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Review article

One-stage revision anatomic anterior cruciate ligament reconstruction with rectangular tunnel technique

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Abstract

We developed the anatomic rectangular tunnel anterior cruciate ligament reconstruction (ART ACLR) with a bone–patellar tendon–bone graft to mimic fibre arrangement inside the native ACL via tunnels with smaller apertures. With a 10-mm-wide graft, the cross-sectional area of the tunnels of 50 mm^2 in ART ACLR is less than that of 79 mm^2 in a 10-mm round tunnel one. Because tunnel encroachment would be less of a problem, the ART ACLR technique could be most frequently applied to patients after a failed primary ACLR. In this instructional lecture, the indication and technical considerations for ART ACLR as one-stage revision ACLR are described.

Keywords: anatomic rectangular tunnel technique; bone–patellar tendon–bone graft; one-stage; revision ACL reconstruction

Introduction

Revision anterior cruciate ligament reconstruction (ACLR) is technically difficult because of preexisting tunnels in the primary ACLR.[1] As the native ACL is oblong in the cross section of its midsubstance, a gold standard bone–patellar tendon–bone (BTB) graft with rectangular cross section is one of the morphologically suitable ones to mimic the native ACL for revision or primary ACLR.[2] Biomechanically, a 10-mm-wide BTB graft has sufficient maximum tensile load (1.2 × that for the normal ACL) with bone–tendon junctions and bone plugs.[3]

We developed the anatomic rectangular tunnel ACL reconstruction (ART ACLR) with a BTB graft to mimic natural fibre arrangement inside the native ACL and to minimize tunnel size.[4–6] The crescent-shaped ACL femoral attachment area is < 10 mm in width, whereas the triangular-shaped tibial attachment area is wider.[7–11] Thus, the technique makes it possible to create the tunnel aperture inside the attachment area. The tunnel aperture remaining inside the area with a thicker cortex could be assumed as more robust, and may potentially reduce the tunnel widening.[12] Biomechanically, this reconstruction technique is superior to the conventional transtibial tunnel single bundle procedure.[13]

The cross-sectional area of the tunnels of 50 mm^2 (5 mm × 10 mm) in ART ACLR is less than that in a conventional 10-mm round tunnel technique (79 mm^2), if a 10-mm-wide BTB graft is used. For revision ACLR, therefore, the ART procedure is advantageous because it leaves a larger space between the previous tunnels and the new ones. Because tunnel encroachment would hypothetically be less of a problem, the ART ACLR technique could be more frequently applied as a one-stage revision procedure to patients after a failed primary ACLR.

Surgical principles

Our principle at the time of one-stage revision ACLR is either (1) to create rectangular tunnels (parallelepiped tunnels

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with rectangular apertures) inside the anatomic attachment areas regardless of preexisting nonanatomic tunnels (Figs. 1 and 2) or (2) to reuse the preexisting tunnel apertures if they were in the anatomic attachment areas.

Description of technique for a 10-mm-wide graft

The patient is placed in the supine position with the thigh horizontally kept using a leg holder. The anteromedial portal is used for an arthroscope, whereas instruments are introduced via the far anteromedial portal.[14]

For creating rectangular tunnels, two continuous 5-mm round tunnels along the long axis of the attachment area are created in the centre of the attachment area, and then dilated using the 5 mm × 10 mm dilator with a hockey stick-shaped head (Ref.: E0014050-2; Smith & Nephew Inc., Andover, MA, USA; Fig. 3).

For the femoral tunnel, the instruments are used in an inside-out manner through the far anteromedial portal with the knee flexed beyond 145°. In case the knee could not be flexed beyond 145°, this step also can be accomplished in an outside-in fashion via a small lateral thigh incision to avoid blowout of the tunnel.

The tibial tunnel is created from the anteromedial cortex to the anatomic intra-articular insertion.[5]

Technical considerations

For graft choice

With this procedure, autogenous or allogeneic tendon grafts with or without bone plugs can be used. As we are located in Japan where allogeneic tissues are not readily available, our primary graft choice for revision is a BTB graft from the contralateral knee, or the one from the ipsilateral knee if it had not been used at the time of the primary ACLR. However, the BTB graft may not be indicated for every patient. For example, some judo wrestlers would not accept the BTB graft harvest from the contralateral knee. They tend to prefer an unbalanced dominant leg to well-balanced bilateral legs

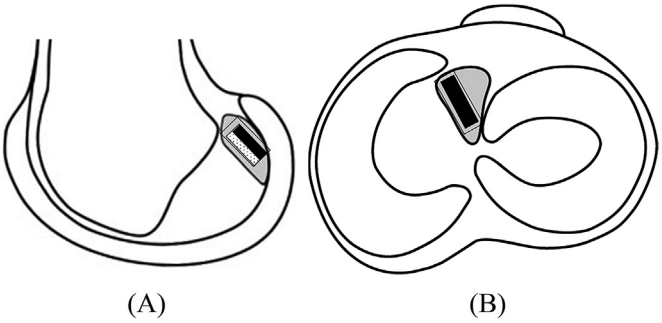

Fig. 1. Intra-articular tunnel apertures of the femoral and the tibial attachment areas for anatomical rectangular tunnel anterior cruciate ligament reconstruction (ART ACLR). (A) Note the tendinous side of the bone plug (black area) located posteriorly–superiorly in the femoral tunnel. (B) The tibial tunnel is almost filled with the tendon (black area).

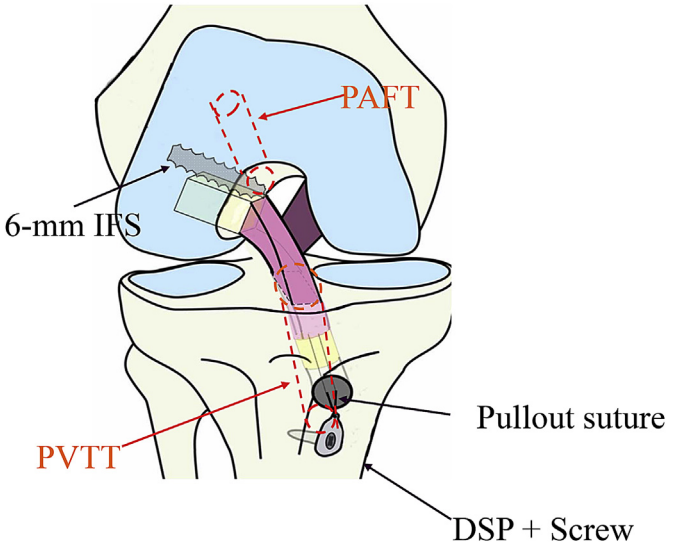

Fig. 2. Schema of revision rectangular tunnel ACL reconstruction with BTB graft. The bone plug is fixed to the femur with a 6-mm interference screw (IFS), whereas tibial fixation is achieved with a modified pullout suture technique using the DSP (Double Spike Plate) and a screw. A new anatomic femoral tunnel can be properly placed in most cases without overlapping tunnels despite the previous anterior femoral tunnel (PAFT) leading to a vertical graft. A new tibial tunnel is created to the aperture of the previous vertical tibial tunnel (PVTT) in most cases, whereas the direction of the tunnel is changed.

because of their sport event. For these patients, the ART technique could be applied with semitendinosus tendon (SMT) or quadriceps tendon–bone (QTB) graft if the double/triple bundle procedure might be compromised because of preexisting tunnel(s).[15] On the contrary, rugby or American football players may be good candidates for use of the contralateral BTB graft, because muscle imbalance between legs could be dissolved. However, an extremely careful postoperative rehabilitation has to be taken to minimize anterior knee pain or

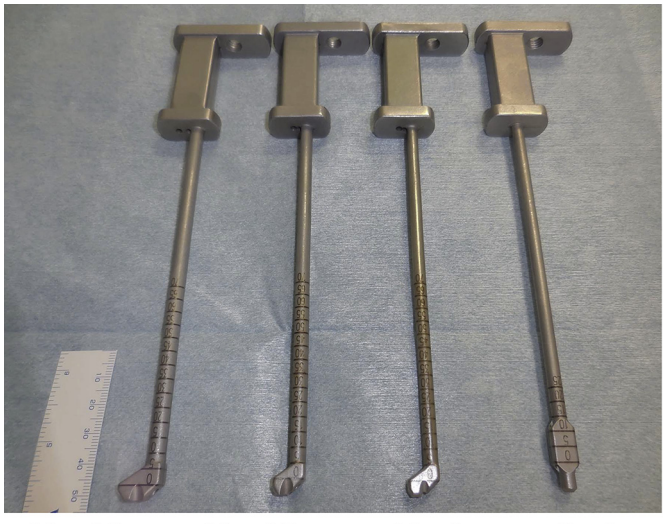

Fig. 3. Dilators of four sizes: 13 mm × 6.5 mm, 10 mm × 6.5 mm, 10 mm × 5 mm, and 8 mm × 5 mm.