

Patellar Tendon Imbrication for the Treatment of Patella Alta in Skeletally Immature Patients



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Abstract: Patella alta is a major contributor to recurrent patellar instability, which is commonly seen in young athletes. Distalizing tibial tubercle osteotomy has been used for the correction of patella alta and patellar instability, but this procedure is contraindicated in the skeletally immature patient population, as it could lead to growth arrest of the proximal tibial physes. We propose a patellar tendon imbrication technique as a soft-tissue alternative to tibial tubercle osteotomy. When used with concomitant medial patellofemoral ligament reconstruction, we suggest this procedure may prove beneficial for the treatment of patellar instability in skeletally immature patients.

Patella alta is a major contributor to recurrent patellar instability, which is commonly seen in young athletes.^{1,2} This anatomical predisposition is characterized by an abnormally high-riding patella in relation to the tibia, femur, and trochlear groove and can interfere with proper joint kinematics and cartilage contact points.^{3,4} Patella alta was found in 24% of patients with episodic patellar dislocation compared with only 3% in controls.⁵ It has also been implicated in recurrent instability seen in patients following medial patellofemoral ligament (MPFL) reconstruction.⁶⁻⁸

Distalizing tibial tubercle osteotomy has served as an effective treatment for patients with patella alta and patellar instability.⁹⁻¹¹ However, this procedure is contraindicated in the skeletally immature patient population, as it could lead to growth arrest of the proximal tibial physes. Patellar tendon imbrication has been proposed as a soft-tissue alternative in

skeletally immature patients with patellar instability.¹²⁻¹⁶ We propose a patellar tendon imbrication technique for the correction of patella alta, which circumvents the need for tendon transection. When used with concomitant MPFL reconstruction,¹⁷ we suggest this procedure may prove beneficial for the treatment of patellar instability in skeletally immature patients.

Surgical Technique (With Video Illustration)

As this procedure is always done in concert with MPFL reconstruction, the combined procedure is described here. The patient is placed in the supine position with a tourniquet applied. An inferolateral scope portal is made, followed by an inferomedial instrument portal made under direct visualization. Diagnostic arthroscopy is used for debridement of cartilage lesions and excision of loose bodies if present.

Attention is then turned to the arthrotomy after the limb is exsanguinated by an elastic Esmarch and the tourniquet is inflated to 250 mm Hg. Using a lateral parapatellar approach (Fig 1), the iliotibial band is released from the capsule. Reaching across the patella, a small incision is made medially, with the surgeon finding the layer between the capsule and the medial retinaculum. A Bovie is used to remove soft tissue from the superior half of the patella. Two 1.8-mm Q-FIX anchors (Smith & Nephew) are placed approximately at the midpoint of the patella and 5 mm proximally (Fig 2). A hamstring allograft is marked at the midpoint and tied down with the sutures from the anchors (Fig 3).

A patellar tendon imbrication is performed with 2 figure-of-eight ORTHOCORD sutures (Mitek) placed

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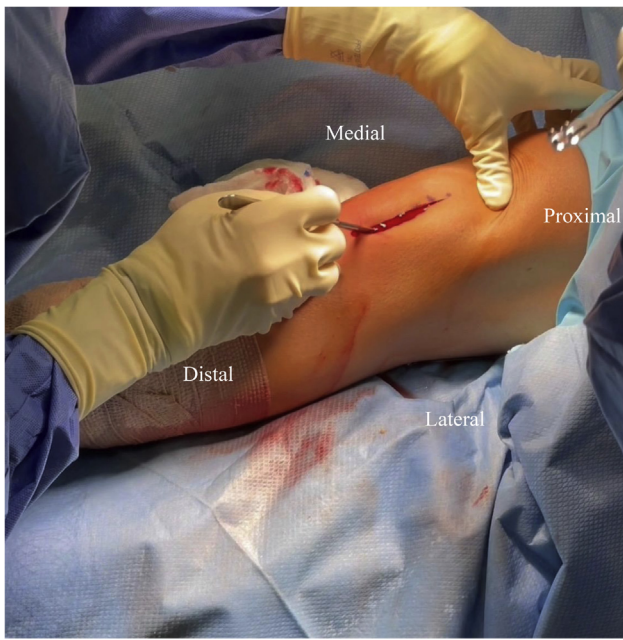


Fig 1. This image shows the patient placed in the supine position. On the left knee, an anterolateral parapatellar incision is made and the iliotibial band is released from the capsule. This will allow for suspensory fixation of the medial patellofemoral ligament, access to the patellar tendon, and access to the medial aspect of the patella by retracting the patella laterally.

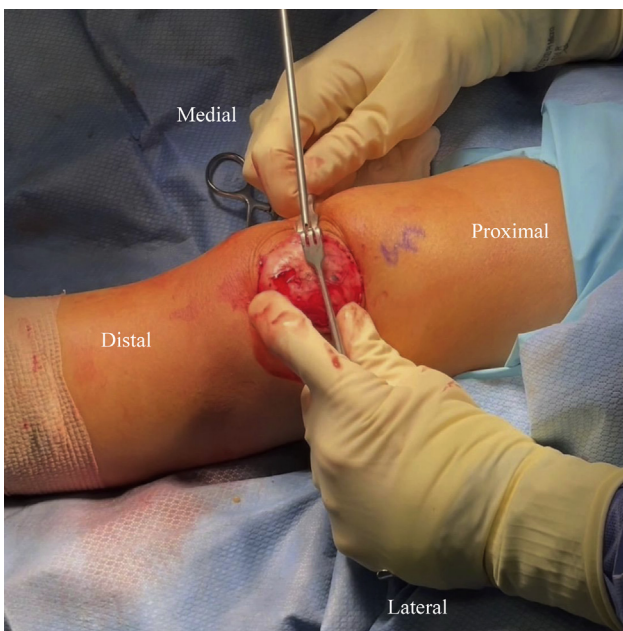


Fig 2. This image shows the patient placed in the supine position. On the left knee, the patella is retracted laterally to allow for placement of the suture anchors. Two 1.8-mm Q-FIX anchors (Smith & Nephew) are placed along the medial aspect of the patella. The first anchor is placed approximately at the midpoint of the patella and another is placed 5 mm proximally.

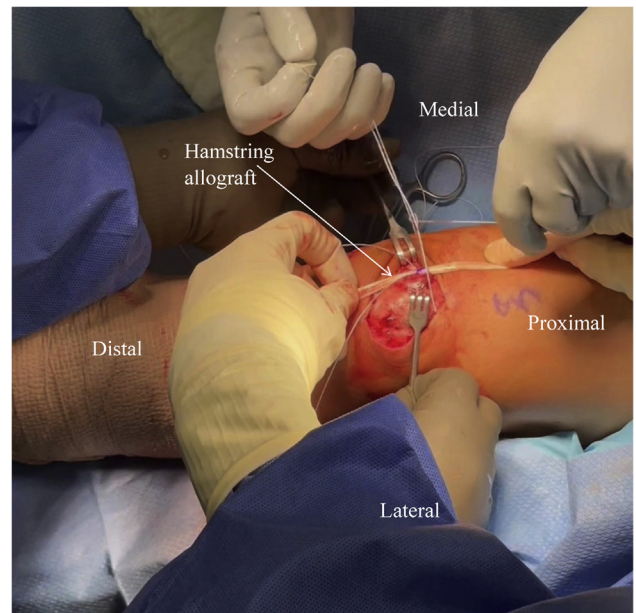


Fig 3. This image shows the patient placed in the supine position. On the left knee, a hamstring allograft is marked at the midpoint and tied down using the sutures from the 2 anchors along the medial aspect of the patella.

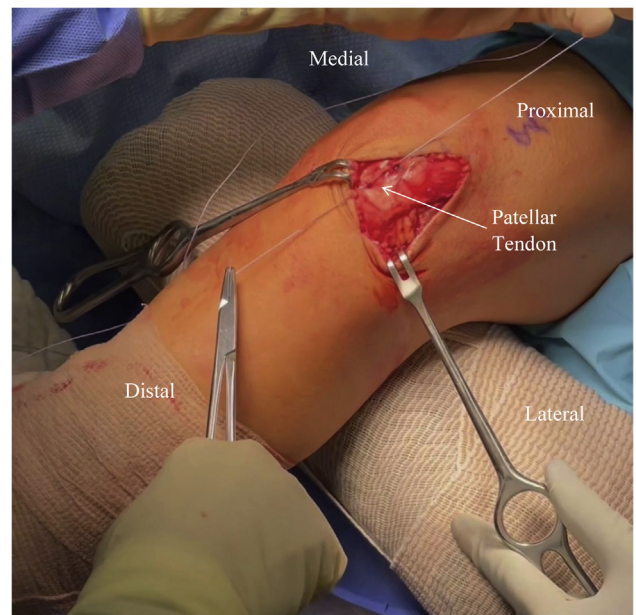
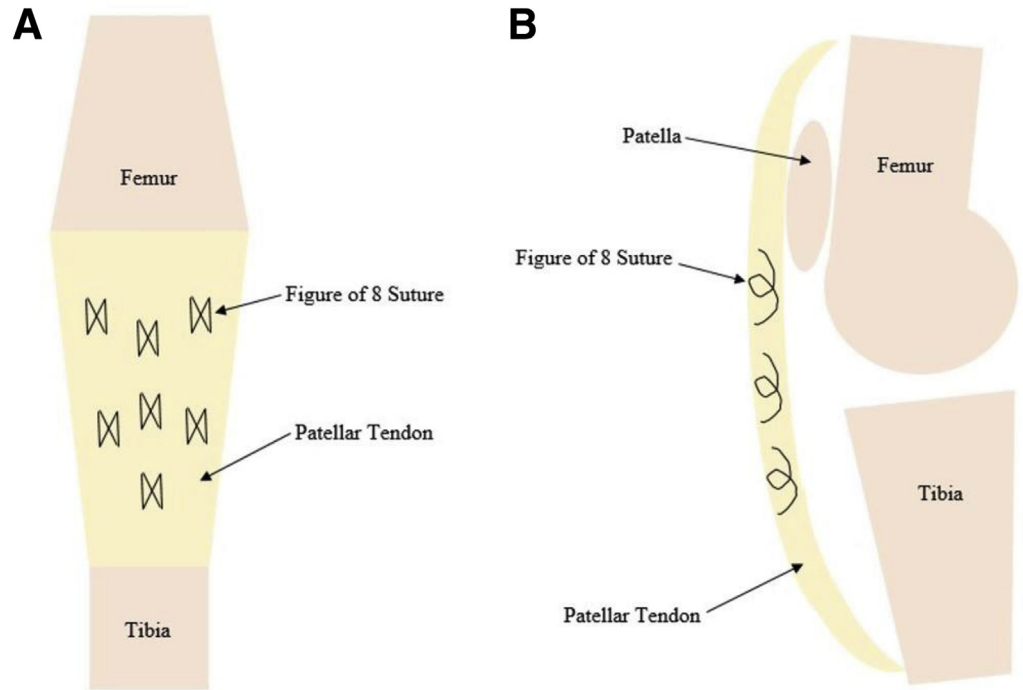


Fig 4. This image shows the patient placed in the supine position with their left knee positioned on a padded bump with about 30° of flexion. Two retractors are used to hold open a lateral parapatellar incision to allow sufficient access for the patellar tendon imbrication. The completion of the first figure-of-eight suture is shown along the medial patellar tendon. Upon completion of the 7 figure-of-eight sutures, the patellar tendon is shortened by 1 cm.

Fig 5. An anteroposterior (A) and lateral (B) schematic demonstrating the placement of the figure-of-eight sutures along the patellar tendon to complete the patellar tendon imbrication. Two figure-of-eight ORTHOCORD sutures (Mitek) are placed proximal to distal along both the medial and lateral aspect of the patellar tendon (4 in total). Then, 3 VICRYL figure-of-eight sutures (Ethicon) are placed centrally along the patellar tendon.



proximal to distal both medially and laterally, and 3 VICRYL figure-of-eight sutures (Ethicon) centrally to bring down the patella (Figs 4 and 5 and Video 1). One-centimeter bites of tendon are taken with each figure of eight (Fig 6).

A small incision is made just posterior to the medial epicondyle. The sulcus between the adductor tubercle

and the medial epicondyle is palpated. A guidewire is drilled up into the femur (Fig 7), and isometry of the MPFL graft is checked through a full range of motion. Fluoroscopy is used to confirm the placement of the tunnel. After drilling to approximately 35 mm, a spade-tip guidewire is used to drill through the lateral cortex (Fig 8). The graft is prepared with a suture tape

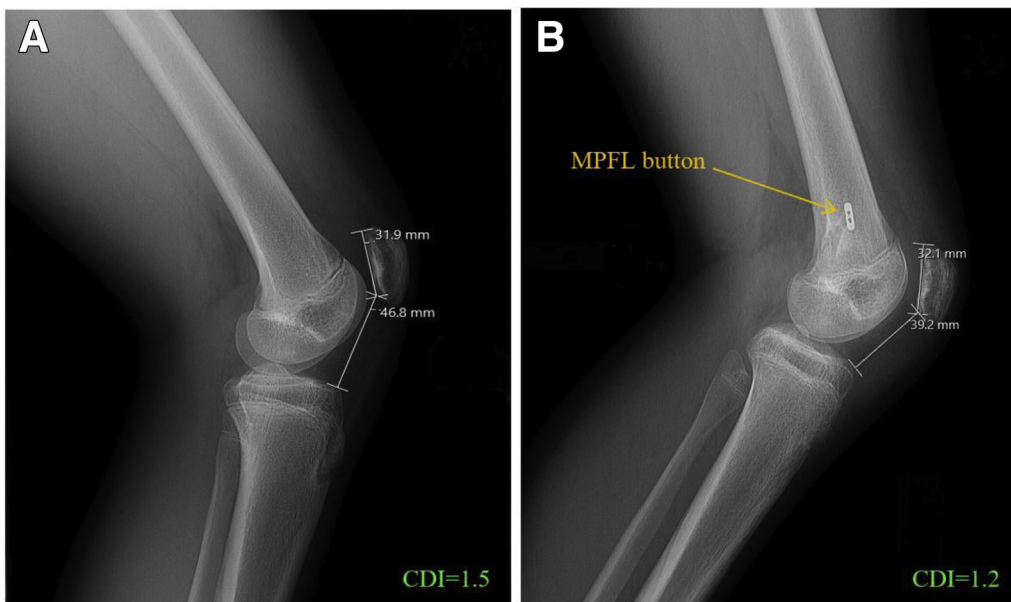


Fig 6. Lateral radiographs of a left knee demonstrating the measurement of the Caton–Deschamps index (CDI) preoperatively (A) and postoperatively (B) in a 15-year-old female patient with patella alta and patellar instability status post combined medial patellofemoral ligament reconstruction and patellar tendon imbrication. The CDI was 1.5 preoperatively and 1.2 postoperatively, showing a reduced patellar height.

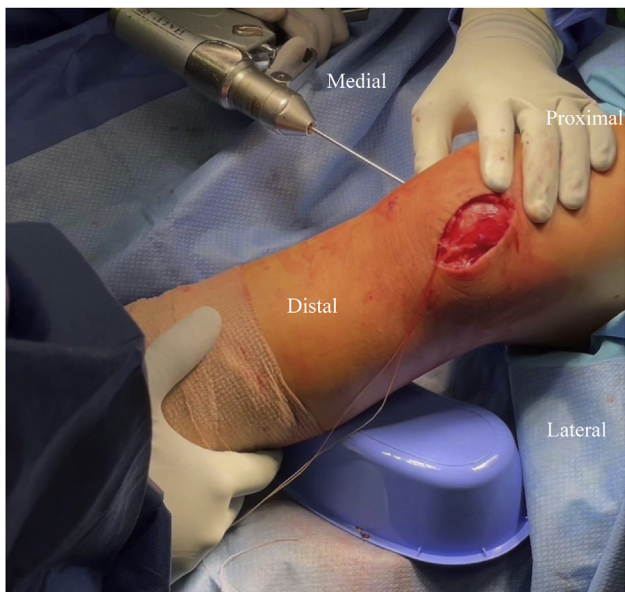


Fig 7. This image shows the patient placed in the supine position. On the left knee, a small incision is made just posterior to the medial epicondyle and a guide wire is drilled approximately 35 mm into the femur to establish the femoral tunnel.

FiberLoop and TightRope (Arthrex). The MPFL is passed with a suture and secured into the femoral tunnel with the TightRope RT (Fig 9). The end point of the patella is examined in full extension as well as 30° of flexion and range of motion evaluated. Wounds are then closed in a routine fashion. The patient is placed in a hinged knee orthosis and taken to the recovery room. The patient is advised to in full extension be for 4 weeks with range of motion as tolerated.

Discussion

Patellar instability is a common pathology among adolescent patients, and the anatomical predisposition of patella alta can further play a role in frequent subluxation and dislocation events.¹⁻³ While tibial tubercle osteotomy has been used successfully for the correction of patellar height,⁹⁻¹¹ it can cause damage to the open physes of skeletally immature patients. In light of these limitations, soft-tissue procedures are better suited to treat this patient population, and may avoid the complications associated with tibial tubercle osteotomy such as nonunion, fracture, or hardware irritation.¹⁸

Patellar tendon imbrication was first described by Andrish¹² in 2007 as a treatment for skeletally immature patients with patellar instability. Servien and Archbold¹³ have since suggested a similar technique for patella alta associated with an especially long patellar tendon. While several techniques have been proposed that involve elevation of the anterior half of the patellar

tendon while leaving the posterior half intact,¹²⁻¹⁶ these methods must be approached with great caution, as complete tendon transection poses a risk during the procedure as well as postoperatively in the case of trauma or poor healing. Although tendon repair is possible in the event of complete transection, it may lead to a more difficult recovery and diminished outcomes.¹⁶

A recent study by Patel et al.¹⁹ looked at the outcomes for a sample of 32 knees from 27 patients following the technique proposed by Andrish.¹² Lateral radiographs were used to identify the amount of shortening attained by the procedure as well as the maintenance of the shortened patellar tendon at a baseline of 2 years postoperatively. Insall–Salvati, Blackburne–Peel, and Caton–Deschamps index measurements showed minimal adjustment between 3 weeks and 2 years postoperatively, highlighting the technique's effectiveness in maintaining a shortened

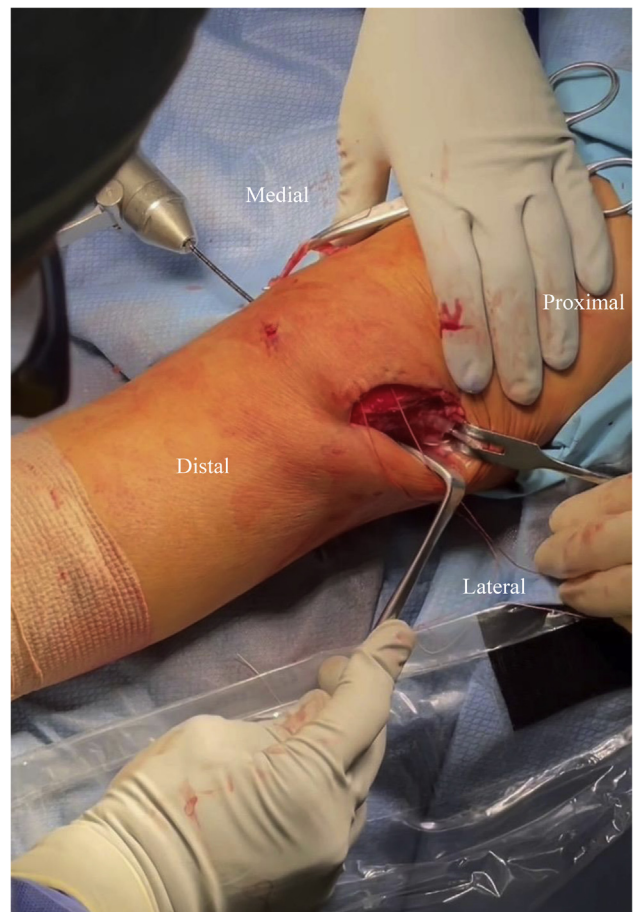


Fig 8. This image shows the patient placed in the supine position. On the left knee, a spade-tip guidewire is drilled through the lateral femoral cortex. The skin is retracted to allow for palpation where the pin is coming through, ensuring there is not significant soft tissue under where the medial patellofemoral ligament button will sit.

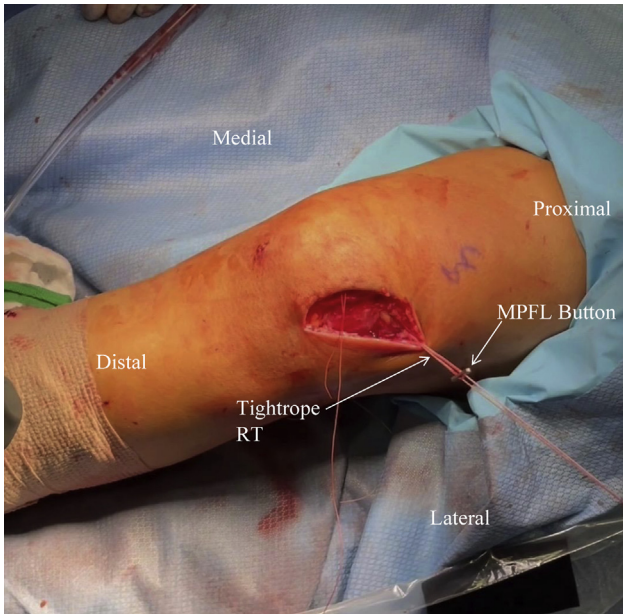


Fig 9. This image shows the patient placed in the supine position. On the left knee, the medial patellofemoral ligament (MPFL) is shown being secured into the femoral tunnel using the TightRope RT. The MPFL button will be fixated into the lateral aspect of the femur.

patellar tendon. In addition, the procedure was noted for its applications in both the pediatric and adult population. Data on long-term patient-reported outcomes remain limited.

Patel et al.¹⁹ noted an average shortening of 1 cm. The imbrication technique that we propose achieves the same degree of shortening while avoiding the need for tendon transection. The repetitive nature of the 7 figure-of-8 sutures also makes this a simpler method of imbrication ideal for use with adjunct procedures. When used with concomitant MPFL reconstruction as described here, the importance of performing the imbrication before ligamentous anchoring of the patella to the femur cannot be underestimated, since the imbrication will impact the relative height. It is also critical to determine the amount of shortening preoperatively, as overshortening during the procedure could lead to patella baja and associated morbidity.

Additional studies are needed to assess both short- and long-term outcomes of the procedure as well as maintenance of the shortened tendon. Table 1 provides a list of advantages and disadvantages of the proposed technique, and Table 2 provides a list of pearls and pitfalls.

Conclusions

This technique provides a simple and effective method for the correction of patella alta, and when used with concomitant MPFL reconstruction it provides a promising treatment for patellar instability in the skeletally immature patient without compromising the integrity of the tibial physes.

Table 1. Advantages and Disadvantages of Patellar Tendon Imbrication using Figure-of-Eight Sutures

Advantages	Disadvantages
Decreases patellar height without the use of distalizing tibial tubercle osteotomy	Lacks studies of long-term patient-reported outcomes and maintenance of patellar height
Protects the proximal tibial physes of a skeletally immature patient	Can lead to thickening of the patellar tendon
Avoids the risk of complete tendon transection	Poses risk of overshortening
Can be used with concomitant procedures for patellar instability	Has potential for postoperative tendon stretching

Table 2. Pearls and Pitfalls of Patellar Tendon Imbrication Using Figure-of-Eight Sutures

Pearls	Pitfalls
Use ORTHOCORD Violet Braided Composite Sutures (Mitek), as the suture is partially dissolvable and knots will be less prominent.	Avoid this procedure in patients with a TT-TG above 20, as a patellar tendon shortening will not improve lateral tracking.
A small incision is usually all that is required, as these patients tend to have fairly elastic skin and you can essentially create a mobile window.	Do not over shorten the patellar tendon. A little alta is better than a little baja.
Start immediate range of motion to avoid arthrofibrosis. Ideally, patients should flex to 90° within a few days.	Using a combination of absorbable and partially absorbable sutures is preferable to avoid palpable knots.
Mark the proximal and distal tendon so that you can measure how much you shortened the tendon and adjust accordingly.	

TT-TG, tibial-tuberosity to trochlear groove.

References

- Palmer RC, Podeszwa DA, Wilson PL, Ellis HB. Coronal and transverse malalignment in pediatric patellofemoral instability. *J Clin Med* 2021;10:3035.
- Sanders TL, Pareek A, Hewett TE, Stuart MJ, Dahm DL, Krych AJ. High rate of recurrent patellar dislocation in skeletally immature patients: A long-term population-based study. *Knee Surg Sports Traumatol Arthrosc* 2018;26:1037-1043.
- Biedert RM. Patella alta: When to correct and impact on other anatomic risk factors for patellofemoral instability. *Clin Sports Med* 2022;41:65-76.
- Conry KT, Cosgarea AJ, Tanaka MJ, Elias JJ. Influence of tibial tuberosity position and trochlear depth on patellar tracking in patellar instability: Variations with patella alta. *Clin Biomech (Bristol, Avon)* 2021;87, 105406.
- Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: An anatomic radiographic study. *Knee Surg Sports Traumatol Arthrosc* 1994;2:19-26.
- Thaunat M, Erasmus PJ. Recurrent patellar dislocation after medial patellofemoral ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2008;16:40-43.
- Sappey-Mariniere E, Sonnery-Cottet B, O'Loughlin P, et al. clinical outcomes and predictive factors for failure with isolated MPFL reconstruction for recurrent patellar instability: A series of 211 reconstructions with a minimum follow-up of 3 years. *Am J Sports Med* 2019;47:1323-1330.
- Yanke AB, Huddleston HP, Campbell K, et al. Effect of patella alta on the native anatomometricity of the medial patellofemoral complex: A cadaveric study. *Am J Sports Med* 2020;48:1398-1405.
- Tan SHS, Ngiam EHK, Lim JY, Lim AKS, Hui JH. Surgical management of patella alta in patellofemoral instability: A systematic review and meta-analysis. *Orthop J Sports Med* 2021;9, 2325967121999642.
- Leite CBG, Santos TP, Giglio PN, Pécora JR, Camanho GL, Gobbi RG. Tibial tubercle osteotomy with distalization is a safe and effective procedure for patients with patella alta and patellar instability. *Orthop J Sports Med* 2021;9, 2325967120975101.
- Knapik DM, Kunze KN, Azua E, Vadhera A, Yanke AB, Chahla J. Radiographic and clinical outcomes after tibial tubercle osteotomy for the treatment of patella alta: A systematic review and meta-analysis [published online ahead of print May 26, 2021]. *Am J Sports Med*. doi:10.1177/03635465211012371
- Andrish J. Surgical options for patellar stabilization in the skeletally immature patient. *Sports Med Arthrosc Rev* 2007;15:82-88.
- Servien E, Archbold P. Shortening the patellar tendon. In: Neyret P, Demey G, eds. *Surgery of the knee*. London: Springer, 2014.
- Kakazu R, Luczak SB, Grimm NL, et al. Patellar tendon imbrication for patella alta. *Arthrosc Tech* 2021;11:e7-e12.
- Yalcin S, Patel RM, Andrish J, Farrow LD. Patellar tendon imbrication [published online ahead of print]. *Video J Sports Med*. doi:10.1177/26350254211006699
- Parvaresh KC, Huddleston HP, Yanke AB. Patellar tendon shortening for treatment of patella alta in skeletally immature patients with patellar instability. *Arthrosc Tech* 2021;10:e1979-e1984.
- Allahabadi S, Pandya NK. Allograft medial patellofemoral ligament reconstruction in adolescent patients results in a low recurrence rate of patellar dislocation or subluxation at midterm follow-up. *Arthroscopy* 2022;38:128-138.
- Payne J, Rimmke N, Schmitt LC, Flanigan DC, Magnussen RA. The incidence of complications of tibial tubercle osteotomy: A systematic review. *Arthroscopy* 2015;31:1819-1825.
- Patel RM, Gombosh M, Polster J, Andrish J. Patellar tendon imbrication is a safe and efficacious technique to shorten the patellar tendon in patients with patella alta [published online October 27, 2020]. *Orthop J Sports Med*. doi:10.1177/2325967120959318.