pitfalls
Care should be taken to avoid anteriorization of the plate when performing distal femoral osteotomy, as this can abut the trochlea and create iatrogenic patellar chondral injury and maltracking
Lateral release should be avoided in favor of lateral lengthening to prevent medial patellar instability, but when necessary, we recommend lateral retinacular and capsular reconstruction with dermal allograft, with the added benefit of soft tissue coverage of hardware
Stiffness after this procedure is common and post-operative pain control is crucial to minimize this occurrence.

MPFL, medial patellofemoral ligament.

Table 2. Risks and Limitations

Risks
Recurrent instability or maltracking (especially medially if overlengthening of the lateral retinaculum occurs)
Iatrogenic patellar chondral injury with anterior malpositioning of plate
Distal femoral osteotomy delayed union, non-union, or fracture
Extensor mechanism issues (disruption, deficiency, atrophy, lag)
Arthrofibrosis/stiffness
Hardware irritation
Infection
Neurovascular injury
Limitations
Increases difficulty of subsequent surgeries such as arthroplasty
The presented technique cannot address femoral version, tibial torsion or trochlear dysplasia and these require alternative strategies
Dermal allograft can be costly and autogenous tissue may be an appropriate cost-saving solution, albeit with donor-site morbidity
Limited weightbearing and rehabilitation may be prohibitive for patient
Requires intraoperative fluoroscopy

demonstrated significant improvements in Lysholm, Tegner, Kujala, and pain scores without any subsequent instability events.

Few studies have investigated the outcomes of using multiple procedures to treat obligate flexion patellar dislocation with most reports consisting of case reports or case series.[30] Hung et al.[31] reported excellent results in 56 of 76 knees (73.7%) that underwent reconstruction with iliotibial band with concomitant VY quadricepsplasty to improve knee flexion and patellar tracking. In addition, Song et al.[25,32] reported the outcomes of 13 knees who underwent their "4-in-1" approach, which included a tibial tubercle proximalization and medialization, extensive lateral release, and MPFL reconstruction. The authors reported significant improvements in the Kujala score (from 41.4 to 94.9, $P < .01$) in addition to improvements in congruence angle and lateral patellofemoral angle. Prior studies have also described positive outcomes using techniques analogous to the one presented here. Mittal et al.[33] reported on 6 children who underwent lateral release, VM advancement, patellar tendon transposition, and MPFL reconstruction and reported significant improvements in Kujala scores with no patellar instability recurrence after 12 months. This approach is similar to ours, albeit in patients without valgus malalignment. However, instead of using a lateral release we would strongly suggest attempting a lateral lengthening and, if this is not feasible, to use a dermal allograft to maintain the overall integrity of the lateral retinaculum and decrease the risk of iatrogenic medial instability and its associated complications.

The literature has described a wide array of techniques and related outcomes for surgical treatment of the rare obligate flexion patellar dislocation patient. This technique describes a four-pronged approach for treating flexion dislocation in a patient with an excessively tight lateral retinaculum and quadriceps with genu valgum. Future clinical studies are needed to investigate the outcomes of this specific combination of procedures.

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