



Patella instability in the skeletally immature patient: pearls for surgical treatment

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Abstract: The surgical management of patella instability has evolved over time to become an “al a carte” menu of surgical options to address the numerous pathoanatomies which predispose to recurrent patella dislocations and subluxations. The challenge when managing patella instability in the skeletally immature patient relates to the presence of open growth plates which can be subject to iatrogenic injury. That said, most often these challenges can be overcome and lead to successful outcomes. This section will present a series of “pearls” to consider when preparing a surgical plan of action for the care of children and youth with recurrent patella subluxations and dislocations.

Keywords: Patella instability; surgical treatment; immature

Received: 23 March 2018; Accepted: 11 April 2018; Published: 10 May 2018.

doi: 10.21037/aoj.2018.04.04

View this article at: <http://dx.doi.org/10.21037/aoj.2018.04.04>

Introduction

The management of patella instability in children and youth is problematic with a recurrence rate of patella dislocation following non-operative treatment reported to be from 15 to 80 percent and on average, 40 percent (1). The reason for this high failure rate is no doubt multifactorial, in part due to the lack of scientific validation of non-operative treatment regimens and in part due to the presence of pathoanatomies that predispose to patella instability (2). These pathoanatomies include trochlear dysplasia, patella alta, increased knee valgus, increased Q-angle and increased tibial tuberosity:trochlear groove distance (TT:TG distance). Other features that create susceptibility to patella instability in children include hyperelasticity and torsional abnormalities of the lower extremity.

With such a high failure rate of non-operative management, surgical alignments and reconstructions are frequently required. When designing a surgical approach for the treatment of patella instability, the ideal process should address the “correction” of the underlying pathoanatomies that have been shown to be associated with the instability. In the skeletally immature patient, this can present a

problem due to the presence of open growth plates (physes) since osteotomies can result in premature growth arrest and progressive deformity. For example, trochlear dysplasia has been shown to be commonly associated with failure of surgical treatment and one that cannot be addressed with osteotomy without the risk of growth plate injury (3,4). Therefore, when designing a surgical approach the risk versus benefit should be understood not only by the surgeon, but also by the parents and child as well.

The following discussion of “pearls” for the surgical management of patella instability is based upon the available literature as well as the experience of the author.

It is all about balance

When addressing patella instability surgically, it is all about restoring the balance of the extensor mechanism of the knee (5). This balance includes the static structures of ligaments and retinaculum as well as the dynamic myotendinous structures. With this approach we need to remember that competence of both medial and lateral retinaculum are required. Although we may visualize the retinacular

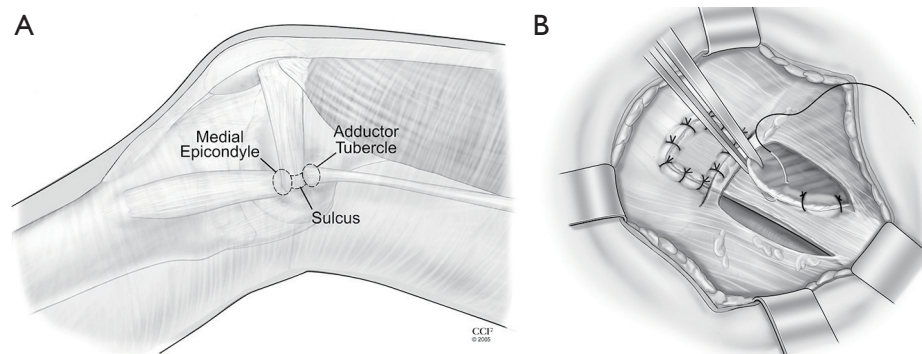


Figure 1 The medial patellofemoral ligament (MPFL) is the primary soft tissue restraint to lateral displacement of the patella with its main function occurring during the first 30–40 degrees of knee flexion. (A) The MPFL lies within the intermediate layer of the medial retinaculum. The femoral origin of the transverse fibers of the MPFL is described as lying within a sulcus between the adductor tubercle and the medial femoral epicondyle but with oblique fibers extending along the anterior boarder of the superficial medial collateral ligament. The MPFL traverses forward to insert along the medial boarder of the proximal half of the patella as well as blending with the deep layer of the quadriceps mechanism; (B) In the absence of trochlear dysplasia, hyper-elasticity or patella alta, recurrent patella instability can be successfully managed with medial retinacular imbrication as pictured.

restraints as coming from the medial/lateral coronal plane, they are actually more oriented closer to the sagittal plane with a function to guide and settle the patella into the trochlear groove, from which the slope of the lateral wall of the trochlea has been shown to then become the primary restraint to lateral patella displacement (6).

Too loose is better than too tight

Patients with patella instability present in two types; those with instability and patellofemoral malalignment (patella subluxation and even dislocation) and those with instability but with normal patellofemoral alignment relative to the trochlear sulcus. In either case, the objective of the operation is to prevent further dislocations and that will include a medial repair and/or reconstruction. Although the temptation for medial repair/reconstruction is to follow a (false) principle that “tighter is better,” that temptation only leads to over-constraint with potential complications of stiffness, pain, and patellofemoral arthrosis (7). Therefore when repairing and/or reconstructing the medial side, insure that the normal medial/lateral patella translation of two quadrants of patella glide is restored. Too tight is definitely not better than too loose.

Don't give up on the medial retinaculum

A tendon reconstruction of the medial patellofemoral

ligament (MPFL) has become a generally accepted component of the surgical treatment for patella instability and for good reason. However, it is technically demanding and associated with potentially devastating complications such as knee stiffness, pain, and patellofemoral arthrosis (7). That said, if the patient does not have trochlear dysplasia and does not have hyper-elasticity and does not have patella alta, a proximal patella alignment to include imbrication of the medial retinaculum (and lateral retinacular lengthening as needed) can be very effective with much less potential for post-operative complications (8). Remember that the normal state of patellofemoral equilibrium only requires the competence of a very thin and relatively weak retinaculum (*Figure 1*).

Don't wait until growth plate maturity

Although the surgical treatment of patella instability in children is problematic, the benefits of creating realignment of the patellofemoral joint outweigh the risks. Namely, the development of a competent immature trochlea is dependent upon the presence of patella contact. Leaving significant patella subluxation (patellofemoral malalignment) along the developing distal femur can be associated with trochlear dysplasia. The flip-side of this is that restoration of normal patellofemoral alignment in the very young (pre-pubescent) child can have the potential of restoring normal trochlear development. Perhaps a “softer” justification

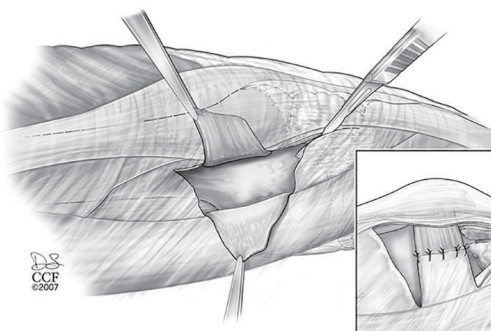


Figure 2 Lateral retinacular lengthening is safer than release. It allows for the peaceful relocation of the patella within the trochlea, yet maintaining its function of assisting in medial and lateral patella stability, as well as avoiding the complication of iatrogenic medial patellar instability.



Figure 3 Transfer of a portion of the iliotibial band can serve to reconstruct the deep transverse lateral retinaculum and provide assistance for patellar stability.

of proceeding with surgical intervention in the skeletally immature patient is the pure disability and morbidity that is associated with episodes of patella dislocation as well as the potential for chondral injury.

Lateral lengthening rather than lateral release

As noted above, the balance of the extensor mechanism of the knee and stability of the patella is dependent upon a functioning medial and lateral retinaculum. Although the primary soft tissue restraint to lateral patellar displacement

is the MPFL (located within the intermediate layer of the medial retinaculum) (9,10), the lateral retinaculum (primarily the deep transverse lateral retinaculum) provides 10–15% of the soft tissue restraint to lateral translation (11). Furthermore, the primary cause of medial patella subluxation/dislocation (medial instability) is post-lateral retinacular release. When first recognized as the painful disabling condition that it is, the primary cause was found to be an excessive lateral release that was carried well proximal into the tendon of the vastus lateralis (12). The only true indication for a lateral retinacular release is refractory anterior knee pain associated with a tight lateral retinaculum. And even then, it is probably best to lengthen the lateral retinaculum rather than release (*Figure 2*).

When dealing with patella instability in the hyper-elastic patient, part of the proximal soft tissue alignment and reconstruction can often be aided by the addition of a lateral reconstruction (not release or lengthening) as well as medial reconstruction (*Figure 3*).

Medial patellofemoral ligament reconstruction (MPFL-R)

Perhaps one of the most important surgical techniques developed for the management of recurrent lateral patella dislocations has been the reconstruction of the MPFL (13,14). Although described decades ago, it has been over the past decade that a better understanding of the anatomy and biomechanics has been provided (15). Although there are various interpretations of the origins and insertions, most commonly it is felt that the transverse fibers of the MPFL originate from a sulcus located between the adductor tubercle and the medial femoral epicondyle and insert into the proximal half of the medial boarder of the patella (9). More recently, Fulkerson has illustrated the additional fibers that blend with the quadriceps tendon (16). Baldwin has also described oblique fibers that blend into the anterior boarder of the superficial medial collateral ligament (9). That said, for most the attachment of a tendonous reconstruction (typically using either semitendinosus or gracilis or quadriceps tendon autograft; or similar allografts) will be docked at this sulcus. Whether adult or child, when reconstructing the MPFL, avoid transverse drill holes across the patella for fear of subsequent stress fracture and test for “isometry” prior to final fixation. Too loose is better than too tight and allow for a normal amount of patella stability with two quadrants of patella translation.

The issue in the skeletally immature patient is the distal

femoral growth plate. This physis is not linear. It undulates and has a convex distal orientation. Therefore, if a drill hole to be used for a docking type of femoral fixation is used, the orientation should be directed slightly distal and not transverse for fear of violating the physis (17) (Figure 4). Furthermore, Farrow has also advocated that the direction should not only be directed distally but also anteriorly to avoid physis injury. Finally, two other techniques for femoral fixation have been described for the skeletally

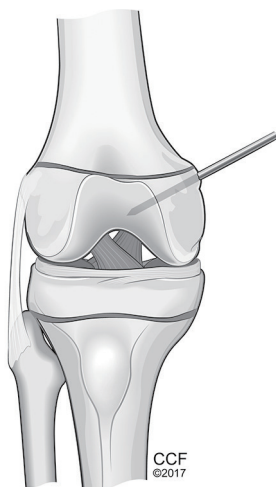


Figure 4 When performing an MPFL reconstruction and using a docking technique for femoral fixation, it is important to recognize the undulating course of the distal femoral physis. In order to avoid possible growth plate injury, the guide pin should be directed slightly anterior and distal. MPFL, medial patellofemoral ligament.

immature patient in order to avoid the growth plate (18,19) (Figure 5A,B). A free tendon graft can be anchored around the tendon of the adductor magnus adjacent to the adductor tubercle; or the graft can be passed around the superficial medial collateral ligament adjacent to the medial femoral epicondyle. When using these variations of attachment, it is critically important to understand the strain patterns of the graft. When using the medial collateral ligament as an attachment site it will result in greater length (and strain) required in extension and lessening strain in flexion. Therefore as the final fixation is applied to the patella, the knee should be in full extension with proximal traction applied to the central quadriceps tendon (simulating quadriceps contraction). The flip-side of this is when the tendon of the adductor magnus is used as the femoral anchor. Those that use this method will perform the final fixation with the knee in 45–60 degrees of flexion in order not to over-constrain the knee as it goes into flexion. In either case, as emphasized before, too loose is better than too tight.

Patella alta

A frequent pathoanatomy associated with recurrent patella dislocations in children and youth is patella alta. There are several problems with this diagnosis, one of which is deciding how to define it in the first place. Radiographic indices such as the Insall-Salvati Index, the modified Insall-Salvati Index, the Blackburne-Peel Ratio and the Caton-Deschamps Index have been well documented with the latter being judged to be the most consistent (20). However,

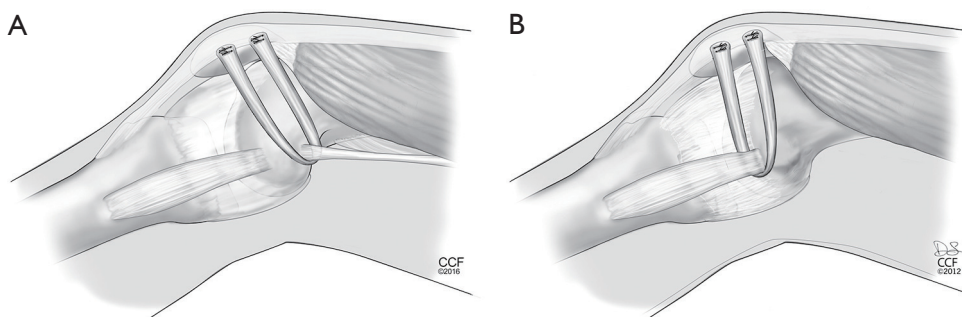


Figure 5 Soft tissue anchors may be used in order to avoid potential injury to the distal femoral growth plate. (A) Femoral fixation may be achieved by using the tendon of the adductor magnus as the anchor. If this is used, final fixation and tensioning on the patella should be done with the knee in 45–60 degrees of flexion in order to avoid potential over-constraint during knee flexion; (B) if the superficial medial collateral ligament is used for femoral fixation, the final fixation and tensioning on the patella should be done with the knee in full extension while traction is applied to the central quadriceps tendon in order to avoid potential medial patella subluxation during active terminal extension of the knee.

since plain radiography only illustrates the bony anatomy and not cartilage, Biedert has described a method using Magnetic Resonance Imaging (Patella-Trochlea Index) (21). However it is determined, a patella that rests too far proximal to the trochlea with the knee in extension is a risk factor for dislocation. In the adult this pathoanatomy can be addressed by tibial tuberosity osteotomy with distalization. In the child, this is not an option due to the open apophysis of the tuberosity. However, methods of patella tendon shortening have been described and modified by Andrich, which can be applied to the child as well as the adult (22) (Figure 6).

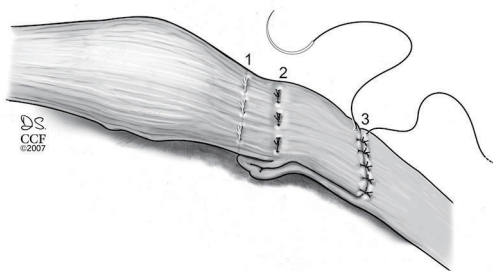


Figure 6 The surgical correction of patella alta in the skeletally immature patient can be achieved by the technique of patella tendon imbrication.

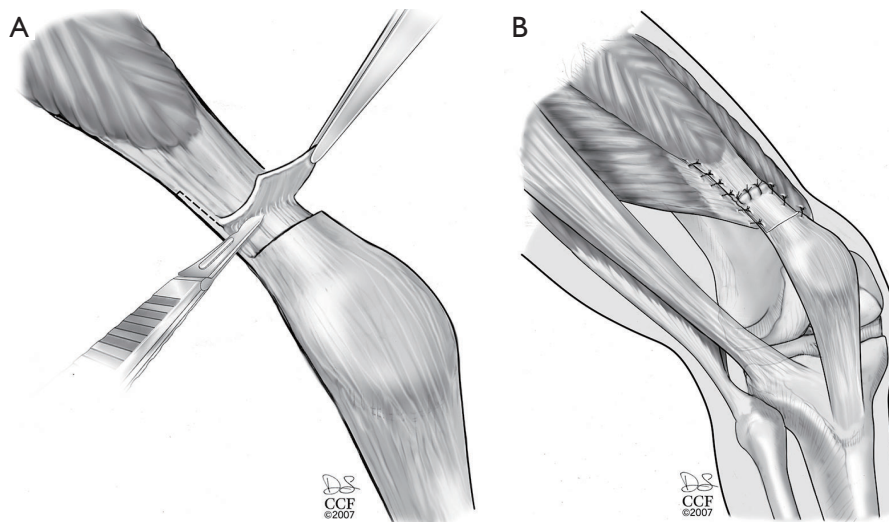


Figure 7 The surgical treatment of congenital fixed lateral patella dislocation requires extensive lateral releases in order to achieve relocation. (A) Because contracture of the quadriceps most often is present as well, lengthening of the central tendon (rectus femoris and vastus intermedius) of the quadriceps is required in order to allow for adequate knee flexion while avoiding recurrent obligatory patella dislocation; (B) final repair includes a lengthened vastus lateralis.

Trochlea dysplasia

This pathoanatomy is one of the most common associations with patella instability and the most common condition linked to failure of surgical intervention (3). In the adult, various methods of trochleoplasty have been described with documented efficacy. In the skeletally immature patient, however, osteotomy is risky and for most, avoided. The addition of MPFL reconstruction, however, has been a significant help for the treatment of these individuals, especially in the more common mild forms of dysplasia (14,23).

Congenital fixed lateral patella dislocation/obligatory patella dislocation in flexion

Much less common are the fixed lateral patella dislocations as well as those that dislocate every time the knee flexes. In those conditions there is most often an associated contracture of the quadriceps. Although the alignment of the extensor mechanism can be achieved by appropriate lateral releases and lengthenings followed by medial imbrications and reconstructions, in order to maintain alignment while achieving adequate flexion, a lengthening of the quadriceps tendon is required (Figure 7). Without including a quadriceps lengthening, one of two complications can occur. The first is a permanent restriction

of flexion while maintaining patellofemoral alignment. The second possibility is that adequate flexion is achieved during the rehabilitation process, but at the expense of the loss of patella stability with recurrent obligatory lateral patella dislocation as the knee flexes (22).

Summary

The management of patella instability in children and youth can be challenging due to the presence of open growth plates that prevent the use of osteotomies of the tibial tuberosity and trochlea. Furthermore, reconstructions of the MPFL have the potential to violate the distal femoral physis, leading to premature closure and subsequent angular deformity. That said, most often surgical techniques are available to address these issues and lead to the safe establishment of balance and stability of the extensor mechanism of the knee necessary for improving the quality of life in the young patient. There is no need to delay surgery until skeletal maturity. For those seeking the latest consensus on the management of patella instability, a recent on-line publication is available (13).

Acknowledgments

I would like to acknowledge the editorial assistance by Nipun Sodhi in the preparation of this manuscript as well as David Schumick (Department of Medical Illustrations, Cleveland Clinic) for the preparation of the medical illustrations.

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editors (Vicente Sanchis-Alfonso and Scott F. Dye) for the series “The Patellofemoral Joint” published in *Annals of Joint*. The article has undergone external peer review.

Conflicts of Interest: The author has completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/aoj.2018.04.04>). The series “The Patellofemoral Joint” was commissioned by the editorial office without any funding or sponsorship. The author has no other conflicts of interest to declare.

Ethical Statement: The author is accountable for all

aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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doi: 10.21037/aoj.2018.04.04

Cite this article as: Andrish J. Patella instability in the skeletally immature patient: pearls for surgical treatment. *Ann Joint* 2018;3:38.