Journal of ISAKOS xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of ISAKOS

journal homepage: www.elsevier.com/locate/jisakos

Lateral augmentation procedures in anatomic anterior cruciate ligament reconstruction. How to avoid tunnel collision with intraoperative tunnel visualization: A technical note

Vasileios Mitrousias [a], Georgios Chalatsis [a], George Komnos [a], Thomas Neri [b,c], Michael Hantes [a,*]

[a] Department of Orthopaedic Surgery, School of Health Sciences, Faculty of Medicine, University of Thessaly, General University Hospital of Larissa, Larissa, 41334, Greece
[b] Department of Orthopaedic Surgery, University Hospital of Saint Etienne, Saint Etienne, 42000, France
[c] EA 7424 - Inter-university Laboratory of Human Movement Science, University Lyon - University Jean Monnet Saint Etienne, 42000, France

ARTICLE INFO

Keywords:
Lateral extra-articular tenodesis
Lemaire procedure
ALL reconstruction
Tunnel convergence
Anatomic ACL reconstruction

ABSTRACT

Lateral extra-articular tenodesis (LET) or anterolateral ligament (ALL) reconstruction can be used as an augmentation procedure in anatomic anterior cruciate ligament (ACL) reconstruction and are thought to minimize rotational instability, lower re-rupture rates of the ACL graft and improve functional outcomes after surgery. Young patients with high-grade pivot shift or generalized laxity participating in high demand/pivoting sports are considered as the ideal candidates for such a procedure. Both in LET and in ALL reconstruction, femoral fixation of the graft using an interference screw remains a challenge due to the possibility of tunnel convergence of the two tunnels created in the femur, namely the ACL femoral tunnel and the tunnel created in the lateral femur for the LET or ALL procedure. With this technical note, we aim to describe a safe approach for femoral tunnel creation by providing the surgeon not only with instructions for a safe orientation but also with the possibility to check for a possible tunnel collision by using the arthroscope through the anteromedial portal. Although instructions can be used both for LET and ALL reconstruction (same femoral tunnel), a modified Lemaire LET is extensively described since this procedure is the authors' preference for augmenting anatomic ACL reconstruction.

Novelty of the technique

- The novelty of this technique is that its use permits intraoperative visualization of the femoral ACL tunnel by placing the arthroscope through the anteromedial portal, during drilling the lateral extra-articular tenodesis/anterolateral ligament femoral tunnel, to assess for a possible convergence.

Advantages

- The integrity of the tunnel is checked intraoperatively.
- In case of tunnel convergence, direction of the drill guide can be revised without damaging the anterior cruciate ligament graft.
- An interference screw can be used safely as a fixation method of the lateral procedure in the femur, thus providing more stability.

Disadvantages

- Loss of orientation during drilling of the lateral extra-articular tenodesis tunnel may lead to damaging the trochlea.
- There is a risk of over-constraining the lateral compartment, if excessive force is applied during fixation of the lateral extra-articular tenodesis graft.

Outline of the clinical problem

Lateral augmentation procedures following anterior cruciate ligament (ACL) reconstruction are thought to minimize rotational anterolateral instability and improve functional outcomes [1,2]. Lateral extra-articular tenodesis (LET) and anterolateral ligament (ALL) reconstruction are two of the most common options for lateral augmentation. Both have been shown to reduce ACL re-ruptures, as well as pivot shift [3,4]. However, the use of an interference screw as a fixation method in the

* Corresponding author. Department of Orthopaedic Surgery, Faculty of Medicine, University of Thessaly, Larissa, 41334, Greece.
E-mail address: hantesmi@otenet.gr (M. Hantes).

https://doi.org/10.1016/j.jisako.2023.03.001
Received 4 April 2022; Received in revised form 19 February 2023; Accepted 7 March 2023
Available online xxxx

Please cite this article as: Mitrousias V et al., Lateral augmentation procedures in anatomic anterior cruciate ligament reconstruction. How to avoid tunnel collision with intraoperative tunnel visualization: A technical note, Journal of ISAKOS, https://doi.org/10.1016/j.jisako.2023.03.001

femur is a demanding step of the procedure since collision of the lateral procedure tunnel with the femoral ACL tunnel may lead to failure.

Surgical indications and contraindications

Indications for LET as an augmentation in ACL reconstruction are now revisited in the literature. However, young patients aged 14–25 years with a high-grade pivot shift, patients planning to return to collision and pivoting sports, patients with generalized ligamentous laxity or knee hyperextension recurvatum and patients undergoing a revision ACL reconstruction are the main candidates for this operation [1,5]. On the other hand, patients with arthritis of the lateral compartment of posterolateral corner injury should not be considered for such an intervention.

Current surgical techniques

In LET, a strip of the Iliotibial band (ITB) is often used as a soft-tissue source, which is passed deep to the lateral collateral ligament (LCL) and fixated just proximal to the lateral femoral epicondyle. Fixation of the ITB graft in the femur has been described using a staple, an anchor or an interference screw [5–7]. ALL anatomic reconstruction is usually performed using a hamstrings autograft. Femoral fixation of the graft has been described just proximal and posterior to the lateral femoral condyle using knotless anchors or screws [8,9]. When using either an interference screw or an anchor, there is a high risk of tunnel collision in combined ACL reconstruction with LET or ALL.

Novelty of the new technique

With this surgical technique, we aim to answer the problem of a possible tunnel collision. The femoral ACL tunnel is checked by placing the arthroscope through the anteromedial portal, during drilling the LET/ALL femoral tunnel to assess for a possible convergence. To our knowledge, no surgical techniques using the arthroscope to check intraoperatively for a possible tunnel collision have been described till today.

Surgical technique

LET is the authors' preferred lateral augmentation procedure and is extensively described below. However, tunnel orientation and intraoperative assessment of the tunnels with the arthroscope through the anteromedial portal can be also used in an anatomic ALL reconstruction, during the preparation of the femoral fixation point.

LET

Patient positioning

The patient is positioned supine, the knee is brought in 90° of flexion and lateral side support is used at the level of the mid-thigh.

Timing

The LET graft preparation and tunnel drilling is performed after preparation of the femoral and tibial ACL tunnels, but before positioning of the ACL graft. As reported in our previous laboratory study, the ACL reconstruction (ACLR) tunnel should be performed with a posterior orientation (alpha angle >40°) in order to minimize the risk of tunnel collision or trochlear damage [10]. Final fixation of the ITB graft is performed after ACL reconstruction.

Skin incision

A curved lateral incision of approximately 7 cm is created, starting 1 cm proximal to Gerdy's tubercle and extending over the lateral epicondyle and at least 5 cm proximally.

Harvesting of the ITB graft

After dissecting the subcutaneous tissue, the ITB is exposed. Then the central one-third of the ITB band is carefully harvested making sure that the distal attachment to the Gerdy's tubercle is left intact. The width of the graft should be minimum 1 cm. The length of the graft should be approximately 10 cm to ensure adequate length for the interference screw stabilization. Thickness of the graft should be carefully chosen, making sure that the most posterior fibres of the ITB (capsule-osseous layer) are left intact. The proximal side of the graft is sutured with a No. 2 FiberWire using the Krachow whipstitched technique. The graft diameter is measured using a graft diameter measurement guide.

Passage of the ITB graft deep to the LCL

The LCL is identified by palpation. Placing the leg in the figure-of-4 position aids in the identification process by stretching the LCL. After identification of the LCL, a small incision just deep to its proximal part is created using a forceps dissector and a Metzenbaum scissors. The soft-tissue tunnel created should be extracapsular while ensuring that no iatrogenic trauma is caused to the popliteus or the LCL. Finally, the sutured graft is passed beneath the LCL from distal to proximal using a curved Kelly clamp.

Preparation of the femoral tunnel—the "no doubts" technique

The area just proximal and posterior to the lateral femoral epicondyle is cleared by soft tissue. A 1.8 mm diameter guide is positioned 5 mm proximal and 5 mm posterior to the lateral femoral epicondyle and drilled through the opposite cortex. Tunnel should be aimed with one of the following three orientations: 40° axial and 10° coronal, 35° axial and 5° coronal or 30° axial and 0° coronal, since with this orientation, a low risk of collision of the tunnels and a low risk of trochlea damage has been reported [10]. During pin drilling, the arthroscope is advanced inside the femoral ACL tunnel through the anteromedial portal to ensure the integrity of the ACL femoral tunnel. Then, using an appropriate drill size, according to the measurement of the graft diameter, a femoral tunnel is created. Careful and slow drilling is performed, and at the same time, a possible tunnel collision is again checked with the scope through the anteromedial portal. In case a tunnel collision is seen, drilling stops and direction of the guide pin and drill are revised. The length of the tunnel is at least 25 mm to ensure adequate length for graft insertion. Fixation of the ACL graft in then performed.

Outcomes of the novel technique

A retrospective analysis of 85 cases performed in our department showed excellent results in terms of the tunnel integrity and orientation. Tunnel convergence was noticed in 3% of the cases; however, intraoperative visualization of the collision permitted us to revise the direction without damaging the ACL graft. No postoperative complications such as hematoma or infection were noticed. Re-tear rate at 2 years follow-up was 1% and anterior tibial motion measured with the KT-1000 arthrometer was significantly decreased in all cases. Finally, patient-reported outcomes measured using the International Knee Documentation Committee Subjective Knee Function score, the Knee Injury and Osteoarthritis Outcome Score and the Lysholm knee score were excellent in the majority of cases.

Conclusion and future perspectives

The main advantage of the described surgical technique is the ability provided to the surgeon, to intraoperatively assess the ACL and LET/ALL femoral tunnels, thus reducing the risk of tunnel collision and its complications for the patient. The technique provides an excellent visualization of the osseous and soft tissue landmarks required for the operation and needs no special additional equipment. The total operative time is minimally increased but the benefit for the surgeon and the patient is notable.

As every surgical technique, this technique is also not free of risks and limitations. Postoperative scarring is present since this is an open procedure. Preparation of the ITB graft should be mindful since a too thin or too short graft could result in failure, while a too thick graft involving the deepest part of the ITB could result in a vastus lateralis hernia. However, till today authors have not encountered such a complication. Finally, positioning of the leg during graft stabilization is important since internal rotation of the tibia could result in a loose, non-functional fixation and external rotation of the tibia could lead in an over-constraint or non-isometric graft placement, thus limiting knee range of motion.

Conflict of interest

All authors declare that there is no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jisako.2023.03.001.

References

[1] Weber AE, Zuke W, Mayer EN, Forsythe B, Getgood A, Verma NN, et al. Lateral augmentation procedures in anterior cruciate ligament reconstruction: anatomic, biomechanical, imaging, and clinical evidence. Am J Sports Med 2019;47(3):740–52. https://doi.org/10.1177/0363546517751140.

[2] Getgood AMJ, Bryant DM, Litchfield R, Heard M, McCormack RG, Rezansoff A, et al. Lateral extra-articular tenodesis reduces failure of hamstring tendon autograft anterior cruciate ligament reconstruction: 2-year outcomes from the STABILITY study randomized clinical trial. Am J Sports Med 2020;48(2):285–97. https://doi.org/10.1177/0363546519896333.

[3] Hurley ET, Bloom DA, Hoberman A, Unil U, Gonzalez-Lomas G, Strauss EJ, et al. There are differences in knee stability based on lateral extra-articular augmentation technique alongside anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 2021;29(11):3854–63. https://doi.org/10.1007/s00167-020-06416-4.

[4] Perelli S, Morales-Avalos R, Formagnana M, Rojas-Castillo G, Serrancolí G, Monllau JC. Lateral extraarticular tenodesis improves stability in non-anatomic ACL reconstructed knees: in vivo kinematic analysis. Knee Surg Sports Traumatol Arthrosc 2022;30(6):1958–66. https://doi.org/10.1007/s00167-021-06854-8.

[5] Schlichte LM, Aitchison AH, Green DW, Cordasco FA. Modified Lemaire lateral extra-articular tenodesis in the pediatric patient: an adjunct to anterior cruciate ligament reconstruction. Arthrosc Tech 2020;9(1):e111. https://doi.org/10.1016/J.EATS.2019.09.010.

[6] Jesani S, Getgood A. Modified Lemaire lateral extra-articular tenodesis augmentation of anterior cruciate ligament reconstruction. JBJS Essent Surg Tech 2019;9(4). https://doi.org/10.2106/JBJS.ST.19.00017.

[7] Puzzitiello RN, Agarwalla A, Bush-Joseph CA, Forsythe B. Iliotibial band tenodesis with a tenodesis screw for augmentation of anterior cruciate ligament reconstruction. Arthrosc Tech 2019;8(4):e389–93. https://doi.org/10.1016/J.EATS.2018.11.017.

[8] Helito CP, Bonadio MB, Gobbi RG, Albuquerque RFM, Pécora JR, Camanho GL, 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):e239–44. https://doi.org/10.1016/j.eats.2015.02.006.

[9] Smith JO, Yasen SK, Lord B, Wilson AJ. Combined anterolateral ligament and anatomic anterior cruciate ligament reconstruction of the knee. Knee Surg Sports Traumatol Arthrosc 2015;23(11):3151–6. https://doi.org/10.1007/s00167-015-3783-5.

[10] Stordeur A, Grange S, Servien E, Blache Y, Klasan A, Putnis SE, et al. Optimal combination of femoral tunnel orientation in anterior cruciate ligament reconstruction using an inside-out femoral technique combined with an anterolateral extra-articular reconstruction. Am J Sports Med 2022;50(5):1205–14. https://doi.org/10.1177/03635465221078326.