Abstract: During the past few decades, surgical techniques for anterior cruciate ligament (ACL) reconstruction have been developing significantly. To date, studies have shown that after ACL reconstruction, rotational stability has a greater impact on the patient’s satisfaction, functional scores, and return to sports than translational stability. Although challenged by many authors in the literature, biomechanical studies on the anterolateral ligament (ALL) of the knee and clinical studies regarding ALL reconstruction have been revealing promising results. Thus, the potentially significant role of the ALL in biomechanical load sharing and improving rotational control of the knee has led to the development of various reconstruction techniques whose goal is to achieve simplicity and yield the best results possible. Guided by this idea, we have developed a modified ACL-ALL reconstruction surgical technique. In this article, our simple, bone-saving, anatomic technique to reconstruct both the ACL and ALL using hamstring tendon autograft is described.

Techniques for anterior cruciate ligament (ACL) reconstruction have considerably evolved over the past few decades. Even though advances in surgical techniques have brought satisfactory and reliable results over time, concerns regarding high graft failure rates (up to 18%), as well as residual rotational instability, remain. Currently, it is known that rotational stability has a larger impact on the patient’s satisfaction, functional scores, and return to sports than translational stability. Although challenged by many authors in the literature, biomechanical studies on the anterolateral ligament (ALL) and clinical studies regarding ALL reconstruction have been revealing promising results. Claes et al. were the first authors to highlight the positive effect of the ALL on knee rotational stability and its role in preventing the pivot-shift phenomenon. Given that it is known that concomitant injury to the anterolateral structures occurs in up to 90% of ACL-injured knees, it is evident that isolated ACL reconstruction cannot optimally restore both the anteroposterior stability and rotational stability observed in ACL-intact knees. In 2017, the SANTI (Scientific Anterior Cruciate Ligament Network International) Study Group showed that combined ACL and ALL reconstruction was associated with a 2.5- to 3-fold reduction in the ACL graft rupture rate compared with isolated ACL reconstruction using quadrupled hamstring and bone–patellar tendon–bone graft. This group also found that combined ligament reconstruction was associated with significantly higher odds of returning to the preinjury sport level. Thus, the potentially significant role of the ALL in biomechanical load sharing and improving rotational control of the knee has led to the development of various reconstruction techniques whose goal is to achieve simplicity and yield the best results possible.

Surgical Technique

In this article, we present our surgical technique for combined ACL and ALL reconstruction, developed at...
the University Hospital, with tripled ACL graft and double-bundle ALL graft mimicking the shape of the native ALL (Video 1). Indications and contraindications for our reconstruction technique are shown in Table 1.

### Table 1. Indications and Contraindications of ACL-ALL Reconstruction

| Indications |
|-------------|
| Patients aged <20 yr |
| High-demand contact or pivoting sports |
| Positive pivot-shift result (grade 2 or 3) |
| Reruptured ACL |
| Segond fracture |

| Contraindications |
|-------------------|
| Hamstring insufficiency |
| Insufficient size of gracilis tendon |
| Lack of knowledge about ALL anatomy |
| Lack of knowledge about combined surgical technique |

ACL, anterior cruciate ligament; ALL, anterolateral ligament.

Patient Setup

The patient is placed in the supine position with a lateral post proximal to the knee, level with a padded tourniquet, and a leg holder (Maquet, Rastatt, Germany) to allow the knee to freely move through its full range of motion (ROM). After the establishment of high anterolateral and anteromedial portals, the feasibility of reconstruction is determined by confirming the ACL rupture with arthroscopy. Thereafter, 3 bony landmarks are marked: the lateral epicondyle, the Gerdy tubercle, and the head of the fibula. The joint line is drawn after its position is precisely determined using fine-needle probe punctures.

### ALL Tibial Drilling

Two convergent bony tunnels are drilled in the proximal part of the tibia with a 4.5-mm drill bit, separated by roughly 2 cm. The first tunnel is placed just in front of the anterior border of the head of the fibula; the second tunnel is then placed posterior to the Gerdy tubercle. The tunnels are 1 cm distal to the joint line. A suture (No. 2 Vicryl; Ethicon, Somerville, NJ) is then passed through the tunnels in a retroverted fashion to create a loop for further ALL graft (gracilis tendon) passage.

### Graft Harvest and Preparation

Through a vertical incision 1 cm medial to the tibial tuberosity, the insertions of the semitendinosus and gracilis are cut, whipstitched at the distal end, and harvested using a closed-ended tendon stripper (Arthrex, Naples, FL). Both tendons are then prepared on a graft preparation station. Minimal muscle tissue is left to potentially promote bone-tendon healing. The semitendinosus tendon is tripled over a TightRope (Arthrex) on the tibial side while a graft length between 8 and 8.5 cm is ensured (Fig 1). The gracilis tendon is

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**Fig 1.** (A) On the Graft Prep Station Base (Arthrex, Naples, FL), the tripled semitendinosus graft is measured (single-headed arrow) to a length between 8 and 8.5 cm (double-headed arrow). (B) The gracilis tendon is put inside the tripled semitendinosus graft and secured with multiple sutures (arrows). (C) FiberWire is placed on the femoral side of the tripled semitendinosus graft (arrow). (D) Demarcations (single-headed arrow) are drawn 3 cm from both the femoral side and tibial side (double-headed arrows) that represent parts of the graft that will be placed inside the bone tunnels.
put inside the tripled semitendinosus graft, and the whole graft is then tagged with multiple sutures (No. 2-0 Vicryl) to secure the gracilis position and to tubularize the graft. A No. 2 FiberWire (Arthrex) is placed on the femoral end of the tripled semitendinosus graft to ensure secure further manipulation (Table 2). An ACL graft consisting of 3 parts semitendinosus and 1 part gracilis is obtained, with a diameter of 8 to 10 mm.

**Femoral Tunnel Placement and Drilling**

An outside-in ACL femoral guide (Arthrex) is introduced through the anteromedial portal and placed at the femoral footprint of the ACL (Fig 2). A Kirschner wire is used to mark the femoral epicondyle. A guidewire is then placed on the lateral femoral cortex underneath the iliotibial band (ITB) and into the incision made longitudinally through the ITB fibers. To optimize the isometry of the ACL, the guidewire is placed 1 cm proximal and 8 mm posterior to the Kirschner wire. The guidewire is placed in an outside-in manner from the cortex to the femoral ACL stump. Then, subsequent femoral bone drilling is performed to the appropriate measured ACL size. The proximal part of the femoral tunnel is cleaned with a shaver to reduce soft-tissue entrapment.

**Fig 2.** (A) Outside-in femoral tunnel drilling (right knee, lateral view). The guide is introduced through the anteromedial portal. The tip of the guide is anchored at the anterior cruciate ligament femoral insertion. The guide sleeve is pushed onto the lateral cortex through the femoral stab incision to position a drill for femoral tunnel drilling. (B) The proximal part of the femoral tunnel is cleaned with a shaver to reduce soft-tissue entrapment (arrow) (right knee, anteromedial portal view).
Tibial Tunnel Placement and Drilling

A tibial guide is placed at 55°. Subsequent reaming with a retro-drill is performed for 35 mm according to the previously measured ACL graft size, with preservation of the ACL remnant synovial cover and tibial attachment (Table 2).

Graft Passage

By use of a suture, the TightRope and graft are passed through the ITB and the femoral tunnel to the distal 3-cm mark inside the tibial tunnel (Fig 3A). To ensure the exact length of the graft in the tibial bone tunnel (distal mark), tension on the graft from the femoral side is used. Subsequently, the TightRope is tightened on the tibial side and secured with the knee at 90° of flexion (Fig 3B). The knee is placed at 20° of flexion, and the ACL graft is tightened and secured with an outside-in bioabsorbable interference screw, with a length of 23 mm and the same width as the ACL graft (Fig 4). Tension of the graft is then checked through the ROM from 90° to 0° of flexion, and additional tension, if needed, is secured through the TightRope system.

Fig 3. (A) Arthroscopic view of the right knee through the anteromedial portal showing correct positioning of the anterior cruciate ligament graft with both demarcations (arrows) at the entrance of the bone tunnels. (LFC, lateral femoral condyle.) (B) Under the control of the arthroscope, while tension is maintained on the femoral side (dotted arrow), the TightRope is tightened with the knee at 90° of flexion (right knee, lateral view).

With the use of a grasper, the suture tied to the gracilis is shuttled to the tibial bone tunnel under the ITB (Table 2). This is subsequently shuttled through the tibial bone tunnel using the previously passed suture. The gracilis graft is brought back proximally and tied with FiberWire in extension and neutral rotation (Fig 5).

Postoperative Course

Immediate full weight bearing without a brace and progressive ROM exercises are allowed. Early rehabilitation focused on obtaining full extension and vastus medialis activation is milestone based.

Discussion

Despite ongoing debate about the biomechanical role and even the existence of the ALL, the clinical outcomes of combined ACL and ALL reconstruction are showing promising results. In 2010, Monaco et al. showed that a lesion of the ALL in the knee increases tibial rotation and could correlate to the pivot-shift phenomenon. Moreover, the SANTI Study Group
has shown that ALL reconstruction has a protective effect on the ACL graft, as well as on the repaired medial meniscus. Previous ACL studies performing nonanatomic extra-articular lateral tenodesis, despite having good rotational control, failed to show overall better clinical results owing to excessive pressure on the lateral compartment and found that limited ROM and degenerative arthritis resulted. A potential solution to avoid these problems could be an anatomic reconstruction of the anterolateral structures of the knee.

Guided by this idea, we have developed a modified surgical technique. One of the advantages of our modified ACL-ALL reconstruction technique is bone saving, which is attained by retrograde drilling of the tibial tunnel. By placing the TightRope on the tibial tunnel, we achieve secure fixation with the TightRope button (Arthrex, Naples, FL) under our control and avoid the possibility of a tissue reaction to the screw. On the basis of our knowledge, the most significant advantage for the operator is that the ACL graft tension can be adjusted via the TightRope system after the placement of the femoral screw; in contrast, in the original technique, the graft tension cannot be modified after the femoral screw has been placed. The possibility of simultaneous graft preparation and drilling of the ACL and ALL tunnels significantly reduces the time required to perform the procedure. However, the disadvantages of this technique are the need for an assistant, the need for knowledge of multiple-ligament reconstruction, the possibility of a tibial or femoral condylar fracture, and the use of a suspension device for fixation (Table 3). Even though current indications for combined ACL and ALL reconstruction are still debatable, we suggest that isolated ACL reconstruction might not be appropriate for young patients in pivoting and contact sports and with high-grade pivot shifts after injury.

### Table 3. Advantages and Disadvantages of Combined ACL-ALL Reconstruction

| Advantages                                                                 | Disadvantages                                                                 |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Anatomic ACL and ALL reconstruction                                       | Need for an assistant                                                        |
| Tibial bone saving owing to tibial tunnel retro-drilling                  | Need for a suspension device for graft fixation                              |
| Possibility of tissue reaction to screw avoided owing to placement of TightRope system on tibial side | Longer learning curve for graft preparation                                   |
| After fixation of femoral screw, ability to additional adjust tension of ACL graft, if needed, via TightRope system | Anterolateral plateau fracture                                               |
| Shorter time to perform procedure because of simultaneous preparation of graft (assistant) and bone tunnels (operator) | Irritation of iliotibial band by protruding screw                            |
|                                                                             | Potential lateral discomfort owing to iliotibial tract incision and suturing |

ACL, anterior cruciate ligament; ALL, anterolateral ligament.

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