



Complex Patellofemoral Reconstruction for Recurrent Instability

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Background: Patellofemoral instability is due to a combination of bony and soft tissue factors. While recurrent patellar dislocations are rare, evaluation and treatment of these conditions require addressing patellar height and lateralization of the tibial tubercle (TT), restraint to lateral patellar subluxation, and trochlear dysplasia. Other factors to consider are coronal limb-length alignment outside of the physiologic 5 to 8° of valgus, which may significantly alter the Q angle and contribute to lateral instability. Other ligaments around the patella contribute to soft-tissue restraint, including the medial and lateral patellotibial ligaments, patellomeniscal ligaments, and the medial quadriceps tendon femoral ligament. Patellar tilt is assessed with and without quadriceps contraction to further evaluate the patella's relationship to the trochlear groove. The Caton-Deschamps Index, as well as patellar trochlear index (PTI), are used to measure patellar height for patella alta or baja.

Technique Description: The technique is to surgically manage a patient in neutral mechanical alignment on standing limb radiographs, with moderate-to-severe DeJour type B trochlear dysplasia and a trochlear sulcus angle of around 145°, patella alta with a Caton-Deschamps Index of 1.6 and PTI of 0.22, a TT to trochlear groove (TT-TG) distance of 8 mm, and a deficient medial patellofemoral ligament (MPFL). The MPFL reconstruction is done first, with harvesting of the ipsilateral quadriceps tendon and maintenance of its distal attachment on the superior patellar pole. The quadriceps tendon graft is folded medially upon its distal attachment and fixed in this position with suture anchors. Tibial tubercle osteotomy is accomplished by spacing drill holes 2 mm apart, medially and laterally, on the TT and connecting the drill holes with an osteotome and reciprocating saw. A distalized location to secure the TT is selected and superficial bone is excised. A medial parapatellar arthrotomy is performed, and bur attachments are used to drill into the subchondral bone beneath the femoral articular surface to create a V-shaped flap of trochlear cartilage. An arthroscope is inserted under the trochlear flap during this process to visualize the appropriate depth. The trochlear flap is then secured with screws passed over guide pins to secure the flap to the desired location. Cannulated screws and washers are then used to secure the TT to its distalized and/or medialized position, with fluoroscopic verification of screw depth and location. The arthrotomy is then closed with the knee at 45°. The quadriceps graft is passed through a subretinacular channel and secured with suture anchors, adjacent to the adductor tubercle, to complete the MPFL reconstruction. Before closure, appropriate tracking and translation of the patella is verified.

Results: Sulcus-deepening trochleoplasty, with or without MPFL reconstruction, has been reported to obtain satisfactory outcomes at 2 years, with close to 85% return to sport and 100% return to work, with improvements in International Knee Documentation Committee (IKDC) scores from 50.8 to 79.1 in some studies. MPFL reconstruction with tibial tubercle osteotomy (TTO) has yielded a 94.5% patient satisfaction rate in the literature.

Discussion/Conclusion: In patients with recurrent patellar instability and DeJour types B-D trochlear dysplasia, MPFL reconstruction with TTO and sulcus-deepening trochleoplasty provides excellent subjective outcomes and restores patellar tracking with elimination of recurrent subluxation.

Keywords: patellofemoral disorders; medial patellofemoral ligament; MPFL reconstruction; trochlear dysplasia; tibial tubercle to trochlear groove distance

VIDEO TRANSCRIPT

Sulcus-deepening trochleoplasty with tibial tubercle osteotomy (TTO) and medial patellofemoral ligament (MPFL) reconstruction. This video presents the surgical management of an 18-year-old man with recurrent patellar dislocations incompetent MPFL and a flattened, dysplastic trochlea.

This is an uncommon condition but can be recurrent when multiple dislocations have occurred.

A dysplastic trochlea contributes more to instability of the patella in flexion, while an incompetent MPFL leads to instability in extension. The MPFL is the strongest of the retinacular ligaments around the patella and provides 60% of resistance to lateral movement of the patella. Its origin is between the adductor tubercle and the medial epicondyle.

An incompetent MPFL can be seen on axial magnetic resonance imaging (MRI) as demonstrated here. The trochlea is composed of medial and lateral facets and a central

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trochlear groove. The lateral facet of the trochlea is larger and extends further proximally. The trochlear groove itself deepens and deviates laterally as it courses distally and serves as a static bony restraint to patellar dislocation.

The normal trochlear sulcus angle is around 128°. Greater than 145° is dysplastic and associated with a greater risk of recurrent patellar dislocations.

Physical examination for patellar instability consists of the patellar J-sign, seen subtly in the video at the top, assessment of medial and lateral tracking in terms in quadrants of displacement both in extension and in flexion. Patellofemoral grind for chondromalacia is assessed with compressive force directly on the patella with activation of the quadriceps.

Patellar apprehension is assessed with laterally directed force on the patella, and a thorough knee examination is completed. Patients with trochlear dysplasia are categorized based on the DeJour classification.

Radiographic features of trochlear dysplasia, such as a crossing sign, supratrochlear spur, double contour lines, or medial hyperplasia are used to grade the patients as A through D. Adults with grades B through D of DeJour dysplasia and sulcus angles greater than 145° are treated with sulcus deepening trochleoplasty and MPFL reconstruction.

Varus or valgus alignment in the coronal plane is assessed on standing long leg x-rays with a line drawn from the femoral head to the center of the talar dome. The indicated x-ray taken from our patient shows a neutral alignment. These sunrise x-rays taken in a patient preoperatively and at 6 months after surgery show a 20° reduction in sulcus angle after trochleoplasty. Our patient has a 148° sulcus angle indicating a dysplastic trochlea. Axial CTs are used to measure the tibial tubercle to trochlear groove distance. A TT—TG distance > 20 mm may be an indication for a medializing tibial tubercle osteotomy.

The image to the right comes from our patient and shows a relatively normal TT—TG distance. There are several methods for measuring patellar height; two of the most common are the Caton-Deschamps Index and the Patellar Trochlear Index. According to the Caton-Deschamps Index, our patient has patella alta. In light of this workup, we will plan to perform a sulcus-deepening trochleoplasty, distalizing tibial tubercle osteotomy, and MPFL reconstruction.

The patient is positioned supine on the operating table and, after examination under anesthesia and induction with general anesthetic, the foot rest of the operating table is removed to permit better mobility of the operative limb. The quadriceps tendon autograft is first harvested,

followed by identification and exposure of the adductor tubercle. Tibial tubercle osteotomy is performed followed by medial parapatellar arthrotomy. Sulcus-deepening trochleoplasty is then performed followed by secure fixation of the tibial tubercle and then MPFL graft.

A generous midline incision is made from the distal quadriceps tendon aponeurosis to just distal to the tibial tubercle. The extensor mechanism is exposed, and an 8-cm long by 8-to-10 mm wide quadriceps tendon autograft is harvested. The distal attachment of the graft will be retained. The graft is folded on itself medially and the patellar attachment is reinforced with a suture anchor. The adductor magnus tendon is then located and followed down to the adductor tubercle. The adductor tubercle is cleared with a scalpel and 2 suture anchors are placed where the MPFL would normally attach.

A channel is then cleared beneath the medial retinaculum to later pass the graft. The tibial tubercle is then exposed and 2-mm drill holes are placed 2 to 3 mm apart. Osteotomes are used to carefully connect the drill holes, and an anterior cruciate ligament (ACL) oscillating saw is used to complete the tibial tubercle osteotomy.

After removing the tibial tubercle, the ACL saw is then used to create a distalized position for the tubercle, about 12 mm distally in order to correct the patient's patella alta. A rasp and rongeurs are used to smooth these surfaces for later fixation.

Next, a medial parapatellar arthrotomy is made for sulcus-deepening trochleoplasty. A marker is used to outline the new contours of the sulcus, and the sulcus midline can be lateralized in severely dysplastic knees. We then proceed to use a standard bur attachment for a drill to undermine the articular cartilage. Copious irrigation is used to keep the bur from overheating the subchondral bone. The bur is then used to create a deepened V-shape, shallower at the edges and deeper in the sulcus. The supratrochlear spur can be removed with the bur or with an osteotome to ensure the cartilage flap sits flush against the femoral cortex.

As the surgeon gets closer to the center of the sulcus, a longer necked bur attachment can be helpful to deepen the center of the "V." The shallower edges of the trochleoplasty can make it difficult to ascertain the central portion, so the insertion of an arthroscope beneath the cartilage flap can be useful to ensure that appropriate depth has been achieved. The cartilage flap is made thin and flexible to avoid having to cut the articular surface to reduce.

When the desired depth of trochlear sulcus has been achieved, a sufficient number of cannulated, bioabsorbable compression screws should be passed over guide wires to

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secure the trochlear flap. Depending on the system used, the compression screw may have a laser line, which, when fully seated, should sit 2 to 3 mm beneath the articular surface. The screws should sit 2 to 3 mm below the smooth shaft of the driver when fully seated. Staples and absorbable suture anchors have also been used to compress cartilage leaflets.

Finally, it may be noted that while these authors used the freehand technique, various guides are available to help gage the depth of trochleoplasty. The tibial tubercle is then reduced to its distalized position and temporarily secured with guide pins. The position of these is verified fluoroscopically. Cannulated screws and washers are then passed over the guide pins to secure the distalized tibial tubercle and their position checked fluoroscopically.

The arthrotomy is closed with the knee at 45° of flexion, and finally the quadriceps tendon graft is passed through the channel earlier created in the medial retinacular structures and is secured to the anatomic location of the MPFL using the suture anchors previously described. The arthroscope is placed in the joint to confirm that the patella has only about one quadrant of lateral translation and is well-seated.

The knee is examined again to make sure that the joint has full range of motion and the patella is stable to one quadrant of translation. Closure of the deep then superficial structures, followed by skin, completes the procedure.

After surgery, the patient will remain nonweightbearing for 6 weeks, with flexion limited to 90° for 2 weeks. Range of motion into extension is passive at first, with the aid of a physical therapist. After reestablishing range of motion, quadriceps activation and strengthening is emphasized.

A minimum time to return to normal activity is 6 to 9 months depending upon the patient passing strength testing and a progressive physical therapy regimen that increases the level of challenge up to the patient's desired activity level.

One recent study examined 2-year follow-ups for patients who underwent trochleoplasty with MPFL reconstruction, plus or minus a tibial tubercle osteotomy and lateral release. Their patients had at 100% return to work and improvement in preoperative to postoperative International Knee Documentation Committee scores of 50.8 to 79.1.


Several more studies with positive results for this combination of procedures are reported on the following


reference slide. The results of these studies indicate that for patients with appropriate soft tissue and bony abnormalities, MPFL reconstruction with sulcus-deepening trochleoplasty and tibial tubercle osteotomy is an effective combination of procedures for preventing recurrent patellar dislocations.

Some complications include non-union, chondral injury, MPFL malpositioning, and arthrofibrosis.

Remembering to use copious irrigation, anatomic landmarks, and a rigorous and careful rehabilitation schedule are key to ensuring positive outcomes.

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