Technical Note

Combined Anterior Cruciate Ligament and Anterolateral Ligament Reconstruction Using a Single Peroneus Longus Tendon Graft

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Abstract: The peroneus longus tendon seems a viable graft option for knee ligament reconstructions, with adequate biomechanical properties and low morbidity after harvesting. The objective of this article is to describe a combined anterior cruciate ligament and anterolateral ligament reconstruction technique using a single peroneus longus tendon graft harvested from the infra malleolar region to ensure sufficient length.

The graft options for anterior cruciate ligament (ACL) reconstruction are a highly studied topic and are still much discussed in the literature. The most commonly used autografts include the bone–patellar tendon–bone, the hamstrings, and the quadriceps tendons.[1-3] A recent meta-analysis did not demonstrate superiority of one graft type over the others regarding clinical and functional outcomes and reconstruction survival rates.[2,3] Recently, the peroneus longus tendon, which has been satisfactorily used as a graft for other orthopaedic surgeries,[4-7] has gained attention as a promising option for ACL reconstructions.[8] Several studies have shown biomechanical properties of the peroneus longus tendon graft comparable with those of the hamstring tendons,[9-11] with adequate diameter for reconstruction, satisfactory postoperative functional scores,[8] and low donor-site morbidity.[12]

It is well established that, for certain risk groups, lateral extra-articular procedures, such as anterolateral ligament (ALL) reconstruction or modified Lemaire iliotibial band tenodesis, reduce the risks of ACL reconstruction failure.[13-15] Several techniques have been described for ACL and ALL reconstruction using the hamstring tendons, including reconstructions with a single combined femoral tunnel for both ligaments, with excellent clinical results.[15,16]

To perform extra-articular reinforcement using the peroneus longus tendon, Escudeiro de Oliveira et al.[17] described an ACL and ALL reconstruction technique using a quadruple hamstring graft associated with a single strand of the peroneus longus tendon, harvested from the lateral malleolus region. Peroneus longus tendon harvest can be alternatively performed in the inframalleolar region, resulting in a longer graft length,[18] which is sufficient for the combined reconstruction, with a double or triple graft for the ACL and a remaining single strand for ALL reconstruction. The objective of this article is to describe an ACL and ALL reconstruction technique with a combined femoral tunnel and a single peroneus longus tendon graft harvested from the inframalleolar region.

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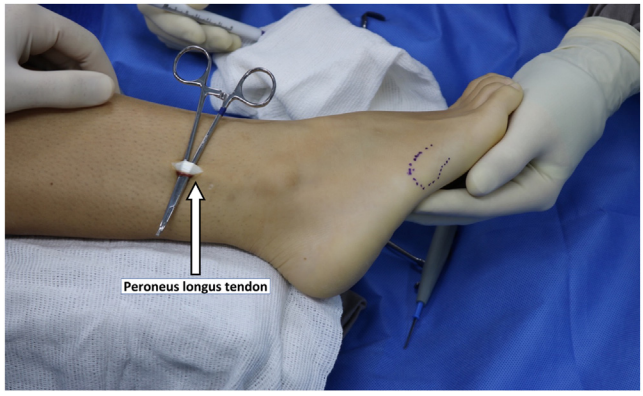

Fig 1. Lateral view of the right ankle with a posterolateral incision to the fibula, about 5 cm from the lateral malleolus, and the peroneus longus tendon identified with aid of a Kelly forceps.

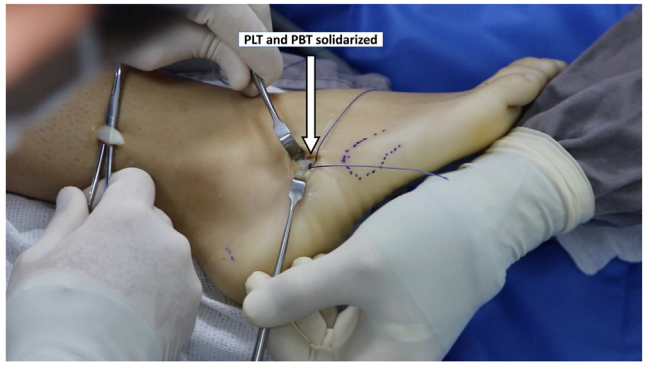

Fig 3. Lateral view of the right foot and ankle, showing the peroneus longus tendon repaired with Kelly forceps in the proximal incision, and the peroneus longus (PLT) and peroneus brevis (PBT) tendons solidarized with an absorbable suture in the distal incision.

Surgical Technique (With Video Illustration)

The patient is placed in a supine position on the operating table, with a pneumatic tourniquet positioned at the proximal region of the thigh. After preparing the limb and placing sterile drapes in the usual manner, the limb is exsanguinated, and the pneumatic tourniquet is inflated.

Peroneus Longus Tendon Harvest by the Infra-Malleolar Technique

A longitudinal incision of approximately 2 cm is performed in the posterolateral region of the fibula, about 5 cm proximal to the tip of the lateral malleolus (Fig 1). The dissection is performed through the skin and subcutaneous tissue until the peroneus tendons can be visualized. The peroneus longus tendon is more superficial, and the peroneus brevis tendon, in this region, has a muscle belly next to the tendon that facilitates its identification. With the tendons identified, a second longitudinal incision of approximately 3 cm is performed in the dorsolateral region of the foot, about 2 cm proximal to the fifth metatarsal base, over the cuboid (Fig 2). Dissection is performed through the skin and subcutaneous tissue, and peroneus tendons are visualized. The tendons are pulled individually in the proximal incision with the aid of a Kelly forceps, facilitating their identification in the distal incision by the tendon's movement. The peroneus longus and brevis tendons are solidarized in the distal incision using a no. 1-0 VICRYL (Ethicon, Somerville, NJ) thread (Fig 3), and the peroneus longus tendon is sectioned proximally to the suture with the scalpel blade (Fig 4). After sectioning, the peroneus longus tendon is pulled to the proximal incision (Fig 5) and then harvested with the aid of a tendon stripper towards its proximal insertion (Fig 6). Care should be taken to keep the stripper 4 to 5 cm distal to the fibula head to avoid peroneal nerve injury.[19]

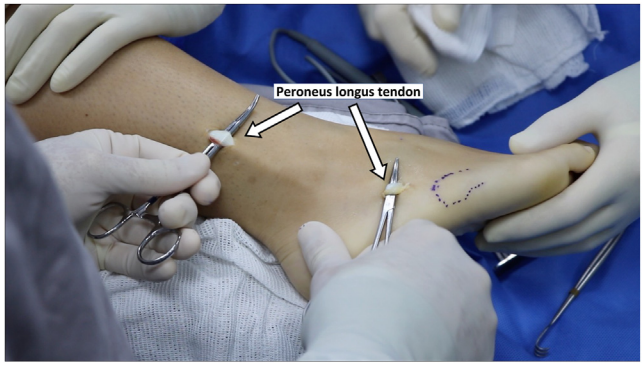

Fig 2. Lateral view of the right foot and ankle, showing 2 incisions: the first incision is approximately 5 cm proximal to the tip of the lateral malleolus, and a second longitudinal incision is approximately 2 cm proximal to the base of the fifth metatarsal. The image shows the peroneus longus tendon repaired with Kelly forceps in both incisions.

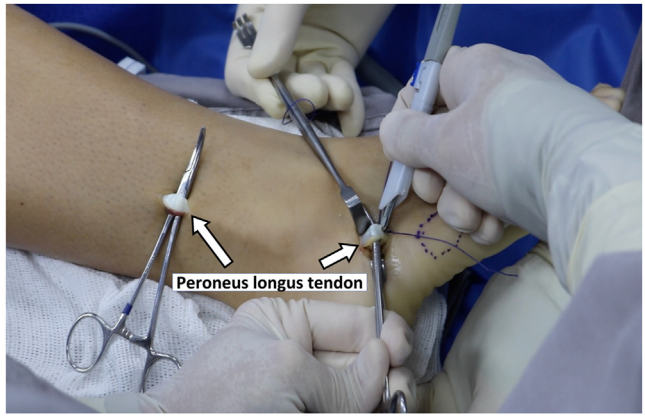

Fig 4. Lateral view of the right foot and ankle. With the peroneal tendons solidarized, the peroneus longus tendon is sectioned in the distal incision using a scalpel blade about 1 cm from the suture region.

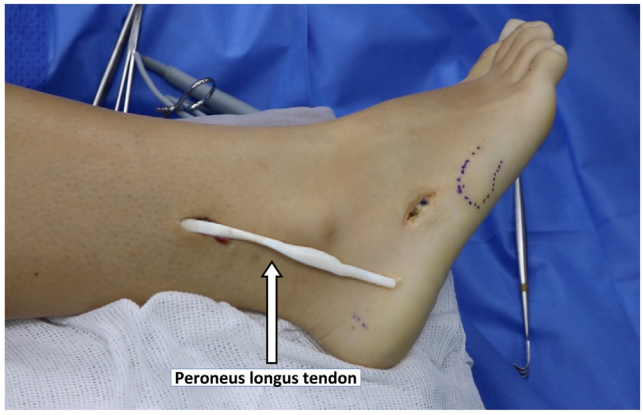

Fig 5. Lateral view of the right foot and ankle. After being solidarized with the peroneus brevis tendon in the distal incision and sectioned with a scalpel blade, the peroneus longus tendon is pulled to the proximal incision.

Fig 7. Peroneus longus tendon graft. After cleaning the graft, both ends are prepared with continuous sutures, and their total length is measured. In this case, the total length of the graft was 35 cm.

Graft Preparation

On an auxiliary table, the remaining muscle tissue is removed from the tendons, and both ends of the grafts are prepared with continuous sutures (Fig 7). The proximal portion of the graft, usually the thickest, is used for the ACL reconstruction, and the distal portion for the ALL reconstruction. At approximately 9 to 10 cm from its proximal end, the graft is folded, having a double-strand portion of approximately 9 to 10 cm and a single strand remaining portion. The thickness of the graft is measured in its double portion.

After making the ACL tunnels, which will be addressed in detail to follow, an ETHIBOND (Ethicon) thread is passed through the femoral and tibial tunnels, passing inside the joint, and the entrances of the tunnels are marked on the thread with a Codman pen. The ETHIBOND suture is removed of the joint and the optimal length of the ACL graft is measured, so that the double part of the peroneus longus tendon fills the entire tunnels path. Then, the length of the double portion of the graft that will be used for ACL reconstruction is adjusted according to the measured size (Fig 8).

Arthroscopy

Standard anterolateral and anteromedial arthroscopic portals are performed. At this point, the joint is inspected and the treatment of any associated chondral or meniscal injuries is caried out.

Combined Femoral Tunnel

The femoral tunnel is performed using the outside-in technique, with a single tunnel for both the anterior cruciate ligament and the anterolateral ligament.[15] An incision is made over the lateral epicondyle of the femur and the ALL anatomical point on the outer wall

Fig 6. Lateral view of the right leg. The peroneus longus tendon is harvested with the aid of a tendon stripper in its proximal direction. The assistant keeps their thumb 5 cm from the fibula head to define the safety zone of the tendon stripper and avoid peroneal nerve injury.

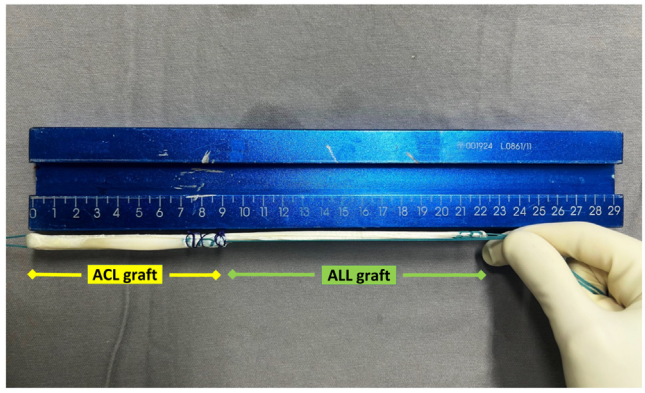

Fig 8. Combined ACL and ALL graft, prepared with a single peroneus longus tendon graft. The double-strand part of the graft is prepared in its proximal portion, according to the length measured for the ACL graft. The remaining single-strand portion is used for the ALL graft. (ACL, anterior cruciate ligament; ALL, anterolateral ligament.)

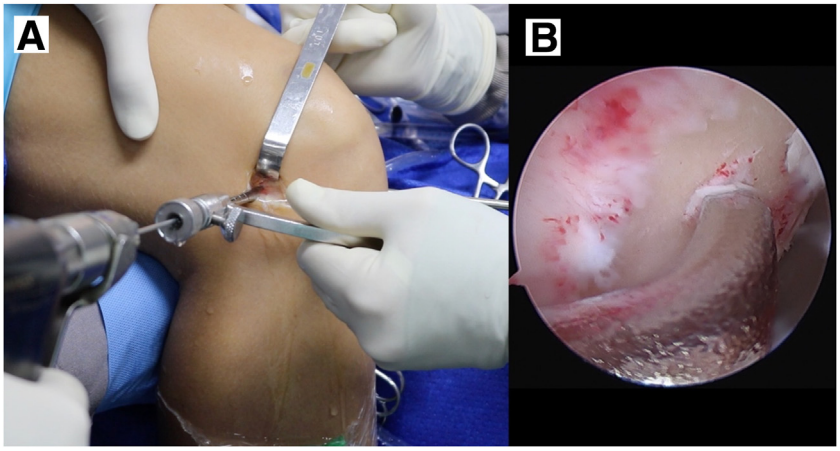

Fig 9. Preparation of the combined femoral tunnel. (A) Lateral view of the right knee, showing the positioning of the outside-in guide at the ALL anatomical point on the outer wall of the lateral femoral condyle, posterior and proximal to the lateral epicondyle. (B) Arthroscopic view through the anteromedial portal showing the positioning of the outside-in guide at the ACL anatomical point on the inner wall of the lateral femoral condyle. (ACL, anterior cruciate ligament; ALL, anterolateral ligament.)

of the lateral femoral condyle is located, posteriorly and proximally to the lateral epicondyle.

After that, the outside-in guide is positioned at the ACL anatomical point on the inner wall of the condyle and, externally, at the previously marked point of the ALL origin (Fig 9). Then, the tunnel is drilled with the previously measured diameter of the ACL graft.

ACL Tibial Tunnel

The tibial tunnel is performed conventionally so that the tunnel's exit in the joint is in the center of the native ACL footprint.

ALL Tibial Tunnel

A longitudinal incision of approximately 2 cm is made in the anterolateral region of the tibial plateau, at the midpoint between the Gerdy tubercle and the fibular head. A guidewire is positioned at the anatomical point of the ALL insertion, approximately 5 to 10 mm distal to the articular surface, at the midpoint between Gerdy's tubercle and the fibular head, and passed towards a point a digital pulp distal to the ACL tunnel on the anteromedial face of the tibia, avoiding tunnels confluence. The tunnel is drilled with the diameter of the smallest interference screw available.

Graft Passage and Fixation

The graft passage entering the femoral tunnel towards the tibial tunnel is usually easier, but the graft can also be passed from the tibia to the femur. After properly positioning the graft in the tunnels, it is fixed in the femoral tunnel with an interference screw of the same diameter as the tunnel. Then, after pretensioning the graft, tibial fixation is performed with an interference screw 1 mm larger than the tunnel, with the knee around 20° of flexion and a posteriorization force applied to the tibia.

Subsequently, the single strand of the graft exiting the femoral tunnel is passed underneath the iliotibial tract towards the anterolateral incision of the tibia and then pulled into the tibial tunnel of the ALL. Finally, the ALL graft is fixed in the tibial tunnel, with the knee in full extension and neutral rotation. If the graft's length goes until the tibial tunnel's exit, the interference screw can be passed from both medial to lateral or lateral to medial direction. If the graft is not long enough to exit

Table 1. Pearls and Pitfalls of the Combined ACL and ALL Reconstruction Technique With a Single Peroneus Longus Tendon Graft

Pearls	Pitfalls
Closure of the incisions in the foot and ankle is performed just after harvesting the graft to avoid surgical wound complications.	During the passage of the tendon stripper, the assistant should position his or her hand about 5 cm distal to the fibula head, serving as a safety parameter to avoid peroneal nerve injury.
With the double graft, it is sometimes easier to descend the graft through the femoral tunnel towards the tibia.	When making the combined femoral tunnel, care must be taken not to excessively posteriorize the guide during positioning at the ALL point, so that the posterior wall of the tunnel remains intact.

ALL, anterolateral ligament.

Table 2. Advantages and Disadvantages of the Combined ACL and ALL Reconstruction Technique With a Single Peroneus Longus Tendon Graft

Advantages	Disadvantages
ACL and ALL reconstruction performed with just one graft.	Need for harvesting the graft outside the knee.
Combined ACL and ALL tunnel in the femur, reducing the required number of implants	Need for 2 incisions for inframalleolar harvest of the peroneus longus tendon graft.

ACL, anterior cruciate ligament; ALL, anterolateral ligament.

the tibial tunnel, the screw must be passed from lateral to medial (Video 1).

Discussion

Isolated ACL reconstruction with peroneus longus tendon graft has shown satisfactory results in the literature.[8,19,20] Comparative studies show failure rates, residual pivot-shift, and residual Lachman test similar to hamstring graft reconstructions,[8,20] with the International Knee Documentation Committee and the Tegner-Lysholm Knee Scoring Scale similar[20] or even slightly greater in cases of reconstruction using peroneus longus graft,[8] which can be explained by the fact that the graft harvesting occurs outside the knee, avoiding the imbalance of muscle strength between the quadriceps and flexors.

Combined ACL and ALL reconstruction is a well-established technique with benefits for certain risk groups, with favorable functional outcomes and a lower risk of reconstruction failure (Tables 1 and 2). The main indications are the presence of an explosive pivot shift, Segond fracture, generalized ligament laxity, knee hyperextension, young patients, intention to return to pivoting sports, revision surgeries, and chronic ACL injuries.[14-16,21-27] To perform the ACL and ALL reconstruction with a single graft, the combined femoral tunnel technique should be used.

The described technique uses a double full-thickness peroneus longus tendon graft for ACL reconstruction and a single strand for ALL reconstruction. Marín Fermín et al.,[20] in a systematic review, evaluated the diameter of the double peroneus longus graft in 5 studies, totaling 176 patients, and found a mean diameter of 8.4 mm, which is a satisfactory size for ACL reconstruction, similar or even greater than the quadruple hamstring graft.[11] Regarding the graft length, for ALL reconstruction with a combined femoral tunnel, we consider 6 cm for ligament length (the ALL size in anatomical studies ranged from 3.4 cm to 5.9 cm[21]), and a minimum of 2 cm of graft within the tibial tunnel for fixation with an interference screw, totaling 8 cm. For ACL reconstruction, a double graft length of 9 cm is considered; therefore, 18 cm of graft is required. Thus, a minimum 26 cm length graft is necessary for the combined reconstruction with a safety margin. Khan et al.[18] harvested the peroneus longus graft through the inframalleolar access in a cohort of 52 patients and obtained a mean length of 32.14 ± 2.67 cm, ranging from 28 cm to 37 cm. Therefore, harvesting through the inframalleolar region can ensure sufficient length for the combined reconstruction. With grafts of 35 cm or longer, it is usually possible to perform the ACL in a triple configuration, with a more robust ACL graft.

Concerning donor area morbidity, several studies have evaluated the consequences for the foot and ankle when harvesting the peroneus longus tendon. In the meta-analysis performed by He et al.,[8] there were no significant differences regarding pain or paresthesia at the donor site compared with the hamstring graft. In the comparison of pre- and postoperative foot and ankle functional scores, there was no significant difference for the Foot and Ankle Disability Index score, and there was a small mean decrease of 0.31 on a 100-point scale of the American Orthopaedic Foot and Ankle Society Ankle Hindfoot Scale, which of little clinical relevance.[8] Regarding the isokinetic test, in early evaluations, there was a significant difference in eversion/inversion strength in relation to the non-operated side,[28] but no significant difference after 2 years of follow-up.[11] Therefore, harvesting the peroneus longus tendon to use as a graft seems feasible, with acceptable morbidity for the donor site. The procedure presented is technically simple, does not significantly increase the surgical time, and can be used by surgeons as a great option in ACL reconstructions with the indication of extra-articular reinforcement.

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