Technical Note

Treatment of Proximal Trochlear Dysplasia in the Setting of Patellar Instability: An Arthroscopic Technique

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Abstract: Patellar instability is a complex disorder with multiple etiologies, and treatment must be individualized to the unique pathoanatomy of each patient. Medial patellofemoral ligament reconstruction is one of the most commonly performed procedures for the treatment of patellar instability. Patients with a symptomatic supratrochlear spur, defined by the presence of a "jumping" J sign on examination, also may benefit from an adjunctive proximal trochlear resection. Here, we describe a technique for an arthroscopic proximal trochlear resection, or "bumpectomy," involving resection of the supratrochlear spur. In appropriately indicated patients, we have found this procedure to be a useful adjunct to medial patellofemoral ligament reconstruction without the need for concurrent trochlear sulcus deepening.

Trochlear dysplasia is a major cause of recurrent patellar instability and pathologic patellofemoral biomechanics.[1-3] Within trochlear dysplasia, there is a spectrum of deformity ranging from mild loss of trochlear sulcus depth to grossly convex trochlear surfaces. Dejour et al.[4] classically divided trochlear dysplasia into 4 types based on characteristic radiographic features. Two of these types, B and D, have a supratrochlear convexity or spur that precludes smooth patellar entrance into the trochlea.

Several arthroscopic and open techniques have been described to address trochlear dysplasia with the goal of increasing sulcus depth and eliminating trochlear entrance irregularities.[5-9] These techniques involve resection of bone posterior to the femoral trochlea to allow for deepening of the trochlear groove with preservation of thick trochlear osteochondral flaps.[10] In arthroscopic deepening trochleoplasty, as described by Blønd, a burr is used to resect the supratrochlear bone to access the bone posterior to the osteochondral flap.[11] A consequence of this is complete resection of the supratrochlear spur. However, to date there are no technical descriptions in the literature of isolated supratrochlear spur resection without concurrent trochlear sulcus deepening. In cases with a significant supratrochlear spur but some maintained trochlear sulcus depth, isolated proximal trochlear resection in conjunction with medial patellofemoral ligament reconstruction (MPFL) may be sufficient to restore stability without concurrent sulcus deepening. This article outlies a technique for arthroscopic proximal trochlear resection, or "bumpectomy," for treatment of trochlear entrance irregularities at the time of MPFL reconstruction.

Surgical Technique (With Video Illustration)

Preoperative Assessment

Preoperative assessment, including thorough physical examination and imaging, is critical to accurately diagnose patellar instability and to determine appropriate treatment. Examination begins with evaluation of mechanical alignment, as genu valgum, pes planus, and hindfoot valgus have been associated with patellar

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instability.[12] A J sign may be seen during active knee extension and is associated with trochlear dysplasia, patella alta, and soft-tissue imbalances that predispose patients to patellar instability.[13,14] In particular, patients should be evaluated for a "jumping" J sign, which occurs when the patella suddenly "jumps" laterally as it exits the trochlear groove.[15] This phenomenon can be associated with a supratrochlear spur and is the primary indication for our arthroscopic resection trochleoplasty technique (Table 1). Other useful maneuvers include the patellar glide and patellar apprehension tests.[13,16,17]

A full series of knee radiographs should be obtained for all patients with patellar instability.[12,18] The true lateral view is especially helpful in the assessment of trochlear dysplasia and patellar height. In particular, the lateral view is scrutinized for a supratrochlear spur, a "crossing sign," and a "double contour" sign, as described by Dejour and Le Coultre.[19] Although there are several methods to assess patellar height, the authors prefer the Caton–Deschamps index, with a ratio greater than 1.2 indicative of patella alta.[20] The lateral view is also used to assess the size and location of the supratrochlear spur. Proximal trochlear resection is indicated for spurs at least 5 mm in height (relative to the anterior femoral cortex) and those proximal to the posterior femoral condyles, to avoid significant shortening of the articular trochlea. Axial radiographs, also known as "sunrise" or "merchant" views, can be useful to assess patellar tilt and tracking and help rule out arthritic changes.

Advanced imaging, including computed tomography or magnetic resonance imaging (MRI), is also recommended. Coronal alignment of the extensor mechanism may be assessed by the tibial tubercle–trochlear groove and tibial tubercle–posterior cruciate ligament distance. Cross-sectional imaging also can better characterize the size and location of a supratrochlear spur, as seen in Dejour type B and D dysplasia.[19,21] MRI also can be scrutinized for disruption of the medial retinaculum or MPFL, medial patellar facet osteochondral injury, and impaction of the lateral femoral condyle.[22,23]

After initial assessment, the presence or absence of all contributing pathoanatomic factors should be noted. In cases of a "jumping J" sign with a supratrochlear spur seen on radiographs or advanced imaging, arthroscopic proximal trochlear resection can be considered (Table 1).

Table 1. Indications and Contraindications for Arthroscopic Proximal Trochlear Resection

Indications	Contraindications
• Dejour type B or D dysplasia with a supratrochlear spur ≥5 mm • "Jumping" J sign on examination • Symptomatic patellar instability • Planned medial patellofemoral ligament reconstruction with knee arthroscopy	Absolute: • Skeletally immature patient with open physes Relative: • Planned definitive trochleoplasty • Short trochlear length • Uncorrected osseous abnormalities (e.g., significant femoral anteversion)

Examination Under Anesthesia and Setup

The patient is positioned supine with all bony prominences well-padded. The nonoperative leg is placed in a lithotomy leg holder, and the operative leg is positioned in an arthroscopic leg holder with a proximal thigh tourniquet. The foot of the operating table is lowered to provide access to both sides of the operative extremity. The fluoroscope can be positioned on the contralateral or ipsilateral side of the patient depending on room geometry.

An examination under anesthesia should be performed at the beginning of the procedure to further assess patellofemoral stability (Video 1). First, the knee is ranged to observe patellar tracking. Evaluation for a "jumping" J sign is again important, although it may be less evident at this stage due to the lack of quadriceps activation. Patellar translation should be then be assessed. This begins with the knee in full extension and is repeated with gradually increasing degrees of flexion, noting the presence of a soft or firm end point as well as the flexion angle at which the patella no longer subluxates. This angle at which instability disappears represents an important measure of the working arc of the MPFL ligament.

Diagnostic Arthroscopy

A diagnostic arthroscopy is then performed via the standard inferolateral portal to assess for intra-articular derangements and cartilage lesions. A superolateral portal is created for further visualization of the superior aspect of the patellofemoral joint. In some cases, a 70° arthroscope may be used to improve visualization of the patellar articular surface.[24] It is important to note the extent and location of patellar cartilage wear. In cases of trochlear entrance dysplasia, patellar lesions are most commonly seen along the distal patella. The size and location of the supratrochlear spur also should be documented. Gentle flexion of the knee during arthroscopy allows for direct visualization of patellar tracking. The indication proximal resection can be confirmed at this stage by the presence of a supratrochlear spur of sufficient size to disrupt the patella's entrance into the trochlea.

Proximal Resection

Once the supratrochlear spur is determined to be a contributing factor to patellar maltracking, it is further localized with simultaneous arthroscopy and fluoroscopy.

Fig 1. When evaluating a supratrochlear spur for potential resection, the extent of resectable "bump" is determined by a line drawn from the proximal femoral posterior condyles on a perfect lateral radiograph.

Radio-opaque instruments can be placed on the spur and then localized fluoroscopically on anteroposterior and lateral views. Dual localization is important to guide safe and adequate resection. While arthroscopy permits direct visualization of the spur and its cartilage cap, fluoroscopic views better characterize the shape of the proximal trochlea. The lateral view is most helpful in characterizing the anteroposterior height of the spur and can direct resection to a smooth trochlear contour. Landmarks for adequate resection are the anterior cortex of the femur and the most proximal aspect of the femoral condyles (Fig 1).

First, a diagnostic arthroscopy is performed to evaluate the chondral surfaces and determine whether any wear is present. Assuming there is no concern for arthritis, the spur is localized on lateral fluoroscopic imaging with a spinal needle. A superolateral portal is created and used as the primary working portal. Localization and marking of the resectable spur area with a probe and knife are performed under simultaneous arthroscopic and fluoroscopic visualization (Fig 2). A curette is then used to begin the resection, followed by an arthroscopic burr (Arthrex, Naples, FL). A direct lateral portal is created to complete resection of the spur perpendicular to the portal while viewing from the superolateral portal (Fig 3). Final resection is completed to the level of the anterior femur. Using multiple different portals for viewing and resection is vital for the 3-dimensional shaping and visualization of the spur, as to ensure a smooth and gradual transition into the trochlea. Only the cartilage directly overlying the pathologic supratrochlear spur should be removed. Gradual resection of the supratrochlear spur is guided by progressive lateral fluoroscopic images to ensure a smooth trochlear contour (Fig 4). Dynamic examination can then be carried out to assess patellofemoral tracking. If resection is adequate, there will no longer be a "jumping" J sign.

At this point, concomitant procedures are performed. In most cases, this includes MPFL reconstruction. Additional procedures may include corrective tibial

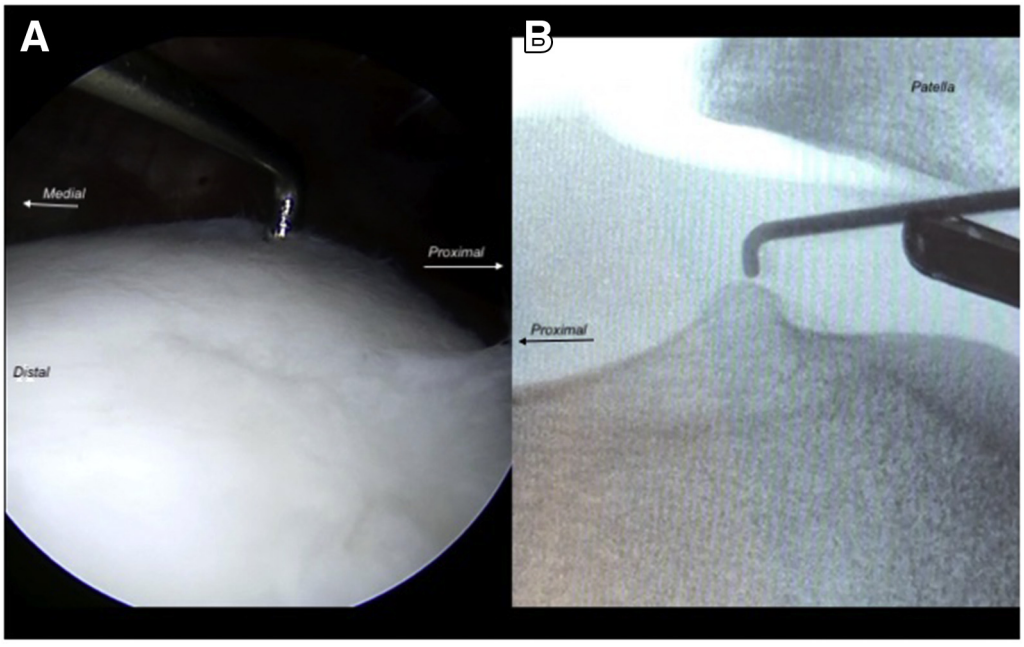

Fig 2. View of the supratrochlear spur from the inferolateral portal through a 30° arthroscope. Simultaneous arthroscopic (A) and fluoroscopic (B) views should be used to accurately localize and plan the boundaries of supratrochlear spur resection.

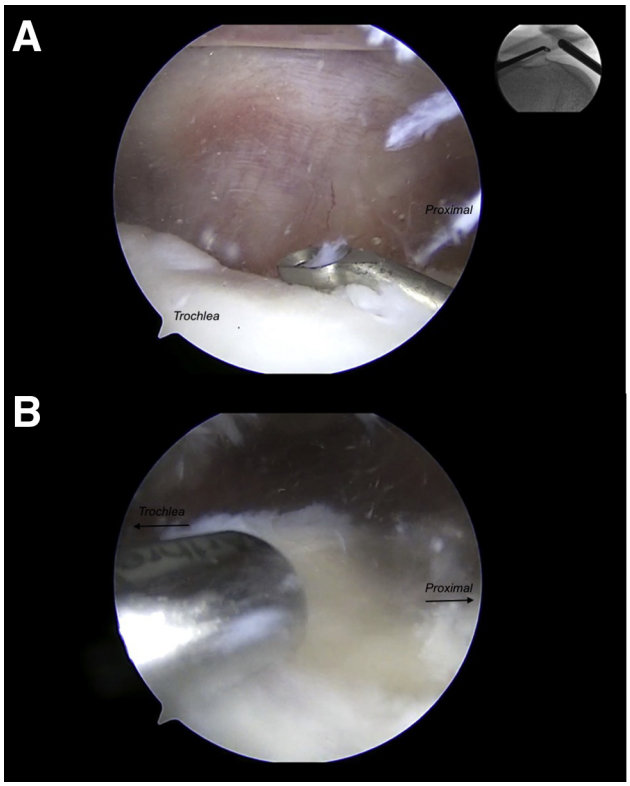

Fig 3. Arthroscopic view of resection through a 30° arthroscope from (A) the inferolateral viewing portal with resection performed by curette through the superolateral portal, followed by (B) viewing from the superolateral portal while resection is performed with an arthroscopic burr through the direct lateral portal. Resection of the bump using multiple working and viewing portals is necessary to ensure complete 3-dimensional approach to reshaping the supratrochlear spur.

tubercle osteotomies or lateral retinacular lengthening. At the conclusion of the procedure, a final examination under anesthesia should be performed to ensure restoration of smooth, central, and stable patellar motion (Table 2).

Postoperative Rehabilitation

The postoperative course is directed by concomitant procedures, since the proximal resection itself does not alter rehabilitation. After MPFL reconstruction with proximal trochlear resection, patients are made full weight-bearing as tolerated with a knee brace locked in extension and crutches for support as needed. They are permitted to unlock the brace during physical therapy and their home exercise program. Patients at risk for postoperative stiffness are encouraged to use mechanical stretching devices. In the first 6 weeks postoperatively, patients progress to full active and passive knee range of motion. After 6 weeks, patients may begin transitioning out of their brace as tolerated once they have demonstrated the ability to perform a straight leg raise without any extensor lag outside of the brace. Full passive range of motion should be achieved by postoperative week 8 at the latest. After 12 weeks, patients are permitted to begin single-leg strengthening exercises and sport-specific drills. All restrictions are typically lifted with a gradual return to play by 6 months postoperatively.

Discussion

Patellofemoral stability requires a complex interplay of static ligamentous restraints, dynamic musculotendinous control, and articular congruity. Treatment of patellofemoral instability thus requires careful consideration of many pathoanatomic factors. In cases in which trochlear dysplasia is a contributing factor, correction of trochlear anatomy can improve biomechanics and reduce the risk of recurrent instability.[25-27] Many techniques have been described to improve trochlear sulcus depth and orientation.[5-8,11,28] However, trochlear dysplasia is a spectrum of pathology, necessitating a broad range of treatment options. In this article, we present a resection technique on the most minimally invasive end of that range—arthroscopic supratrochlear spur resection.

Resection of the supratrochlear spur associated with trochlear dysplasia is not unique to this technique. Existing trochleoplasty descriptions all include some mention of the importance of correcting the supratrochlear spur in Dejour type B and D dysplasia. The closest description in the literature is the Blønd arthroscopic trochleoplasty technique, wherein the author describes using a 4-mm round burr to remove a supratrochlear spur during trochlear reshaping.[11] What is unique to this current description is the willful

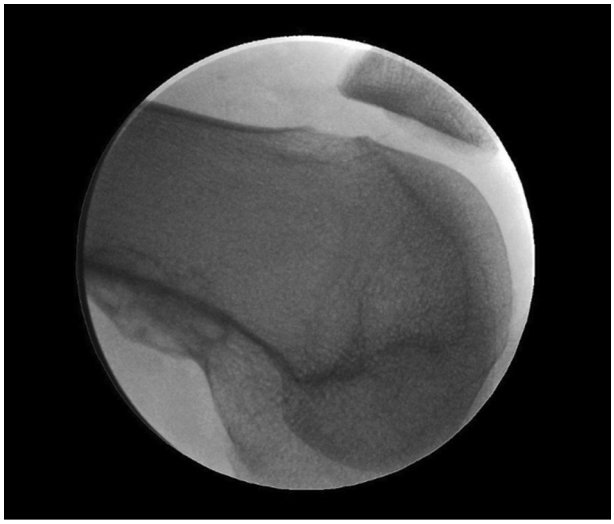

Fig 4. Fluoroscopy should be used throughout proximal trochlear resection for better spatial understanding of tool placement. Live fluoroscopic view after the resection demonstrates the final contour of the proximal trochlea of osseous and cartilaginous components of the spur, confirming that a smooth transition was created.

Table 2. Pearls and Pitfalls of Surgical Technique

Pearls	Pitfalls
• A true lateral of the knee does not always represent the most prominent aspect of the proximal trochlea	• Do not remove the bump and create a vertical step off; taper the transition point
• Use a knife to mark the cartilage arthroscopically at the edge of the planned resection	• Do not rely on your eyes arthroscopically; confirm resection location on fluoroscopy
• Check tracking of the patella and its transition before and after resection	• Resecting from a standard anterior arthroscopy portal will result in under-resection; use an accessory portal
• There may be cartilage covering the bump; this should not preclude resection	• Viewing from the standard arthroscopy portals will not allow for full visualization of the bump; use the proximal accessory portal to visualize before/during/after resection

omission of trochlear sulcus deepening. Regardless of technical details, all described trochleoplasty techniques require the trochlea to be undermined and fixated with a new contour and position. This technique is not indicated in all patients with dysplasia and poses inherent risks to the trochlear cartilage, requires internal fixation, and can be technically challenging. Isolated supratrochlear spur resection requires no open incisions, no internal fixation, and can be performed with a standard arthroscopic burr.

The indications for this procedure overlap with those for definitive trochleoplasty. In many patients with Dejour type B and D dysplasia, the sulcus depth and orientation should be corrected to restore patellofemoral tracking. This is particularly important in revision scenarios or after failed MPFL reconstruction. However, in patients presenting for primary procedures with a "jumping" J sign but some maintained trochlear depth, this more limited option can be a useful adjunct. The key to successful supratrochlear spur resection is concurrent radiographic and arthroscopic assessment of the degree of resection. Surgeons should take care to avoid resecting bone posterior to the anterior cortex of the femur, as seen on a lateral fluoroscopic view. In addition, surgeons should avoid resecting portions of the trochlea distal to the most proximal aspect of the femoral condyles. Finally, care should be taken to resect a smooth contour of bone to restore smooth patellar entrance into trochlear engagement.

In summary, we present here a limited proximal trochlear resection for conservative management of a "jumping" J sign at the time of MPFL reconstruction. This technique does not displace existing validated methods for trochleoplasty when indicated. Rather, it can serve as an additional technical tool for surgeons using standard arthroscopic portals and familiar instruments.

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