Underappreciated Factors to Consider in Revision Anterior Cruciate Ligament Reconstruction

A Current Concepts Review

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Primary anterior cruciate ligament (ACL) reconstructions (ACLRs) are being performed with increasing frequency. While many of these will have successful outcomes, failures will occur in a subset of patients who will require revision ACLRs. As such, the number of revision procedures will continue to rise as well. While many reviews have focused on factors that commonly contribute to failure of primary ACLR, including graft choice, patient factors, early return to sport, and technical errors, this review focused on several factors that have received less attention in the literature. These include posterior tibial slope, varus malalignment, injury to the anterolateral ligament, and meniscal injury or deficiency. This review also appraised several emerging techniques that may be useful in the context of revision ACL surgery. While outcomes of revision ACLR are generally inferior to those of primary procedures, identifying these potentially underappreciated contributing factors preoperatively will allow the surgeon to address them at the time of revision, ideally improving patient outcomes and preventing recurrent ACL failure.

Keywords: anterior cruciate ligament reconstruction failure; posterior tibial slope; varus malalignment; meniscal deficiency; anterolateral ligament

The annual incidence of revision anterior cruciate ligament (ACL) reconstruction (ACLR) continues to rise.5,44 It is estimated that 200,000 ACLRs are performed annually in the United States,44 with reported revision rates ranging from 1% to 13%.5,68,123 Reconstruction of the ACL is a reliable procedure, with 90% of patients reporting improvement in functional outcomes following surgery.7,5,96 However, patient-reported outcomes following revision ACLR have produced less favorable results in the literature.1,41,65,130,131 Furthermore, functional outcomes have been noted to decline further after multiple ACL revisions.125,126 Following ACL revision, patients sustain lower rates of return to sport,4,61 higher rates of chondral damage,1,13,126 and higher rates of subsequent revision surgery.131

Most reviews that address the factors that commonly contribute to failure of primary ACLR have focused on graft choice, patient factors, and technical errors, including tunnel placement, graft tension, and failure of graft fixation.38,95,124,133 The purpose of this review was to highlight several underappreciated factors in the literature that must be considered when evaluating a patient in whom ACLR failed and to appraise novel surgical techniques that have recently been reported to manage these complex patients. Such factors include alignment (both sagittal and coronal), injury to the anterolateral capsule, emerging concepts involving the importance of the injured menisci, and contemporary considerations regarding anatomic features of the ligament and single-stage revision surgery.

ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION FAILURE

A consensus on what constitutes ACLR failure has yet to be reached, with failure being defined through a variety of objective and subjective measures. According to Johnson and Fu,51 failure can be attributed to 1 or more of 4 main categories: recurrent pain or arthritis, arthrofibrosis or loss of motion, extensor mechanism dysfunction, or recurrent instability patholaxity.47 Kamath et al52 highlighted...
various causes for recurrent instability, which they classified as either early or late presentations. Early instability (<6 months) may be attributed to technical error, failure of graft incorporation, premature return to high-demand activities, or overly aggressive rehabilitation. Late causes may include repeated trauma to the graft, poor graft placement, generalized ligamentous laxity, and concomitant abnormality not addressed at the time of the reconstruction.62

While technical errors have frequently been cited as the most common cause of ACLR failure,38,39,52,121 a study by the MARS (Multicenter ACL Revision Study) group74 acknowledged the multifactorial nature of ACL revision failure, recognizing that most failures are due to a combination of technical error, trauma, and/or biological factors. Objective failure of the native ACL was defined by Daniel et al26 as a side-to-side difference of greater than 3 mm. Revision ACLR failure was later defined by Wright et al131 as a pivot-shift grade of 2⁺ or 3⁺ or a positive side-to-side difference greater than 5 mm. Previous authors have also identified failure to return to sport or persistent feelings of knee instability as subjective failures.38,47,83

Given the complex nature of ACL failure, outside of graft rerupture, objective measures and subjective feelings of instability must be addressed on an individualized basis when revision surgery is being considered.

POSTERIOR TIBIAL SLOPE

A risk factor for ACL injury that has received recent attention in the literature is a relative increase in the posterior tibial slope (PTS), which is the angle formed between a line perpendicular to the mid-diaphysis of the tibia and the posterior inclination of the tibial plateau (Figure 1).40,59

Numerous radiographic studies have established an association between a high PTS and subsequent risk for ACL injury in adult15,104,137 and pediatric populations.27,88 However, not all studies corroborate this association78 or have failed to do so in both sexes.50,55,118 Dejour and Bonnin29 reported that for every 1° increase in slope, an additional 6 mm of anterior tibial translation (ATT) can be expected in both the ACL-intact and the ACL-deficient knee. During axial loading through the tibiofemoral joint, vertical shearing forces are converted to anteriorly directed tibial translational forces. The ACL serves as the primary restraint to anterior translation,16,37 so as the PTS increases, a greater force is applied to the ACL (or graft reconstruction) during functional loading.73,77,99,100

Other studies have suggested that the lateral posterior tibial slope (LPTS) may be a more sensitive risk factor for ACL injury.102,112 Han et al46 demonstrated that the slope of the medial and lateral tibial plateau can be disparate in patients, but advanced imaging is needed to reliably identify these differences. A preferential increase in lateral slope results in greater anterior motion of the lateral tibial plateau compared with the medial plateau. This results in relative internal rotation of the tibia compared with the femur, placing increased stress on the ACL during axial loading.25,77 While numerous studies have implicated the

![Figure 1](image-url)
Furthermore, Cantin et al.\textsuperscript{18} stated that while an increased relative to the contralateral knee on standing radiographs.

Prior laxity as evidenced by increased ATT of at least 10 mm was recommended deflexion osteotomies only for patients with a slope of 9.2°.\textsuperscript{14}

In a repeat revision ACL, achieving a postoperative mean PTS of 9.2° (range, 8°-10°). These reports, although limited to a small cohort of patients, indicate that an osteotomy should be considered in the setting of a failed revision ACLR when a PTS of 13° or more is identified. Magnusson et al.\textsuperscript{67} recommended deflexion osteotomies only for patients with a slope of this magnitude who also have significant chronic anterior laxity as evidenced by increased ATT of at least 10 mm relative to the contralateral knee on standing radiographs. Furthermore, Cantin et al.\textsuperscript{18} stated that while an increased PTS may warrant consideration of a tibial deflexion osteotomy, this procedure should not necessarily be performed in all cases of increased PTS, particularly when another source of graft failure can be identified.

While previous studies have highlighted the efficacy and safety of simultaneous tibial osteotomy and ACLR in the setting of primary procedures,\textsuperscript{12,82,120,135} recent results by Dejour et al.\textsuperscript{28} and Sonnery-Cottet et al.\textsuperscript{105} indicate that osteotomy can safely be performed during ACL revision. This reduces the inherent morbidity associated with 2 surgeries and simultaneously addresses all of the aberrant anatomic features that may compromise the reconstruction. Additional work is needed to elucidate the relative contributions of PTS and LPTS in the literature.

**VARUS MALALIGNMENT**

In addition to sagittal malalignment, deviations in the coronal plane, specifically varus malalignment of the knee, have been implicated as a potential cause for increased ACL strain.\textsuperscript{81,122} Varus malalignment is traditionally defined as greater than 3° of varus between the mechanical axes of the femur and tibia or as a weight-bearing line that passes medial to the center of the knee.\textsuperscript{34} Cadaveric studies have demonstrated that higher tension forces are observed in the ACL when varus torque is applied to the extended knee.\textsuperscript{71,72,79,122} Furthermore, several studies have identified that knees with varus thrust that undergo ACLR may be more likely to fail if the varus alignment is not addressed at the time of the reconstruction.\textsuperscript{56,81,85,86,122} Varus-aligned ACL-deficient knees have also been implicated as a risk factor for progression of chondral and meniscal lesions.\textsuperscript{42,53,114}

Varus thrust refers to a dynamic alignment typically observed in varus knees, identified by an abrupt worsening of existing varus during the weightbearing phase of gait, with a return to a reduced varus alignment during the non-weightbearing (swing) phase.\textsuperscript{20} Van de Pol et al.\textsuperscript{112} conducted a cadaveric study investigating the effects of increasing varus moments on ACL tension and lateral joint opening under axial loading conditions. The investigators observed that an extreme varus knee (12° hip-knee-ankle varus angle), particularly when associated with a varus thrust, produced significantly higher ACL tensions in both extension and 10° of flexion. Van de Pol et al.\textsuperscript{122} concluded that under these conditions, enough tension may be placed on an ACL graft to cause failure of an ACLR; furthermore, the investigators suggested that a high tibial valgus osteotomy be considered in ACL-deficient patients with varus alignment and associated varus thrust. In 41 younger adult patients undergoing ACLR, Noyes et al.\textsuperscript{82} demonstrated the efficacy of high tibial osteotomy (HTO) in patients with ACL-deficient knees and associated varus malalignment. The investigators recommended HTO for symptomatic patients with instability and limited medial joint arthrosis who wished to return to a higher level of activity. Patients who underwent the procedure had statistically significant improvement in symptoms, and overall patient satisfaction was high (88%). In a study by Bonin et al.\textsuperscript{12} at 12 years of follow-up, 83% of patients (25/30) who had undergone a combined ACLR and a valgus-producing HTO had returned to moderate, intense, or very intense levels of sporting activity. Additionally, a low rate of progression of arthritis (17%) was observed radiographically among these patients.

In patients with a noted varus knee, preoperative assessment should include clinical inspection of the patient’s gait to determine whether a varus or hyperextension thrust is present. Long-leg weightbearing radiographs should be obtained to assess osseous lower extremity alignment using the hip-knee-ankle angle and to identify medial tibiofemoral compartment degeneration.\textsuperscript{52} Radiographs should also be used to identify patients with constitutional varus, who are not considered candidates for HTO. ACL revision may be performed as a staged or combined procedure.\textsuperscript{30,84,129,135} While previous authors have identified a high rate of associated complications with combined procedures,\textsuperscript{60,82} more recent literature has recognized simultaneous procedures to be efficacious and produce satisfactory results in double varus knees with associated ACL injury.\textsuperscript{64,96,135}

Indications for HTO in ACL-deficient knees with varus alignment include medial compartment arthritis or varus thrust in knees with tibiofemoral malalignment\textsuperscript{2,56,60} and instability in double and triple varus knees.\textsuperscript{14,84} In light of clinical studies demonstrating improved outcomes in symptomatic patients with varus malalignment who have undergone HTO during ACLR, it is reasonable to conclude that these procedures should be considered as a salvage procedure for young patients with double and triple varus knee malalignment for whom ACLR has failed and who wish to return to an increased level of activity or recreational sport. Not only does the procedure improve clinical outcomes, but biomechanical evidence suggests that it reduces stress on the ACL graft and reduces the progression of arthrosis. Lateral closing wedge HTO has recently been demonstrated in a cadaveric study to have the advantage of more reliable PTS correction than medial opening wedge HTO (Figure 2), in addition to significantly decreasing ATT. This led the authors of the study to advocate for lateral closing wedge HTO in the setting of recurrent...
ACLR failure, as it normalizes ACL kinematics, protecting the graft. Furthermore, other studies have shown that opening wedge HTO has a tendency to increase the PTS. However, we would advocate that surgeons perform the osteotomy with which they can reliably achieve the most predictable outcomes.

ANTEROLATERAL LIGAMENT

Anterolateral rotary instability is another potential cause of failure that should be considered in patients with multiple failed ACLRs. Previous research has demonstrated that rotational instability can persist in up to 25% of patients following ACLR. The anterolateral ligament (ALL) is an extra-articular structure of the knee that is often torn in association with ACL injuries, in as many as 78% of cases (Figures 3 and 4). The ALL has been observed to act as a secondary restraint to ATT and rotational instability. ACL-deficient knees with an associated ALL injury can display severe rotatory instability and cause persistent symptoms of giving-way. Injury to the ALL can be difficult to diagnose clinically, and therefore preoperative magnetic resonance imaging or ultrasonographic findings

Figure 2. An anteroposterior weightbearing radiograph of the right knee demonstrates an anterior cruciate ligament reconstruction with medial opening wedge high tibial osteotomy. (Image courtesy of Jacqueline Munch Brady, MD.)

Figure 3. Photograph of a typical right knee after complete dissection of the anterolateral ligament (ALL), popliteus tendon, popliteofibular ligament, and lateral collateral ligament (LCL). (Reprinted with permission from Claes S, Vereecke E, Maes M, Victor J, Verdonk P, Bellemans J. Anatomy of the anterolateral ligament of the knee. J Anat. 2013;223(4):321-328.)

Figure 4. An anteroposterior weightbearing radiograph of the left knee demonstrates a Segond fracture. The Segond fracture is currently thought to be a bony avulsion of the anterolateral ligament from the lateral tibial plateau.
may suggest the diagnosis. Terry et al demonstrated that varying degrees of instability on pivot-shift and Lachman examination maneuvers in ACL-deficient knees did not correlate with ACL injury but instead correlated most closely with variations in injury to the ALL. Failure to address this may ultimately lead to articular cartilage and meniscal damage if the ALL is not reconstructed concurrently with the ACL.

Historically, lateral extra-articular reconstruction, involving nonanatomic reconstruction of the anterolateral structures, has demonstrated mixed clinical results in the literature due to abnormal joint kinematics leading to poor long-term outcomes, including arthrosis, residual instability, and joint overconstraint. Distinction between the ALL and the collective anterolateral structures (including the iliotibial band and anterolateral capsule) must be made when referring to literature about extra-articular reconstructions, as lateral-plasty or lateral extra-articular tenodesis procedures have more recently begun to be replaced by the development of anatomic ALL reconstructions (ALLRs). The ALL is increasingly recognized to be a distinct anatomic structure separate from the “capsulo-osseous layer of the iliotibial band” previously described, and thus these reconstructions seek to address this factor.

In the literature, ALLR has been described as providing rotatory stability without overconstraint, a problem noted by Slette et al. A systematic review of lateral extra-articular tenodesis procedures demonstrated that the function of the ALL has not been fully elucidated. Several cadaveric kinematic studies have helped to identify the role of the ALL, ALLR, and lateral structures, thus restoring normal joint alignment and kinematics. To date, only 1 case series is available, which involved 92 patients who underwent a combined ACLR and ALLR with a minimum 2-year follow-up. Patients had significantly improved Lysholm scores and subjective and objective IKDC scores. This series of patients also had significant decreases in anterior laxity, as only 7 patients had a postoperative pivot-shift score of 1, whereas all patients had a preoperative pivot-shift score of 1 or higher. Only 1 patient in this series had ACLR graft of rupture.

Although these studies may suggest a potential role for ALLR in select patients with grade 3 pivot shifts and patients with ACLR failure in whom another cause cannot be identified, further prospective studies are needed to evaluate the efficacy of these procedures and further determine their indications. The Stability Trial is a multicenter randomized controlled trial that is currently being conducted by Getgood and others to compare the outcomes and rates of graft failure for high-risk patients who undergo an ACLR with and without lateral extra-articular tenodesis.

MENISCAL DEFICIENCY

Among patients with multiple previous knee surgeries undergoing revision ACLR, many patients are noted to have a high incidence of associated chondral and meniscal abnormality. Meniscal integrity has been implicated as a possible cause for recurrent ACLR failure warranting consideration. It is well established from cadaveric studies that the medial meniscus serves as a secondary restraint to ATI in the ACL-deficient knee. However, biomechanical studies have also implicated the lateral meniscus as a stabilizer during rotatory axial loading, exerting its effect by preventing the pivot shift. Several authors have shown the modified Lemaire procedure to be biomechanically superior to the “anatomic” ALLRs. This slip is harvested in an open fashion and then rerouted underneath the lateral collateral ligament. The central slip is then fixed with a medium staple proximal and posterior to the lateral condyle. The knee is placed at 90° of flexion and relative external rotation during final fixation.

While ALLR may play a role in improving stability, caution should be taken with this approach in patients undergoing primary ACLR, especially given the risk of overconstraint. Sonnery-Cottet et al suggested combined ACLR and ALLR only in the setting of chronic ACL lesions, grade 3 pivot shifts, participation in pivoting or competitive sports, the presence of a Segond fracture, or a lateral femoral notch sign. Helito et al similarly recommended that the combined ACLR and ALLR be reserved for cases of ACL revision without an apparent cause of failure or high-grade pivot shifts. Combined reconstruction in this setting offers the advantage of restoring the attenuated lateral structures, thus restoring normal joint alignment and kinematics. To date, only 1 case series is available, which involved 92 patients who underwent a combined ACLR and ALLR with a minimum 2-year follow-up. Patients had significantly improved Lysholm scores and subjective and objective IKDC scores. This series of patients also had significant decreases in anterior laxity, as only 7 patients had a postoperative pivot-shift score of 1, whereas all patients had a preoperative pivot-shift score of 1 or higher. Only 1 patient in this series had ACLR graft of rupture.

The Orthopaedic Journal of Sports Medicine Revision ACL Reconstruction
Ramp lesions are a specific type of meniscal tear that have recently been reported to occur frequently in the setting of ACL injuries. In a series of 868 patients by Liu et al., 16.6% of patients undergoing ACLR were found to have ramp lesions, which were defined as longitudinal tears of the peripheral attachment of the posterior horn of the medial meniscus. Some authors have referred to this tear pattern as the “Bankart” lesion of the knee. The posterior horn is recognized as a critical stabilizer in the ACL-deficient knee, and Bollen originally described the lesion as being associated with anteromedial rotatory subluxation. In a more recent cadaveric study, sectioning of the

Figure 5. The effect of medial meniscectomy (MM; n = 8) and lateral meniscectomy (LM; n = 8) in response to a pivot-shift test. Anterior tibial translation in the lateral compartment for the intact knee, isolated ACL deficiency ACL–single meniscectomy (ACL/ LM-deficient or ACL/MM-deficient), and ACL–double meniscectomy (ACL/LM/MM-deficient) are shown. The MM group had a significant difference between ACL-deficient and ACL/LM/MM-deficient knees (P < .05). The LM group had a significant difference between ACL-deficient and ACL/LM-deficient knees (P < .01). ACL, anterior cruciate ligament; ACL out, ACL-deficient; ACL/MM out, ACL/MM-deficient; ACL/MM/LM out, ACL/MM/MM-deficient. (Reprinted with permission from Musahl V, Citak M, O’Loughlin PF, Choi D, Bedi A, Pearle AD. The effect of medial versus lateral meniscectomy on the stability of the anterior cruciate ligament-deficient knee. Am J Sports Med. 2010;38(8):1591-1597.)

Figure 6. Arthroscopic view of a ramp lesion in a left knee. (A) View through the anterolateral portal; the posterior horn of the medial meniscus seems normal. (B) View through the intercondylar notch; the dashed area shows the ramp lesion. (C) View through the posteromedial portal. MFC, medial femoral condyle; MTP, medial tibial plateau; PM-Cap, posteromedial capsule; SN, spinal needle; PHMM, posterior horn of the medial meniscus. (Reprinted with permission from Liu X, Feng H, Zhang H, Hong L, Wang XS, Zhang J. Arthroscopic prevalence of ramp lesion in 868 patients with anterior cruciate ligament injury. Am J Sports Med. 2011;39(4):832-837.)
posteromedial meniscocapsular junction in an ACL-deficient knee resulted in a significant increase in ATT and external rotation.\textsuperscript{110} Ramp lesions play a role in disrupting an important secondary stabilizer of the knee, and arthroscopic examination of the posterior structures of the knee and repair of ramp lesions must always be undertaken when revision ACL surgery is performed (Figure 6).

Several authors have noted that the increased strain placed on the ACL graft in patients with ACLR and deficient menisci may result in a higher risk of graft failure.\textsuperscript{32,47,109} In a cadaveric study, the biomechanical interdependence of the ACL graft and the medial meniscus was demonstrated as in situ forces on the ACLR graft were 33\% to 50\% higher in the absence of the medial meniscus.\textsuperscript{89} In another study of patients who underwent ACLR, patients with medial or lateral meniscal deficiency were 4.5 or 3.5 times more likely to experience ACLR failure, respectively.\textsuperscript{94} In a cadaveric study by Spang et al\textsuperscript{107} involving knees that had undergone medial meniscectomy, anterior-posterior loads up to 150 N were applied to knees in 30\(^\circ\), 60\(^\circ\), and 90\(^\circ\) of flexion, resulting in significantly high tibial displacement at all angles. Subsequent meniscal allograft transplant (MAT) restored tibial displacement to normal at 30\(^\circ\) and 90\(^\circ\) of flexion and returned ACL strain values to normal at 60\(^\circ\) and 90\(^\circ\).

In light of these findings, many have begun to advocate for the role of concomitant MAT in patients undergoing ACLR who have irreparable meniscal injury or have undergone previous total or near-total meniscectomy.\textsuperscript{24,45,91,98,109} The goal of this intervention is to restore stability, thus protecting the ACL graft and delaying future chondral degeneration.\textsuperscript{96} In general, MAT is indicated for younger patients with normal alignment and minimal chondrosis who have pain or in whom previous ACLRs have failed.\textsuperscript{76,93} Our indications for a combined MAT/ACLR procedure are for patients with a previous failed ACLR who still have subjective joint line pain or symptomatic instability with an absent meniscus, including those with an absent posterior root or those with less than 40\% of the meniscus intact.

Several authors have investigated the outcomes of MAT with concomitant ACLR. In a small series of patients who underwent valgus HTO, ACLR, and MAT, 6 of 7 (85.3\%) patients experienced good or excellent results.\textsuperscript{17} Sekiya et al\textsuperscript{96} demonstrated that among 28 patients who underwent MAT and ACLR, 85.7\% had normal or nearly normal IKDC scores and 90\% had normal or nearly normal Lachman and pivot-shift tests. In another small series of patients who underwent the combined intervention, all patients had long-term satisfaction with the procedure at 8.5 years follow-up, and 7 of the 8 patients had normal or nearly normal restoration of stability following the procedure.\textsuperscript{45} In a group of 31 patients who underwent isolated MAT (11 patients) or MAT with ACLR (20 patients), all but 1 patient reported that their knee function was normal or nearly normal; an average side-to-side difference of 2 mm was observed, and 63\% of patients reported rare or no instability.\textsuperscript{114} The combination of MAT and ACLR is safe and effective and should be considered in the context of revision ACLR to prevent recurrent failure of the ACL graft by improving stability.

**CONCLUSION**

Although recurrent ACL failure affects only a relatively small subset of patients who undergo ACLR, revision ACLR is a technically challenging procedure that requires careful attention to detail and consideration of all the factors that contributed to previous failures. Even though the vast majority of ACL graft failures occur as a result of technical errors, failure to recognize and address certain anatomic factors highlighted in this review may also represent missed opportunities to ensure a successful revision. If these factors are corrected, stress on the ACL graft can be minimized, thus reducing the risk of future graft disruption and failure. While improved stability of the knee can be achieved in revision ACLR, surgeons should counsel patients about their expectations preoperatively to ensure a successful outcome following surgery.

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**REFERENCES**

1. Ahliden M, Samuelsson K, Sernert N, Forssblad M, Karlsson J, Kartus J. The Swedish National Anterior Cruciate Ligament Register: a report on baseline variables and outcomes of surgery for almost 18,000 patients. Am J Sports Med. 2012;40(10):2230-2235.

2. Amendola A. Unicompartmental osteoarthritis in the active patient: the role of high tibial osteotomy. Arthroscopy. 2003;19(suppl 1):109-116.

3. Amirault JD, Cameron JC, MacIntosh DL, Marks P. Chronic anterior cruciate ligament deficiency: long-term results of MacIntosh’s lateral substitution reconstruction. J Bone Joint Surg Br. 1988;70(4):622-624.

4. Anand BS, Feller JA, Richmond AK, Webster KE. Return-to-sport outcomes after revision anterior cruciate ligament reconstruction surgery. Am J Sports Med. 2016;44(5):580-584.

5. Andermoro D, Desai N, BJörnsson H, Ylander M, Karlsson J, Samuelsson K. Patient predictors of early revision surgery after anterior cruciate ligament reconstruction: a cohort study of 16,930 patients with 2-year follow-up. Am J Sports Med. 2015;43(1):121-127.

6. Anderson AF, Snyder RB, Lipscomb AB. Anterior cruciate ligament reconstruction: a prospective randomized study of three surgical methods. Am J Sports Med. 2001;29(3):272-279.

7. Ardern CL, Webster KE, Taylor NF, Feller JA. Return to sport following anterior cruciate ligament reconstruction surgery: a systematic review and meta-analysis of the state of play. Br J Sports Med. 2011;45(7):596-606.

8. Baer GS, Harner CD. Clinical outcomes of allograft versus autograft in anterior cruciate ligament reconstruction. Clin Sports Med. 2007;26(4):661-681.

9. Bellmanns J, Colyn W, Vandenneucker H, Victor J. The Chitranjan Ranawat award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus. Clin Orthop Relat Res. 2012;470(1):45-53.

10. Bignozzi S, Zaffagnini S, Lopomo N, Martelli S, Iacono F, Marcacci M. Does a lateral plasty control coupled translation during antero-posterior stress in single-bundle ACL reconstruction? An in vivo study. Knee Surg Sports Traumatol Arthrosc. 2009;17(1):65-70.

11. Bollen SR. Posteromedial meniscocapsular injury associated with rupture of the anterior cruciate ligament. Bone Joint J. 2010;92-B(2):222-223.
12. Bonin N, Ati Si Selmi T, Donell ST, Dejour H, Neyret P. Anterior cruciate reconstruction combined with valgus upper tibial osteotomy: 12 years follow-up. Knee. 2004;11(6):431-437.

13. Borchers JR, Kaeding CC, Pedroza AD, et al. Intra-articular findings in primary and revision anterior cruciate ligament reconstruction surgery: a comparison of the MOON and MARS study groups. Am J Sports Med. 2011;39(9):1889-1893.

14. Boss A, Stutz G, Oursin C, Gächter A. Anterior cruciate ligament reconstruction combined with valgus tibial osteotomy (combined procedure). Knee Surg Sports Traumatol Arthrosc. 1995;3(3): 187-191.

15. Brandon ML, Haynes PT, Bonamo JR, Flynn MI, Barrett GR, Sherman MF. The association between posterior-inferior tibial slope and anterior cruciate ligament insufficiency. Arthroscopy. 2006;22(8): 894-899.

16. Butler DL, Noyes FR, Grood ES. Ligamentous restraints to anterior-posterior drawer in the human knee: a biomechanical study. J Bone Joint Surg Am. 1980;62(2):259-270.

17. Cameron JC, Saha S. Meniscal allograft transplantation for unicompartmental arthritis of the knee. Clin Orthop Relat Res. 1997;337: 164-171.

18. Cantin O, Magnussen RA, Corbi F, Servien E, Neyret P, Lustig S. The role of high tibial osteotomy in the treatment of knee laxity: a comprehensive review. Knee Surg Sports Traumatol Arthrosc. 2015;23(10):3026-3037.

19. Chahla J, Dean CS, Moatshe G, et al. Meniscal ramp lesions: anatomy, incidence, diagnosis, and treatment. Orthop J Sports Med. 2016;4(7):232596716657815.

20. Chang A, Hayes K, Dunlop D, et al. Thrust during ambulation and the progression of knee osteoarthritis. Arthritis Rheum. 2004;50(12): 3897-3903.

21. Christensen JJ, Krych AJ, Engasser WM, Vanhees MK, Collins MS, Bonney MF. The association between posterior-inferior tibial slope and anterior cruciate ligament disruption. Knee Surg Sports Traumatol Arthrosc. 2011;19(suppl 1): S109-S114.

22. Christensen JJ, Krych AJ, Engasser WM, Vanhees MK, Collins MS, Bonney MF. The association between posterior-inferior tibial slope and anterior cruciate ligament disruption. Knee Surg Sports Traumatol Arthrosc. 2011;19(suppl 1): S109-S114.

23. Claes S, Bartholomeuesen S, Bellemans J. High prevalence of anterolateral ligament abnormalities in magnetic resonance images of anterior cruciate ligament-injured knees. Acta Orthop Belg. 2014; 80(1):45-49.

24. Cole BJ, Carter TR, Rodeo SA. Allograft meniscal transplantation. J Bone Joint Surg Am. 2002;84(7):1236-1250.

25. Cole BJ, Carter TR, Rodeo SA. Allograft meniscal transplantation. J Bone Joint Surg Am. 2002;84(7):1236-1250.

26. Cole BJ, Carter TR, Rodeo SA. Allograft meniscal transplantation. J Bone Joint Surg Am. 2002;84(7):1236-1250.

27. Dare DM, Fabricant PD, McCarthy MM, et al. Increased lateral tibial slope is a risk factor for pediatric anterior cruciate ligament injury: an MRI-based case-control study of 152 patients. J Orthopaedic AA natomy, incidence, diagnosis, and treatment. Orthop J Sports Med. 2016;4(7):232596716657815.

28. Chang A, Hayes K, Dunlop D, et al. Thrust during ambulation and the progression of knee osteoarthritis. Arthritis Rheum. 2004;50(12): 3897-3903.

29. Chang A, Hayes K, Dunlop D, et al. Thrust during ambulation and the progression of knee osteoarthritis. Arthritis Rheum. 2004;50(12): 3897-3903.

30. Dejour D, Saffarini M, Demey G, Baverel L. Tibial slope correction combined with second revision ACL produces good knee stability and prevents graft rupture. Knee Surg Sports Traumatol Arthrosc. 2015; 23(10):2846-2852.

31. Dodds AL, Halewood C, Guptha CM, Williams A, Ams AA. The anterolateral ligament: anatomy, length changes and association with the Segond fracture. Bone Joint J. 2014;96-B(3):325-331.

32. Doherty BL, Lowe WR. Meniscal root tears: identification and repair. Am J Orthop (Belle Mead NJ). 2016;45(3):183-187.

33. Ducat A, Sariabi E, Lebel B, et al. Posterior tibial slope changes after opening- and closing-wedge high tibial osteotomy: a comparative prospectuve multicenter study. Orthop Traumatol Surg Res. 2012; 98(1):68-74.

34. Dugdale TW, Noyes FR, Stryer D. Preoperative planning for high tibial osteotomy: the effect of lateral tibiofemoral separation and tibiofemoral length. Clin Orthop Relat Res. 1992;(274):248-264.

35. Feucht MJ, Mauro CS, Brucker PU, Imhoff AB, Hinterwimmer S. The role of the tibial slope in sustaining and treating anterior cruciate ligament injuries. Knee Surg Sports Traumatol Arthrosc. 2013;21(1): 134-145.

36. Freedman KB, D’Amato MJ, Nedeef DD, Kaz A, Bach BR. Arthroscopic anterior cruciate ligament reconstruction: a metaanalysis comparing patellar tendon and hamstring tendon autografts. Am J Sports Med. 2003;31(1):2-11.

37. Fukubayashi T, Torzilli PA, Sherman MF, Warren RF. An in vitro biomechanical evaluation of anterior-posterior motion of the knee: tibial displacement, rotation, and torque. J Bone Joint Surg Am. 1982;64(2): 258-264.

38. George MS, Dunn WR, Spindler KP. Current concepts review: revision anterior cruciate ligament reconstruction. Am J Sports Med. 2006; 34(12):2026-2037.

39. Getelman MH, Friedman MJ. Revision anterior cruciate ligament reconstruction surgery. J Am Acad Orthop Surg. 1999;7(3): 189-198.

40. Giffin JR, Vogrin TM, Zantop T, Woo SL-Y, Harner CD. Effects of increasing tibial slope on the biomechanics of the knee. Am J Sports Med. 2004;32(2):376-382.

41. Giftsad T, Drogsot JO, Viset A, Grøntvedt T, Horterno GS. Inferior results after revision ACL reconstructions: a comparison with primary ACL reconstructions. Knee Surg Sports Traumatol Arthrosc. 2012; 21(8):2011-2018.

42. Gillquist J, Messner K. Anterior cruciate ligament reconstruction and the long-term incidence of gonarthrosis. Sports Med. 1999;27(3): 143-156.

43. Gossner J. The anterolateral ligament of the knee—visibility on magnetic resonance imaging. Rev Bras Ortop. 2014;49(1):98-99.

44. Gottlob CA, Baker CL, Pellissier JM, Colvin L. Cost effectiveness of anterior cruciate ligament reconstruction in young adults. Clin Orthop Relat Res. 1999;367:272-282.

45. Graf KW, Sekiya JK, Woytys EM. Long-term results after combined medial meniscal allograft transplantation and anterior cruciate ligament reconstruction: minimum 8.5-year follow-up study, Arthroscopy. 2004;20(2):129-140.

46. Han HS, Chang CB, Seong SC, Lee S, Lee MC. Evaluation of anatomic references for tibial sagittal alignment in total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2008;16(4):373-377.

47. Harner CD, Giffin JR, Dunteman RC, Annunziata CC, Friedman MJ. Evaluation and treatment of recurrent instability after anterior cruciate ligament reconstruction. Instr Course Lect. 2001;50:463-474.

48. Heitello CP, Bonadio MB, Gobbi RB, et al. Combined intra- and extra-articular reconstruction of the anterior cruciate ligament: the reconstruction of the knee anterolateral ligament. Arthrosc Tech. 2015;4(3): e239-e244.

49. Herbstein M, Hoser C, Tecklenburg K, et al. The lateral femoral notch sign following ACL injury: frequency, morphology and relation to meniscal injury and sports activity. Knee Surg Sports Traumatol Arthrosc. 2015; 23(8):2250-2258.

50. Hohmann E, Bryant A, Reaburn P, Tewtrthk S. Is there a correlation between posterior tibial slope and non-contact anterior cruciate ligament injuries? Knee Surg Sports Traumatol Arthrosc. 2011;19(suppl 1): S109-S114.

51. Johnson DL, Fu FH. Anterior cruciate ligament reconstruction: why do failures occur? Instr Course Lect. 1995;44:391-406.

52. Kamath GV, Redfern JC, Greis PE, Burks RT. Revision anterior cruciate ligament reconstruction. Am J Sports Med. 2011;39(1):199-217.

53. Keene GCR, Bickerstaff D, Rae PJ, Paterson RS. The natural history of meniscal tears in anterior cruciate ligament insufficiency. Am J Sports Med. 1993;21(5):672-679.
54. Kennedy MI, Claas S, Fusco FAF, et al. The anterolateral ligament: an anatomic, radiographic, and biomechanical analysis. *Am J Sports Med*. 2015;43(7):1606-1615.

55. Khan MS, Seon JK, Song EK. Risk factors for anterior cruciate ligament injury: assessment of tibial plateau anatomic variables on conventional MRI using a new combined method. *Int Orthop*. 2011;35(8):1251-1256.

56. Kim S-J, Moon H-K, Chun Y-M, Chang W-H, Kim S-G. Is correctional osteotomy crucial in primary varus knees undergoing anterior cruciate ligament reconstruction? *Clin Orthop Relat Res*. 2011;469(5):1421-1426.

57. Kittl C, Halewood C, Stephen JM, et al. Length change patterns in the lateral extra-articular structures of the knee and related reconstructions. *Am J Sports Med*. 2015;43(2):354-362.

58. Klos B, Scholtes M, Konijnenburg S. High prevalence of all complex Segond avulsion using ultrasound imaging. *Knee Surg Sports Traumatol Arthrosc*. 2017;25(4):1331-1338.

59. LaPrade RF, Oro FB, Ziegler CG, Wijdicks CA, Walsh MP. Patellar height and tibial slope after opening-wedge proximal tibial osteotomy: a prospective study. *Am J Sports Med*. 2010;38(1):160-170.

60. Lattermann C, Jakob RP. High tibial osteotomy alone or combined with ligament reconstruction in anterior cruciate ligament-deficient knees. *Knee Surg Sports Traumatol Arthrosc*. 1996;4(1):32-38.

61. Leferve N, Klouche S, Mirouse G, Herman S, Gerometta A, Bohu Y. Return to sport after primary and revision anterior cruciate ligament reconstruction: a prospective comparative study of 552 patients from the FAST cohort. *Am J Sports Med*. 2017;45(1):34-41.

62. Levy IM, Torzilli PA, Warren RF. The effect of medial meniscectomy on anterior-posterior motion of the knee. *J Bone Joint Surg Am*. 1982;64(6):883-888.

63. Li Y, Hong L, Feng H, Wang Q, Zhang H, Song G. Are failures of anterior cruciate ligament reconstruction associated with steep posterior tibial slopes? A case control study. *Chin Med J (Engl)*. 2014;127(14):2649-2653.

64. Li Y, Zhang H, Zhang J, Li X, Song G, Feng H. Clinical outcome of simultaneous high tibial osteotomy and anterior cruciate ligament reconstruction for medial compartment osteoarthritis in young patients with anterior cruciate ligament-deficient knees: a systematic review. *Arthroscopy*. 2015;31(9):507-519.

65. Lind M, Menhert F, Pedersen AB. Incidence and outcome after revision anterior cruciate ligament reconstruction: results from the Danish registry for knee ligament reconstructions. *Am J Sports Med*. 2012;40(7):1551-1557.

66. Liu X, Feng H, Zhang H, Hong L, Wang XS, Zhang J. Arthroscopic performance with a new experimental technique. *J Bone Joint Surg Am*. 1990;72(4):557-567.

67. Marouane H, Shiraiz-Adl A, Adouni M, Hashemi J. Steeper posterior tibial slope markedly increases ACL force in both active gait and passive knee joint under compression. *J Biomech*. 2014;47(6):1353-1359.

68. MARS Group, Wright RW, Huston LJ, et al. Descriptive epidemiology of the Multicenter ACL Revision Study (MARS) cohort. *Am J Sports Med*. 2010;38(10):1979-1986.

69. Marti CB, Gautier E, Wachtli SW, Jakob RP. Accuracy of frontal and sagittal plane correction in open-wedge high tibial osteotomy. *Arthroscopy*. 2004;20(4):366-372.

70. Marx RG. *Revision ACL Reconsruction: Indications and Technique*. Berlin, Germany: Springer Science & Business Media; 2013.

71. McLean SG, Oh YK, Palmer ML, et al. The relationship between anterior tibial acceleration, tibial slope, and ACL strain during a simulated jump landing task. *J Bone Joint Surg Am*. 2011;93(14):1310-1317.

72. Meister K, Talley MC, Horodyski MB, Indelicato PA, Hartzel JS, Batts J. Caudal slope of the tibia and its relationship to noncontact injuries to the ACL. *Am J Knee Surg*. 1998;11(4):217-219.

73. Miyasaka T, Matsumoto H, Suda Y, Otake T, Toyama Y. Coordination of the anterior and posterior cruciate ligaments in constraining the varus-valgus and internal-external rotatory instability of the knee. *J Orthop Sci*. 2002;7(3):348-353.

74. Musahl V, Citak M, O’Loughlin PF, Choi D, Bedi A, Pearle AD. The effect of medial versus lateral meniscectomy on the stability of the anterior cruciate ligament-deficient knee. *Am J Sports Med*. 2010;38(8):1591-1597.

75. Naudie DDR, Amendola A, Fowler PJ. Opening wedge high tibial osteotomy for symptomatic hyperextension-varus thrust. *Am J Sports Med*. 2004;32(1):60-70.

76. Noyes FR, Barber SD, Simon R. High tibial osteotomy and ligament reconstruction in varus angulated, anterior cruciate ligament-deficient knees: a two- to seven-year follow-up study. *Am J Sports Med*. 1993;21(1):12-12.

77. Noyes FR, Barber-Westin SD. Revision anterior cruciate surgery with use of bone-patellar tendon-bone autogenous grafts. *J Bone Joint Surg Am*. 2001;83(8):1131-1143.

78. Noyes FR, Barber-Westin SD, Hewett TE. High tibial osteotomy and ligament reconstruction for varus angulated anterior cruciate ligament-deficient knees. *Am J Sports Med*. 2000;28(3):282-296.

79. Noyes FR, Barber-Westin SD, Roberts CS. Use of allografts after failed treatment of rupture of the anterior cruciate ligament. *J Bone Joint Surg Am*. 1994;76(7):1019-1031.

80. Noyes FR, Schipplein OD, Andriacci TP, Saddemi SR, Weise M. The anterior cruciate ligament-deficient knee with varus alignment: an analysis of gait adaptations and dynamic joint loadings. *Am J Sports Med*. 1992;20(6):707-716.

81. O’Brien SJ, Warren RF, Wickiewicz TL, et al. The iliotibial band lateral sling procedure and its effect on the results of anterior cruciate liga- ment reconstruction. *Am J Sports Med*. 1991;19(1):21-25.

82. O’Malley MP, Milewski MD, Solomito MJ, Erwteman AS, Nissen CW. The association of tibial slope and anterior cruciate ligament rupture in skeletally immature patients. *Arthroscopy*. 2015;31(1):77-82.

83. Papageorgiou CD, Gil JE, Kanamori A, Fenwick JA, Woo SL-Y, Fu FH. The biomechanical interdependence between the anterior cruciate ligament replacement graft and the medial meniscus. *Am J Sports Med*. 2001;29(2):226-231.

84. Ranawat AS, Nwachukwu BU, Pearle AD, Zuiderbaan HA, Weeks KD, Khamaisy S. Comparison of lateral closing-wedge versus medial opening-wedge high tibial osteotomy on knee joint alignment and kinematics in the ACL-deficient knee. *Am J Sports Med*. 2016;44(12):3103-3110.

85. Rao AJ, Erickson BJ, Cvetanovich GL, Yanke AB, Bach BR, Cole BJ. The meniscus-deficient knee biomechanics, evaluation, and treatment options. *Orthop J Sports Med*. 2015;3(10):23259671115611386.

86. Rasmussen MT, Nitir M, Williams BT, et al. An in vitro robotic assessment of the anterolateral ligament, part 1: secondary role of the ante- rolateral ligament in the setting of an anterior cruciate ligament injury. *Am J Sports Med*. 2016;44(3):585-592.
93. Rijk PC. Meniscal allograft transplantation—part I: background, results, graft selection and preservation, and surgical considerations. Arthroscopy. 2004;20(7):728-743.

94. Robb C, Kempshall P, Getgood A, et al. Meniscal integrity predicts laxity of anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc. 2015;23(12):3683-3690.

95. Samitier G, Marcano AI, Alentorn-Geli E, Cugat R, Farmer KW, Moser MW. Failure of anterior cruciate ligament reconstruction. Arch Bone Joint Surg. 2015;3(4):220-240.

96. Savarese E, Biaconci S, Romeo R, Amendola A. Role of high tibial osteotomy in chronic injuries of posterior cruciate ligament and posterior lateral corner. J Ortho Traumatol. 2011;12(1):1-17.

97. Schon JM, Moatahe G, Brady AW, et al. Anatomic anterolateral ligament reconstruction of the knee leads to overconstraint at any fixation angle. Am J Sports Med. 2016;44(10):2546-2556.

98. Sekiya JK, Giffin JR, Irgang JJ, Fu FH, Harner CD. Clinical outcomes after combined meniscal allograft transplantation and anterior cruciate ligament reconstruction. Am J Sports Med. 2003;31(6):896-906.

99. Shao Q, MacLeod TD, Manal K, Buchanan TS. Estimation of ligament loading and anterior tibial translation in healthy and ACL-deficient knees during gait and the influence of increasing tibial slope using EMG-driven approach. Ann Biomed Eng. 2011;39(1):110-121.

100. Shelburne KB, Kim H-J, Sterett WI, Pandy MG. Effect of posterior tibial slope on knee biomechanics during functional activity. J Orthop Res. 2011;29(2):223-231.

101. Shoemaker SC, Markolf KL. The role of the meniscus in the anterior-posterior stability of the loaded anterior cruciate-deficient knee: effects of partial versus total excision. J Bone Joint Surg Am. 1986;68(1):71-79.

102. Simon R, Everhart J, Nagaraja H, Chaudhari A. A case-control study using EMG-driven approach. J Biomech. 2010;43(9):1702-1707.

103. Slette EL, Mikula JD, Schon JM, et al. Biomechanical results of lateral extra-articular tenodesis procedures of the knee: a systematic review. Arthroscopy. 2016;32(12):2592-2611.

104. Sonnery-Cottet B, Archbold P, Cucurullo T, et al. The influence of the tibial slope and the size of the intercondylar notch on rupture of the anterior cruciate ligament. J Bone Joint Surg Br. 2011;93(1):1475-1479.

105. Sonnery-Cottet B, Mogos S, Thaunat M, et al. Proximal tibial anterior closing wedge osteotomy in repeat revision of anterior cruciate ligament reconstruction. Am J Sports Med. 2014;42(8):1873-1880.

106. Sonnery-Cottet B, Thaunat M, Freychet B, Pupim BHB, Murphy CG, Claes S. Outcome of a combined anterior cruciate ligament and anterolateral ligament reconstruction technique with a minimum 2-year follow-up. Am J Sports Med. 2015;43(7):1598-1605.

107. Spang JT, Dang ABC, Mazzocca A, et al. The effect of medial meniscus-cemmency and meniscal allograft transplantation on knee and anterior cruciate ligament biomechanics. Arthroscopy. 2010;26(2):192-201.

108. Spencer L, Burkhart TA, Tran MN, et al. Biomechanical analysis of simulated clinical testing and reconstruction of the anterolateral ligament of the knee. Am J Sports Med. 2015;43(9):2189-2197.

109. Steiner TM, Matava MJ, Parker RD. Revision anterior cruciate ligament reconstruction with combined medial or lateral instability. J Knee Surg. 2007;20(4):323-329.

110. Stephen JM, Halewood C, Kittl C, Bollen SR, Williams A, Amis AA. Postero-medial meniscocapsular lesions increase tibio-femoral joint laxity with anterior cruciate ligament deficiency, and their repair reduces laxity. Am J Sports Med. 2016;44(2):400-408.

111. Sterett WI, Miller BS, Joseph TA, Rich VJ, Bain EM. Posterior tibial slope after medial opening wedge high tibial osteotomy of the varus degenerative knee. J Knee Surg. 2009;22(1):13-16.

112. Stijak L, Herzog RF, Schai P. Is there an influence of the tibial slope of the lateral condyle on the ACL lesion? A case-control study. Knee Surg Sports Traumatol Arthrosc. 2006;14(2):112-117.

113. Strobel M. Manual of Arthroscopic Surgery. Berlin, Germany: Springer Science & Business Media; 2002.

114. Tandogan RN, Tager O, Kayasalp A, et al. Analysis of meniscal and chondral lesions accompanying anterior cruciate ligament tears: relationship with age, time from injury, and level of sport. Knee Surg Sports Traumatol Arthrosc. 2003;12(4):262-270.

115. Tavlo M, Elajaj S, Jensen JT, Siersva DM, Krogsgaard MR. The role of the anterior cruciate ligament in ACL insufficient and reconstructed knees on rotational stability: a biomechanical study on human cadavers. Scand J Med Sci Sports. 2016;26(8):960-966.

116. Terry GC, Norwood LA, Hughston JC, Caldwell KM. How iliotibial tract injuries of the knee combine with acute anterior cruciate ligament tears to influence abnormal anterior tibial displacement. Am J Sports Med. 1992;20(1):53-58.

117. Thein R, Boorman-Padgett J, Stone K, Wickiewicz TL, Imhauser CW, Pearle AD. Biomechanical assessment of the anterolateral ligament of the knee: a secondary restraint in simulated tests of the pivot shift and of anterior stability. J Bone Joint Surg Am. 2016;98(11):937-943.

118. Todd MS, Lalliss S, Garcia E, DeBerardino TM, Cameron KL. The relationship between posterior tibial slope and anterior cruciate ligament injuries. Am J Sports Med. 2010;38(1):63-67.

119. Trichine F, Alsata M, Chouteau J, Moyen B, Bouzittouna M, Maza R. Patellar tendon autograft reconstruction of the anterior cruciate ligament with and without lateral plasty in advanced-stage chronic laxity: a clinical, prospective, randomized, single-blind study using passive dynamic X-rays. Knee. 2014;21(1):58-65.

120. Trojani C, Elhor H, Carles M, Boileau P. Anterior cruciate ligament reconstruction combined with valgus high tibial osteotomy allows return to sports. Orthop Traumatol Surg Res. 2014;100(2):209-212.

121. Trojani C, Sbhihi A, Djian P, et al. Causes for failure of ACL reconstruction and influence of meniscectomies after revision. Knee Surg Sports Traumatol Arthrosc. 2011;19(2):196-201.

122. van de Pol GJ, Arnold MP, Verdonchot N, van Kampen A. Varus alignment leads to increased forces in the anterior cruciate ligament. Am J Sports Med. 2008;37(3):481-487.

123. van Eck CF, Sch Krohowsky JG, Working ZM, Irgang JJ, Fu FH. Prospective analysis of failure rate and predictors of failure after anatomic anterior cruciate ligament reconstruction with allograft. Am J Sports Med. 2012;40(4):800-807.

124. Vergis A, Gillquist J. Graft failure in intra-articular anterior cruciate ligament reconstructions: a review of the literature. Arthroscopy. 1995;11(3):312-321.

125. Webb JM, Salmon LJ, Leclerc E, Pinczewski LA, Roe JP. Posterior tibial slope and further anterior cruciate ligament injuries in the anterior cruciate ligament-reconstructed patient. Am J Sports Med. 2013;41(12):2800-2804.

126. Wegryn J, Chouteau J, Filipppot R, Fessy M-H, Moyen B. Repeat revision of anterior cruciate ligament reconstruction: a retrospective review of management and outcome of 10 patients with an average 3-year follow-up. Am J Sports Med. 2009;37(4):776-785.

127. Williams A, Ball S, Stephen J, White N, Jones M, Amis A. The scientific rationale for lateral tenodesis augmentation of intra-articular ACL reconstruction using a modified “Lemaire” procedure. Knee Surg Sports Traumatol Arthrosc. 2017;25(4):1339-1344.

128. Wirth CJ, Peters G. The dilemma with multiple repaired knee instabilities. Knee Surg Sports Traumatol Arthrosc. 1998;6(3):148-159.

129. Won HH, Chang CB, Je MS, Chang MJ, Kim TK. Coronal limb alignment and indications for high tibial osteotomy in patients undergoing revision ACL reconstruction. Clin Orthop Relat Res. 2013;471(11):3504-3511.

130. Wright R, Spindler K, Huston L, et al. Revision ACL reconstruction outcomes: MOCON cohort. J Knee Surg. 2011;24(4):289-294.

131. Wright RW, Gill CS, Chen L, et al. Outcome of revision anterior cruciate ligament reconstruction: a systematic review. J Bone Joint Surg Am. 2012;94(6):531-536.

132. Wu WH, Hackett T, Richmond JC. Effects of meniscal and articular surface status on knee stability, function, and symptoms after anterior cruciate ligament reconstruction a long-term prospective study. Am J Sports Med. 2002;30(6):845-850.
133. Wylie JD, Marchand LS, Burks RT. Etiologic factors that lead to failure after primary anterior cruciate ligament surgery. *Clin Sports Med*. 2017;36(1):155-172.

134. Yoldas EA, Sekiya JK, Irgang JJ, Fu FH, Harner CD. Arthroscopically assisted meniscal allograft transplantation with and without combined anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2003;11(3):173-182.

135. Zaffagnini S, Bonanzinga T, Grassi A, et al. Combined ACL reconstruction and closing-wedge HTO for varus angulated ACL-deficient knees. *Knee Surg Sports Traumatol Arthrosc*. 2013;21(4):934-941.

136. Zaffagnini S, Marcacci M, Lo Presti M, Giordano G, Iacono F, Neri MP. Prospective and randomized evaluation of ACL reconstruction with three techniques: a clinical and radiographic evaluation at 5 years follow-up. *Knee Surg Sports Traumatol Arthrosc*. 2006;14(11):1060-1069.

137. Zeng C, Yang T, Wu S, et al. Is posterior tibial slope associated with noncontact anterior cruciate ligament injury? *Knee Surg Sports Traumatol Arthrosc*. 2016;24(3):830-837.