

Combined ACL and Anterolateral Ligament Reconstruction

Adnan Saithna, BMedSci(Hons), MBChB, DipSEM, MSc, FRCS(T&O)^{1,2*}

Mathieu Thauinat, MD³

Jean Romain Delaloye, MD³

Hervé Ouanezar, MD³

Jean Marie Fayard, MD³

Bertrand Sonnery-Cottet, MD³

1. Medical Technologies and Advanced Materials, Clifton Campus, Nottingham Trent University, Nottingham, NG11 8NS, UK.
2. Renacres Hospital, Ormskirk, Lancashire, L39 8SE, UK.
3. Department of Orthopaedic Surgery and Sports Medicine, Centre Orthopédique Santy, FIFA Medical Centre of Excellence, Groupe Ramsay-Generale de Sante, Hôpital Privé Jean Mermoz, Lyon, France

**corresponding author*

Professor Adnan Saithna

Medical Technologies and Advanced Materials,
Clifton Campus

Nottingham Trent University

Nottingham

NG11 8NS, UK.

Adnan.saithna@gmail.com

Tel: +44(0)7712045799



ESSENTIAL SURGICAL TECHNIQUES

**JBJS EST Subspecialty Procedures Article
Author Submission Template**

*Instructions are in blue text and will be deleted when the article is published.
All text appearing in black and entered into the gray boxes will remain in the published article.*

*****Type the requested information in the gray box beneath each instruction.*****

Insert title of article.

Combined ACL and Anterolateral Ligament Reconstruction

Insert names and academic degrees of all authors (e.g., John B. Smith, MD, PhD, and Alice C. Jones, MD).

Adnan Saithna, BMedSci(Hons), MBChB, DipSEM, MSc, FRCS(T&O)^{1,2}

Mathieu Thauvat, MD³

Jean Romain Delaloye, MD³

Hervé Ouanezar, MD³

Jean Marie Fayard, MD³

Bertrand Sonnery-Cottet, MD³

Insert affiliation, city, and state (or country) for each author (and e-mail address if you want it published).

1. Medical Technologies and Advanced Materials, Clifton Campus, Nottingham Trent University, Nottingham, NG11 8NS, UK.
2. Renacres Hospital, Ormskirk, Lancashire, L39 8SE, UK.
3. Department of Orthopaedic Surgery and Sports Medicine, Centre Orthopédique Santy, FIFA Medical Centre of Excellence, Groupe Ramsay-Generale de Sante, Hôpital Privé Jean Mermoz, Lyon, France

Published outcomes of this procedure can be found at:

Insert the citation of the article that reports the outcomes of this surgical technique (e.g., J Bone Joint Surg Am. 2012 Apr 4;94(7):654-8.). Attach a copy of the article with your submission.

Thauvat M, Clowez G, Saithna A, Cavalier M, Choudja E, Vieira T, Fayard J, Sonnery-Cottet B. Re-Operation Rates after Combined ACL and ALL Reconstruction: A Cohort Study of 548 patients with minimum two years follow-up. Am J Sports Med. 2017 Jun 1:363546517708982. doi: 10.1177/0363546517708982. [Epub ahead of print]

Sonnery-Cottet B, Saithna A, Cavalier M, Kajetanek, Frois Temponi CE, Daggett M, Helito CP, Thauvat M. Anterolateral Ligament Reconstruction is Associated with Significantly Reduced ACL Graft Rupture Rates at a Minimum Follow Up of 2 Years: A Prospective Comparative Study of 502 Patients from the SANTI Study Group. AJSM Feb 2017. doi: 10.1177/0363546516686057

Sonnery-Cottet B, Thauvat M, Freychet B, Pupim BH, 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 Jul;43(7):1598-605. doi: 10.1177/0363546515571571



ESSENTIAL SURGICAL TECHNIQUES



ESSENTIAL SURGICAL TECHNIQUES

Abstract (*maximum, 400 words*)

Background:

Provide the name of the procedure and why you do it.

Clinical results of combined anterior cruciate ligament (ACL) and anterolateral ligament (ALL) reconstruction demonstrate a significant reduction in ACL graft rupture rates and improved return to sport when compared to isolated ACL reconstruction (ACLR).¹ This is supported by laboratory studies which demonstrate that combined ACLR and lateral extra-articular tenodesis (LET) procedures protect the ACL graft by load sharing with it and also by more reliably restoring normal knee kinematics, when compared to isolated ACLR.

Description:

Provide a brief summary of how you perform the procedure.

The ACL graft is formed from a tripled semitendinosus tendon and a single strand of gracilis. The femoral tunnel is drilled to provide an anatomic location intra-articularly and exit the femur just posterior and proximal to the lateral epicondyle. The additional length of gracilis therefore exits the femoral tunnel at the anatomic origin of the ALL and is then routed (under the iliotibial band) through a tibial tunnel, and back to the femoral origin, to reconstruct the ALL.

Alternatives:

List alternative treatments, either nonsurgical or surgical.

A large number of different types of non-anatomic LET have been reported. The most frequently performed were the Lemaire and MacIntosh procedures but these, and others, were widely abandoned after reports of poor results in the 1980's.

Rationale:

State how this procedure differs from treatment alternatives and why it is better for certain patients, disease states, clinical scenarios, etc. Help the reader understand the context of this particular procedure with respect to alternative treatments and overall management of the condition.

ALL reconstruction differs from other lateral extra-articular tenodesis type procedures by virtue of the fact that the procedure is anatomically based and can be percutaneously performed. Non-anatomical procedures (typically with a strand of ITB passed under the LCL) are associated with reports of overconstraint, early arthritis and an increased risk of infection.^{2,3,4,5} In contrast, ALLR has been shown to restore normal knee kinematics and avoid overconstraint, when correctly fixed in full extension and neutral rotation.⁶ The main concern with any type of LET is based on historical reports of poor outcomes.^{2,3} However, contemporary study demonstrates that combined ACL and ALLR is associated with a re-operation rate that is comparable to the rate seen after isolated ACLR, and a very low rate of complications.⁷ This makes a compelling argument for anatomic ALL+ACLR being considered as the procedure of choice when considering an extra-articular procedure. This is further supported by the fact that even though previous studies have demonstrated a trend to reduced ACL graft rupture with non anatomic LETs they have not shown a statistically significant improvement in outcomes. Combined ACL and ALLR is currently the only type of lateral extra-articular procedure that has been demonstrated to significantly reduce ACL graft rupture risk and improve return to sport.¹

Introductory Statement



ESSENTIAL SURGICAL TECHNIQUES

Insert an introductory statement (single sentence) describing, or stating a key point that highlights, your procedure (e.g., "The plantar approach for management of a Morton neuroma allows the transverse metatarsal ligament to be spared and has a low rate of complications.").

Combined ACLR +ALLR is associated with a significant reduction in ACL graft rupture rates, no increase in the risk of re-operation and a very low rate of ~~specific~~ complications.

NOTE: Your SP article will start with an "overview page" that will begin with this introductory statement, followed by a summary listing of the steps of your procedure.

Indications & Contraindications

Indications

List the indications (as many as appropriate) for your procedure. Press "Enter" for additional bullets.

~~The Our~~ main indication for ALLR is patients undergoing ACLR who are have specific risk factors that predispose them to increased risk of ACL graft rupture. This includes:

- Young patients (age < 20 years)
- Participation in pivoting sports or high-demand athlete
- Presence of high grade pivot shift on examination
- Presence of lateral femoral notch sign on pre-operative imaging
- Segond fracture
- Revision ACL reconstruction
- Chronic (> 12 months) ACL injury

Contraindications to this specific technique

List the contraindications (as many as appropriate) for your procedure. Press "Enter" for additional bullets.

- ~~Tripled/quadrupled ST + gracilis graft diameter less than 7mm:~~ It is recognized that graft diameters less than 7mm increase the risk of ACL graft failure. ~~It is therefore important that adequate graft diameter is not compromised in preference of performing ALLR.~~
- ~~Lateral compartment arthritis:~~ Although there is no clinical evidence to suggest that this technique-ALLR can overconstrain the knee, long term studies specifically studying radiographic evidence of osteoarthritis are currently lacking for ALLR. ~~However, clinical studies of ACLR with lateral extra-articular tenodesis have not shown increased rates of osteoarthritis with long term follow up.⁸ We consider established lateral compartment arthritis as a relative contra-indication to ALLR~~
- ~~Lack of knowledge about extra-articular procedures and ALL anatomy:~~ It is essential to have a good knowledge of ALL anatomy and structures around the lateral epicondyle to perform this procedure safely and with good outcomes

Step-by-Step Description of Procedure



ESSENTIAL SURGICAL TECHNIQUES

Describe the sequential steps of your procedure (as many appropriate, although ≤ 7 are preferred) in the gray box below, following the formatting in this example:

EXAMPLE

Step 1: Incision
Position the incision on the anterior aspect of the thigh.

- *Identify the anterior superior iliac spine.*
- *Outline the incision approximately 1 in (2.5 cm) distal to the anterior superior iliac spine.*
- *Cut the skin with a scalpel.*

Step 2: Heading
Introductory sentence.

- *First step.*
- *Second step.*
- *Etc.*

Each step should include:

Heading (title of the step—“Step 1: Incision” in Example above)

Introductory sentence summarizing, or stating a key feature of, the step (“Position the incision on the anterior aspect of the thigh.” in Example above)

Bullet points describing, in sequence, what the surgeon must do to perform the step. (Word these bullet points as: “Do this, do that.”—e.g., “Identify the anterior superior iliac spine.” in Example above)

Although combined ACL+ALL reconstruction has been previously described, this JBJS Essential Techniques article expands significantly on our previous publication.⁹ Specifically, we provide tips and tricks for surgeons new to this procedure and those who wish to continue using their standard ACLR technique and perform concomitant ALLR with an independent graft. In addition, we also provide detailed instruction on how to precisely identify the correct femoral tunnel location and avoid graft malposition.

The technique is described with the use of three videos: Video 1 demonstrates combined ACL/ALL reconstruction. The combined graft is formed from a tripled semitendinosus tendon and a gracilis tendon. The ACL graft therefore consists of 3 parts semitendinosus and 1 part gracilis and the additional length of gracilis forms the ALL graft. Video 2 describes using a gracilis autograft or allograft for an ALL reconstruction that is performed independently of the ACL reconstruction. Video 3 describes technical tips for ensuring the precise femoral location for ALL reconstruction is correctly identified.

~~Video 1 demonstrates the steps of the combined ACLR+ALLR surgical procedure which are described in detail below. For surgeons who do not wish to change their standard technique for ACLR, Video 2 demonstrates the steps of ALLR performed independently of the concomitant ACLR.~~

Step 1: Patient Setup



ESSENTIAL SURGICAL TECHNIQUES

Position the patient supine on the operating table in the standard arthroscopy position:

- ~~Place a lateral post just proximal to the knee, at the level of the padded tourniquet.~~
- ~~Use a foot roll. This helps to prevent the hip from externally rotating and allows free range of motion, or maintenance of the knee at 90 degrees of flexion, when required.~~

Step 2: Identify/Mark Landmarks and Make Stab Incisions

Identify and mark bony landmarks and locations of stab incisions for ALLR (Fig 1.)

- Mark the head of the fibula, Gerdy's tubercle, and the lateral epicondyle.
- Mark three stab incisions for the ALLR.
 - Mark the femoral incision just proximal and posterior to the lateral epicondyle
 - Mark the tibial incisions 1cm distal to the joint line. Place one just anterior to the fibula head and the other just posterior to Gerdy's tubercle. They should be separated by approximately 2cm.
- ~~Create the pre-marked stab incisions with a #15 blade scalpel~~

Step 3: ALL Tibial Drilling and Verification of Normal ALL Non-Isometry

Create the ALL tibial tunnel and confirm the correct location of the entry point for outside-in drilling of the femoral tunnel

Place guidewires into the tibial incisions. This can be performed using a drill guide (Arthrex, Naples, FL) as seen in Video 1, or using a freehand technique as seen in Video 2

- Use a 4.5-mm cannulated drill bit to overream the guidewires and create two 15mm sockets (Fig 2). Use a circular motion to slightly increase the socket apertures to facilitate subsequent graft passage.
- Connect the bony sockets using a right-angled clamp.
- Create a suture loop by passing a #2 Ethibond suture (Ethicon, Somerville, NJ) in a retrograde fashion from the anterior aperture of the tunnel, to its posterior aperture, this will later be used to facilitate graft passage but in the next steps it is used to confirm that the femoral tunnel position has been correctly identified in order to achieve the normal non-isometry of the anterolateral structures of the knee.
- Insert the femoral guidewire into the stab incision just proximal and posterior to the lateral epicondyle
- Loop the Ethibond suture around all three guidewires, place the knee in full extension (and by default neutral rotation) apply tension to the suture, and then clamp it with a hemostat.
- Take the knee through a full range of motion to ensure that the subsequently placed ALL graft will be non-isometric. The suture (representing the graft that will be placed later) should be tight in extension and slack in flexion, allowing physiological internal rotation, if the tunnels are placed correctly.



ESSENTIAL SURGICAL TECHNIQUES

- This technique is demonstrated in Video 1 and further explained in Video 3 which focuses on how errors in femoral tunnel positioning can affect the biomechanics of the reconstruction.

Step 4: Graft Harvest and Preparation

Harvest the semitendinosus and gracilis tendons and prepare them into a combined ACL+ALL graft

- Make a standard hamstring harvest oblique or vertical incision medial to the tibial tubercle
- Retrieve the hamstring tendons and carefully dissect any bands that may divert the tendon stripper and result in premature graft truncation
- Harvest the semitendinosus and gracilis tendons using an open-ended tendon stripper ensuring that they are not detached from the tibia at this stage.
- Whip stitch the free end of the gracilis tendon
- Measure the semitendinosus tendon from its insertion and mark it using a pen at 4cm and 10cm for a female patient and at 5cm and 11cm for a male patient. (specific tunnel length can be precisely identified at the time of surgery with arthroscopic rulers if required)
- Detach the gracilis from its tibial insertion
- Suture the gracilis onto the semitendinosus, beginning at the proximal mark and finishing at the distal mark, using multiple No. 1 Ethibond sutures (Ethicon, Somerville,NJ).(Fig 3)
- Place a No. 2 FiberWire (Arthrex, Naples, FL) onto the semitendinosus at the distal mark, and then fold it back onto itself. Tag it with a No. 1 Ethibond suture at the proximal mark.
- Then triple the semitendinosus graft and tag it again with No. 1 Ethibond suture to tubularize the graft. This results in an ACL graft that is 3 parts semitendinosus and 1 part gracilis. The ALL graft is the ~~refore~~ the continuation of the gracilis distal to the ACL graft. (Fig 3)
- Measure the graft diameter using a graft sizer

Step 5: Drilling of the Femoral ACL-ALL Tunnel

Drill an outside-in femoral tunnel that ~~exits the~~ starts on the lateral femur at the anatomic origin of the ALL (Fig 45, Fig 56)

- Place the arthroscope in a high lateral portal
- Insert the femoral outside-in ACL guide (Arthrex) into the knee via the anteromedial portal
- Place the tip of the guide at the femoral origin of the ACL (Fig 45)
- Place the bullet tip sleeve of the femoral guide into the previously made (and confirmed correct non-isometric position) femoral stab incision just proximal and posterior to the lateral epicondyle. Although this procedure is typically performed in a percutaneous manner, for surgeons learning ALLR it is recommended that a small longitudinal incision

is made on the femur instead of a stab incision. This allows the lateral collateral ligament to be identified and safely avoided (Fig 5~~6~~)

- Insert a guidewire in an outside-in manner and over ream with a correctly sized drill (based on graft diameter).

Step 6: Drilling of Tibial ACL Tunnel

Drill the tibial tunnel. This can be performed using the surgeons preferred technique but we advocate a remnant sparing approach¹⁰

- Do not excise the tibial ACL remnant
- Set the tibial guide to 55 degrees
- Insert the guide into the knee via the anteromedial portal whilst viewing from the high anterolateral portal
- Position the guide so that a subsequently inserted guidewire will enter the middle of the base of the stump
- Insert a 6-mm reamer taking care to just breach the tibial cortex and avoid damaging the remnant.
- Sequentially ream, using the same careful technique, with larger diameter drills until the correct diameter tunnel (equivalent to graft diameter) is achieved.
- Insert a shaver into the tibial tunnel and into the remnant. Ensure that the suction is switched off, and create a channel within the remnant for graft passage

Step 7: ACL/ALL Graft Passage and Fixation

Use suture passing techniques to shuttle the graft through the tibial tunnel, through the remnant, to the femoral tunnel. Appropriately tension and fix the combined ACL/ALL graft

- Place a TigerStick (Arthrex, Naples, USA) into the femoral tunnel and use a grasper to take it through the remnant and out through the tibial tunnel.
- Use the suture from the TigerStick to shuttle the ACL-ALL graft through the tibial tunnel, into the ACL remnant and then through the femoral tunnel bringing it out through the femoral stab incision (Fig 6)
- Insert a nitinol wire into the tibial ACL tunnel adjacent to the graft
- With tension on the graft as it exits the femoral tunnel, place an interference screw of the same diameter as the ACL graft, into the tibial tunnel, over the guidewire.
- Insert the nitinol guidewire into the femoral tunnel via the femoral stab incision.
- Place the knee at 30 of flexion, tension the graft and insert the femoral interference screw (same diameter as the ACL graft).
- Do not truncate the additional length of gracilis because this forms the ALL graft (Fig 6)



ESSENTIAL SURGICAL TECHNIQUES

Step 8: Passage and Fixation of ALL Graft

Pass the ALL graft from the anatomic ALL origin, to the tibial tunnel and back on itself (under the ITB). (Fig 7 and 8)

- Place a grasper underneath the ITB from the posterior tibial stab incision (just anterior to the fibula head) and use it to retrieve the suture tails from the whipstitched end of the gracilis tendon.
- Place these sutures into the previously created ethibond loop and pull the graft through the ALL tibial tunnel. (Fig 7).
- Insert the grasper (with the retrieved gracilis sutures) under the ITB again, from the anterior tibial stab incision (just posterior to Gerdy's tubercle) and bring them out through the femoral stab incision.
- Place tension on the ALL graft and pass the Ethibond sutures that were placed in the ACL graft during its preparation around the ALL graft, as they exit the femoral tunnel, and tie them with the knee in full extension and neutral rotation
- Confirm that the knee has full range of motion and that the Lachman and pivot shift are abolished
- Truncate any excess suture and graft to complete the reconstruction. (Fig 8 illustrates the final combined ACLR+ALLR.)

Step 9: Rehabilitation

Follow a standard ACL rehabilitation program. No specific differences are required for combined ACLR+ALLR.

- Our routine ACL rehabilitation program is instituted, entailing brace-free, immediate, full weight bearing after the procedure, and progressive range-of-motion exercises. Early rehabilitation is focused on obtaining full extension and quadriceps activation. A gradual return to sports activities is allowed starting at 4 months for non-pivoting sports, at 6 months for pivoting non-contact sports, and at 8 to 9 months for pivoting collision sports.

Results

Enter a brief report on the success of your surgical technique. Please do not use the results section from your original article. Instead, provide a more succinct version of 1 or 2 paragraphs stating the most important results and perhaps adding information about the results in different patient populations or for different indications.

A large prospective comparative series (n=502) with a minimum follow up of two years has demonstrated significantly reduced ACL graft rupture rates in a high risk population (young patients participating in pivoting sports), when compared to a matched cohort undergoing



ESSENTIAL SURGICAL TECHNIQUES

isolated ACLR. The graft rupture rates were 10.77% (range, 6.60%-17.32%) for isolated hamstring tendon ACLR grafts, 16.77% (range, 9.99%-27.40%) for bone-patellar tendon-bone (B-PT-B) grafts, and 4.13% (range, 2.17%-7.80%) for combined ACLR+ALLR ([hamstring](#)) grafts, at a mean follow-up of 38.4 months. [Multivariate analysis was performed in order to account for demographic differences between groups. This demonstrated that the rate of graft failure with combined ACLR+ALLR grafts was 2.5 times less than with isolated B-PT-B grafts \(hazard ratio \[HR\], 0.393; 95% CI, 0.153-0.953\) and 3.1 times less than with isolated hamstring tendon ACLR grafts \(HR, 0.327; 95% CI, 0.130-0.758\) at final follow up.](#)¹

[The rate of graft failure with combined ACLR+ALLR grafts was 2.5 times less than with isolated B-PT-B grafts \(hazard ratio \[HR\], 0.393; 95% CI, 0.153-0.953\) and 3.1 times less than with isolated hamstring tendon ACLR grafts \(HR, 0.327; 95% CI, 0.130-0.758\).](#)¹

The combined ACLR+ALLR graft was also associated with significantly higher odds of patients returning to their pre-injury level of sport than isolated hamstring tendon ACLR grafts (odds ratio [OR], 1.938; 95% CI, 1.174-3.224) but not compared with the B-PT-B graft (OR, 1.460; 95% CI, 0.813-2.613).¹

A separate, multi-centre study (n=548) evaluated the risk of re-operation and complications after combined ACLR+ALLR.⁷ Seventy-two patients (13.1%) underwent ipsilateral reoperation at a mean follow-up of 35.5 months +/- 8.0 months (range, 24-54 months). This comprised a total of 77 procedures. Graft revision occurred in 14 knees (2.6%) at a mean of 18.3 months (67.4 months) after the index procedure. There were 63 reoperations for ipsilateral, non-graft rupture-related indications (meniscus, n=30; arthrofibrosis, n=22; removal of hardware, n=4; deep infection, n=3; arthroscopic lavage without infection, n=4). The only specific complications related to the ALL procedure (n=3) were all related to femoral hardware that required removal. It was concluded that the reoperation rate after combined ACLR+ALLR was broadly comparable to the reoperation rate previously reported after isolated ACL reconstruction. Furthermore, the high rates of knee stiffness and reoperation reported in historical series of non-anatomic, lateral extra-articular tenodesis were not observed.⁷

Pitfalls & Challenges

[List the pitfalls and challenges related to your surgical technique. Press "Enter" for additional bullets.](#)

- *Graft Harvest:* When harvesting the semitendinosus tendon, use a right-angled clamp or tendon hook to pull the tendon out of the wound and cut [all](#) the [-2](#) expansions under direct vision before using the stripper. This is particularly important because if an insufficient length of semitendinosus is harvested it may not be enough to ensure an adequate ACL-ALL graft diameter.
- *Avoid iatrogenic injury to the graft when drilling the ACL tibial tunnel:* Because the tibial attachment of semitendinosus is preserved, there is a risk of injury to it during drilling. The graft should be stored within the wound during drilling and a small swab can then be inserted to further retract and protect it.
- *Drilling of the tibial ALL tunnels:* If using a freehand technique, be careful to avoid drilling the sockets too close together or too far apart because this can hinder the subsequent



ESSENTIAL SURGICAL TECHNIQUES

development of bone tunnels with a right angled clamp and also make it difficult to pass the needle. An approximate distance of 2cm is typical. However, if further reassurance is required, place the #2 Ethibond suture needle on the skin prior to making stab incisions to confirm that they are appropriately distanced to match the size of the needle. An alternative option is to use the Arthrex jig demonstrated in Video 1.

- *Locating the femoral tunnel:* Incorrect placement of the femoral tunnel can potentially result in overconstraint of the knee or a graft that is too loose. Use the described technique to ensure it is correctly positioned. Video 3 specifically focuses on how to identify the correct femoral tunnel location and how to recognize and avoid malposition.
- *Avoid iatrogenic injury to the LCL:* This procedure is intended to be performed in a percutaneous manner. However, surgeons who are learning the procedure may wish to make a small longitudinal femoral incision rather than a stab incision in order to confirm with direct visualization that they will not injure the LCL. Making a small longitudinal incision allows the surgeon to mark the LCL and ensure that the femoral tunnel will not encroach upon it (Fig 5)
- *Avoid femoral tunnel blowout:* Palpate posterior to the femoral guide before drilling to ensure adequate placement on bone.
- *Fixing the ACL graft:* Be careful when inserting the femoral screw in order to avoid injury to the additional length of gracilis that will form the ALL graft
- *Avoid femoral screw prominence:* Be aware that the femoral tunnel is likely to be more horizontal and shorter than the typical tunnel length for isolated ACLR. The femoral tunnel length can be measured to avoid this and arthroscopy can be used to confirm that it is not prominent intra-articularly. The typical screw length used is 20-23mm
- *Avoid overconstraint:* If the ALL graft is secured in non-neutral rotation, or with knee flexion, a gait disturbance or over-constraint may be possible. Avoid this by fixing the knee in full extension (which also ensures neutral rotation)
- *Use your preferred ACLR Technique:* If you wish to continue to use your preferred technique for ACLR but wish to perform ALLR you can do so by performing the ALL reconstruction independently of the ACL surgery. This is demonstrated in Video 2. Graft options include gracilis autograft or allograft.
- *Measure tunnel lengths accurately when required:* The technique of marking the semitendinosus at 4cm and 10cm for female patients, and 5 and 11cm for male patients is a reliable and time saving method of ensuring adequate graft in the tibial and femoral tunnel. However, many different techniques can be used to more accurately measure graft length and these should be employed by surgeons learning the technique or when patients are very tall or short.

References

Insert the references that you are citing in this article.

1. Sonnery-Cottet B, Saithna A, Cavalier M, Kajetanek, Frois Temponi CE, Daggett M, Helito CP, Thauat M. Anterolateral Ligament Reconstruction is Associated with Significantly Reduced ACL Graft Rupture Rates at a Minimum Follow Up of 2 Years: A Prospective Comparative Study of 502 Patients from the SANTI Study Group. *Am J Sports Med.* 2017 ;45(7):1547-1557
2. [Arthur J. Pearl, John A. Bergfeld. Extraarticular Reconstruction in the Anterior Cruciate Ligament Deficient Knee. Human Kinetics Publishers, 1992](#)
3. [Ferretti A. Extra-articular reconstruction in the anterior cruciate ligament deficient knee: a commentary. Joints. 2014 May 8;2\(1\):41-7.](#)
- 3- 4. [Sonnery-Cottet B, Archbold P, Zayni R, Bortolletto J, Thauat M, Prost T, Padua VB, Chambat P. Prevalence of septic arthritis after anterior cruciate ligament reconstruction among professional athletes. Am J Sports Med. 2011 ;39\(11\):2371-6](#)
- 4-5. [Vadala A, Proietti L, Serlorenzi P, Lupariello D, Di Sette P, De Carli A, Ferretti A. Adding an extra-articular tenodesis to intra-articular ACL reconstruction results in higher infection rate. Poster presented at: American Academy of Orthopaedic Surgeons 2016 annual meeting; March 1-5, 2016; Orlando, FL. Available at: <http://aaos2016.conferencespot.org/61513-aaos-1.2968416/t003-1.2974196/f003-1.2974197/a083-1.2974373/p427-1.2974490>](#)
- 5-6. [Jnderhaug E, Stephen JM, Williams A, Amis AA. Anterolateral Tenodesis or Anterolateral Ligament Complex Reconstruction: Effect of Flexion Angle at Graft Fixation When Combined With ACL Reconstruction. Am J Sports Med. 2017 ;45\(13\):3089-3097](#)
- 6-7. [Thauat M, Clowez G, Saithna A, Cavalier M, Choudja E, Vieira T, Fayard J, Sonnery-Cottet B. Re-Operation Rates after Combined ACL and ALL Reconstruction: A Cohort Study of 548 patients with minimum two years follow-up. Am J Sports Med. 2017 Jun 1;363546517708982. doi: 10.1177/0363546517708982. \[Epub ahead of print\]](#)
- 7-8. [Ferretti A, Monaco E, Ponzio A, Basiqlini L, Iorio R, Caperna L, Conteduca F. Combined Intra-articular and Extra-articular Reconstruction in Anterior Cruciate Ligament-Deficient Knee: 25 Years Later. Arthroscopy. 2016 ;32\(10\):2039-2047.](#)
9. [Sonnery-Cottet B, Daggett M, Helito CP, Fayard JM, Thauat M. Combined Anterior Cruciate Ligament and Anterolateral Ligament Reconstruction. Arthrosc Tech. 2016 ;5\(6\):e1253-e1259 doi: 10.1016/j.eats.2016.08.003](#)
10. [Tanabe Y, Yasuda K, Kondo E, Kitamura N. Clinical results of anterior cruciate ligament reconstruction with ligament remnant tissue preservation: A systematic review. Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology, 2016 ;\(4\):1-8.](#)

8-

Formatted: List Paragraph, Numbered + Level: 1 + Numbering Style: 1, 2, 3, ... + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Space Before: 0 pt, After: 10 pt, Line spacing: Multiple 1.15 li

Formatted: Font: (Default) Arial

Formatted: Font: (Default) Arial, 11 pt, Font color: Auto, English (United States), Pattern: Clear

Formatted: List Paragraph, Numbered + Level: 1 + Numbering Style: 1, 2, 3, ... + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Font: (Default) Arial

Formatted: Font: (Default) Arial

Formatted: Font: (Default) Arial

Formatted: Font: (Default) Arial

Formatted: Indent: Left: 0.5", No bullets or numbering



ESSENTIAL SURGICAL TECHNIQUES

NOTE: Do not use a reference manager program (e.g., EndNote) to format the reference list when writing in this document. Either type the references in manually or format them in your reference manager program in a separate file and copy and paste the list of references into this document. Start a new paragraph for each new reference.

Figure Legends

Insert figure numbers and legends in the gray box below, following the formatting in this example:

EXAMPLE

*Fig. 1
Intraoperative photographs showing the surgical incision.*

*Fig. 2
Anteroposterior radiograph of the femur.*

Fig.1 Intra-operative photograph of the lateral aspect of the right knee. The image shows the key bony landmarks and incisions required for anterolateral ligament reconstruction

Fig.2 Intra-operative photograph of the lateral aspect of the right knee. The image shows overreaming of the previously positioned tibial guidewires through percutaneous stab incisions using a 4.5mm drill.

Fig. 3 Illustration to demonstrate ~~graft the final graft construct preparation~~ for combined ACLR+ALLR in a right knee. ~~(A)~~ The tibial attachment of the semitendinosus is preserved after harvesting but the gracilis is detached after whip stitching the free end. ~~(B)~~ The semitendinosus tendon is doubled and tagged with sutures (at 4cm and 10cm for a female patient and at 5cm and 11cm for a male patient) and the gracilis is sutured to it. The semitendinosus is then finally tripled and further sutures are placed to tubularise and secure the graft. ~~(C)~~ The final graft is therefore composed of a tripled semitendinosus (ST) with its tibial attachment preserved, and a single strand of gracilis. (Reproduced with permission, B Sonnery-Cottet, Arthroscopy techniques³, Elsevier)

Fig. 4 Intra-operative arthroscopic view (from high anterolateral portal) of the right knee. The femoral guide is inserted into the knee via the anteromedial portal. The guide is positioned so that the guidewire will exit in the middle of the ACL femoral footprint.

Fig. 5 Intra-operative photograph of the lateral aspect of the right knee. Although the procedure is typically performed percutaneously it is recommended that surgeons learning the technique make a small longitudinal incision in order to safely identify the lateral collateral ligament (highlighted with blue surgical marking pen for demonstration purposes) and avoid iatrogenic injury to it when drilling.

Fig. 6 Illustration demonstrating how the graft ~~preparation-construct~~ shown in Fig 3 results in an intra-articular ACL graft composed of a tripled semitendinosus tendon (ST) and a single strand of gracilis, the additional length of which then goes on to exit the knee from the femoral tunnel to form the ALL graft

Fig. 7 Illustration to show ~~(A)~~ ~~P~~Passage of the ALL graft for combined ACLR+ALLR in a right knee. After fixation of the ACL graft on the femur, the sutured gracilis graft is passed deep to the iliotibial band to the posterior tibial stab incision. The whipstitched suture ends and graft are then passed through the ALL tibial bone tunnel and back proximally under the iliotibial band and out through the lateral femoral tunnel incision.



ESSENTIAL SURGICAL TECHNIQUES

Fig. 8 Illustration to show the key features of the final reconstruction: This includes a preserved tibial attachment of the semitendinosus, a preserved ACL remnant, an ACL graft comprised of a tripled semitendinosus and single strand gracilis, an ALL graft formed with the additional length of gracilis that passes from the femoral tunnel, under the iliotibial band, through a tibial tunnel, and back to the femoral origin underneath the iliotibial band. (Reproduced with permission, B Sonnery-Cottet, Arthroscopy techniques³, Elsevier).

NOTE: The figures themselves must be uploaded as separate image files with your submission in Editorial Manager. The file name for each figure should be FIGURE 1.tiff, FIGURE 2.tiff, etc. Please refer to the EST Instructions to Authors for figure specifications.

Please do not include actual image files with this form.



ESSENTIAL SURGICAL TECHNIQUES

Video Legends

Insert video numbers and legends in the gray box below, following the formatting in this example:

EXAMPLE

*Video 1
Surgical setup and patient positioning.
Video 2
Exposure, resection, and suture method.*

Video 1: Surgical technique for combined ACL and ALL reconstruction

Video 2: Surgical technique for ALL reconstruction (where the surgeon prefers to use their standard technique for ACLR, rather than a combined ACL-ALL graft). The graft is fixed on the femoral side with a 5.5mm closed eyelet SwiveLock Anchor (Arthrex, Naples, FL).

Video 3: Understanding Normal ALL Non-Isometry and the Consequences of Femoral Tunnel Malposition.

NOTE: The videos themselves must be uploaded at <http://video-submissions.jbjs.org/> and linked to during the submission process in Editorial Manager. Please refer to http://sites.jbjs.org/misc/video_upload_instructions.pdf for instructions. The file name for each video should be VIDEO 1, VIDEO 2, etc.



ESSENTIAL SURGICAL TECHNIQUES

Tables

JBJS EST papers rarely have tables as they are meant to describe a technique rather than to present detailed patient or results data. If you are using tables, please upload them as separate files with your submission in Editorial Manager. Please place the table number and title before the table.















