Technical Note

Revision Anterior Cruciate Ligament Reconstruction Using Semitendinosus Tendon With Bone Fragment

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Abstract: After anterior cruciate ligament (ACL) reconstruction, the tibial tunnel becomes widened over time. A revision surgery of the ACL reconstruction is required to fill the widened tunnels. Bone–patellar tendon–bone grafts often are used to fill enlarged bone tunnels. However, due to the variation in tendon length, it is often difficult to adjust the position of the bone fragment to the enlarged part of the bone tunnel. This study describes an arthroscopic ACL reconstruction technique using the semitendinosus tendon as well as a bone fragment which is placed in the enlarged tibial tunnel. The tendon and cortical bone were collected together at the tendon attachment using a flat chisel. The bone fragment was inserted through the tendon in a controlled manner and ultimately placed at the posterior wall of the tibial foramen. This technique was determined to be less invasive than using bone–patellar tendon–bone in a 2-stage revision ACL reconstruction. In addition, this technique can be easily performed by any surgeon who is accustomed to conventional ACL reconstruction using the semitendinosus tendon and does not require any special equipment. Our findings suggest that this technique may be useful for revision ACL reconstruction.

After anterior cruciate ligament (ACL) reconstruction, the tibial tunnel becomes widened over time.[1] The revision of the ACL reconstruction is used to fix the widening. The position and fixation of the transplanted tendon worsens when the tunnel is enlarged on the tibial side; therefore, it is necessary to devise a surgical procedure. Bone–patellar tendon–bone (BTB) grafts are often used to fill the enlarged bone tunnel.[2] However, because the length of the tendon varies, it is often difficult to adjust the position of the bone fragment to fit the enlarged part of the bone tunnel. The length of the semitendinosus tendon (STT) can easily be adjusted; however, it is difficult to fill the enlarged bone tunnel. This report describes the use of an arthroscopic reconstruction technique for patients with re-rupture after ACL reconstruction using the STT with a bone fragment for the enlarged tibial tunnel.

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Methods

Indications

This method was found to be suitable for patients with re-rupture after ACL reconstruction, whereby the femoral tunnel could be created independently of the tunnel used in the initial surgery, and the posteriorly expanded tibial tunnel could be filled with bone fragments (Fig 1).

Surgical Technique (With Video Illustration)

Surgery is performed with the patient in the supine position under general anesthesia. After disinfection of the lower limb, an air tourniquet is attached and 280-mm Hg pressure is applied. The portals are prepared on the medial and lateral sides of the patella. ACL injuries are initially evaluated using routine arthroscopy.

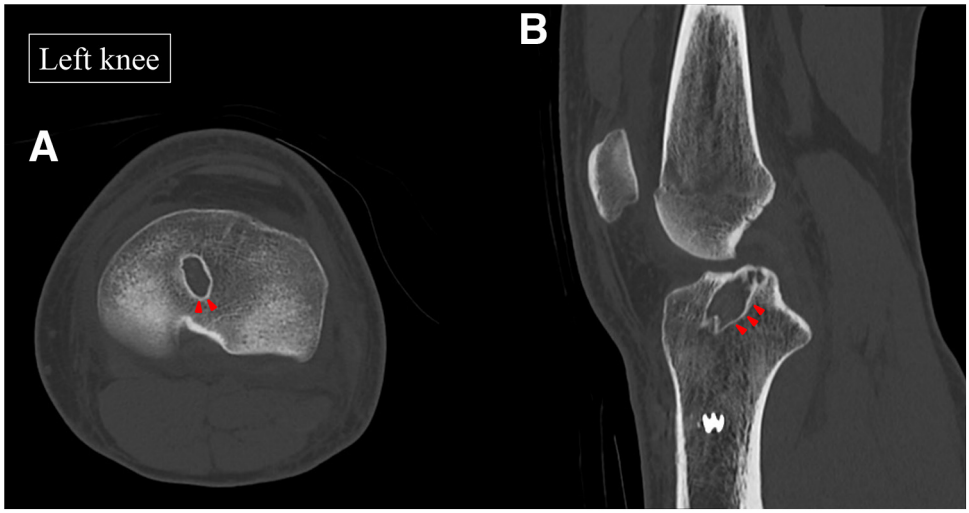

Fig 1. Preoperative computed tomography images (A, transverse view, B, sagittal view) showing how the tibial tunnel expands posteriorly.

The tendon length is determined by measuring the distance between the femoral and tibial tunnels (Fig 2). This distance is often approximately 25 to 30 mm. A 4- to 5-cm skin incision is made on the medial side of the tibial tuberosity. The attachment of the gracilis tendon and STT is checked, and an incision is made in the sartorius fascia, which is located directly above the attachment. The STT is removed from the muscle using a tendon harvester (CONMED, Utica, NY). An incision is made in the periosteum at the tendon attachment in an 8- to 10-mm square. The cortical bone is pre-drilled with a Kirschner wire of Φ1.0 mm, and the tendon and cortical bone are collected together at the tendon attachment using a flat chisel (Fig 3). As much cancellous bone as possible should be collected. The length of the STT is fine-tuned such that when the STT is quadruple-folded, the bone fragments are in the enlarged part of the tibial tunnel. The bone fragment is shaved with the Luer bone rongeurs to fit the width of the tunnel. If the distance between the tunnels is 25 mm and a quadruple bundle of tendons is pulled into the tunnel by 15 mm, the required tendon length would be $(15 + 25 + 15) \times 4 = 220$ mm.

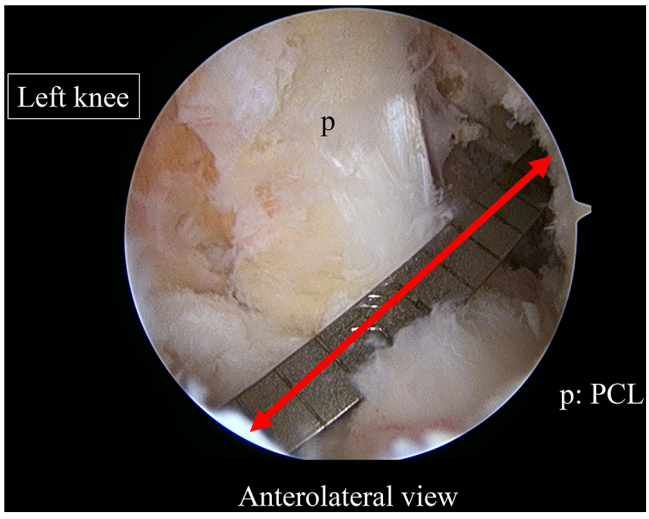

Fig 2. Measuring of the distance between the femoral and tibial tunnels to determine the length of the tendon.

Considering that the length of the tendon is lost at the point where the tendon is folded back, it is advisable to increase the length of the tendon to approximately 240 mm. The STT is arranged in a 4-fold loop with a diameter of approximately 8 mm. One end of the stump is sutured with 0 Surgilon (Medtronic, Dublin, Ireland), and 8 sutures are placed for fixation. A RIGIDLOOP device (DePuy Synthes Mitek, Raynham, MA) is attached to the looped end of the graft for femoral fixation. In addition, the adjustable type made it easier to fine-tune the position of the bone fragments. A Telos artificial ligament (Aimedic MMT, Tokyo, Japan) is connected to the sutured end of the graft for tibial fixation (Fig 4). In the case of reoperation, the tibial tunnel position is determined with reference to the previous tunnel using a special instrument (ACL Guide System; CONMED). A passing pin (Smith & Nephew, Andover, MA) is passed through the joint from the tibial tunnel to the femoral tunnel. With the passing pin, the RIGIDLOOP−STT is pulled into the femoral tunnel through the tibial tunnel and pulled out on the lateral cortex. The RIGIDLOOP is flipped and fixed as an anchor. When passing through the tendon, the bone fragment is controlled by grasping it with tweezers or Kocher forceps so that the bone fragment touches the posterior wall of the tibial foramen. The space between the posterior wall and bone fragment is filled with the preserved cancellous bone. The Telos artificial

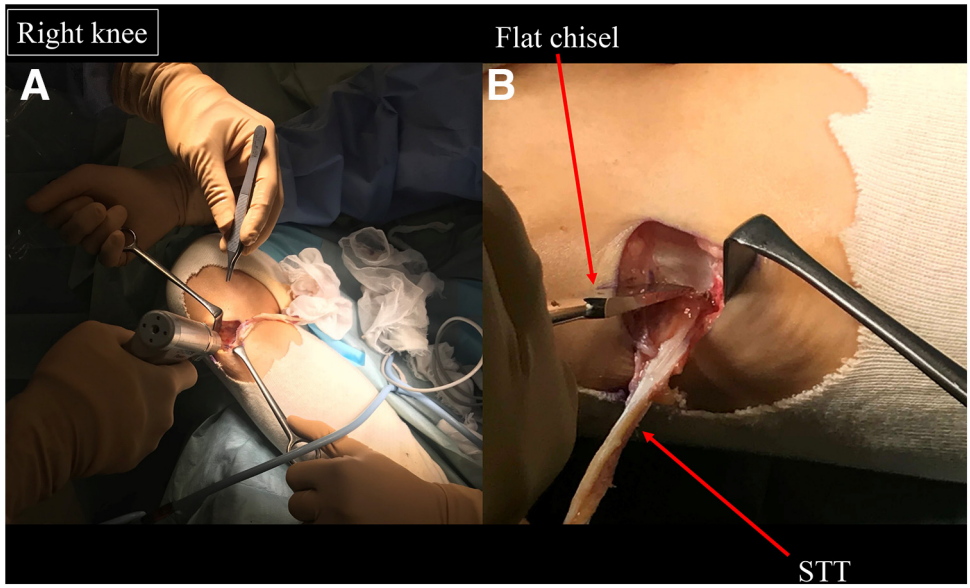

Fig 3. Pre-drill with a Kirschner wire of Φ1.0 mm (A) and collect the tendon together with the cortical bone at the tendon attachment with a flat chisel (B).

ligaments are pulled distally and fixed onto the tibia using a ligament button (KYOCERA, Kyoto, Japan) or a 6.5-mm cancellous post screw (CONMED) with the knee flexed at 20°. Postoperatively, the positions of the RIGIDLOOP and ligament buttons are confirmed by 2-direction radiography (Video 1).

Postoperative Therapy

Isometric exercises used to strengthen the quadriceps muscle are started 2 days postoperatively. Partial weight-bearing is initiated following 1 week of postoperative non–weight-bearing exercises, with full weight-bearing exercises initiated 3 weeks after surgery. Range of motion exercises are performed without restrictions. Radiography and computed tomography imaging are performed 3 to 6 months later to confirm bone union (Fig 5 A and B), after which the patients are allowed to return to their jobs and play sports without any restrictions. The fixation device is removed 1 to 2 years after surgery, and arthroscopy is performed.

Discussion

ACL reconstruction with hamstring tendons is one of the most widely used surgical methods.[3,4] This procedure can be easily performed by any surgeon who is accustomed to conventional ACL reconstruction using STT, and the procedure does not require any special equipment. It was determined that this method is less

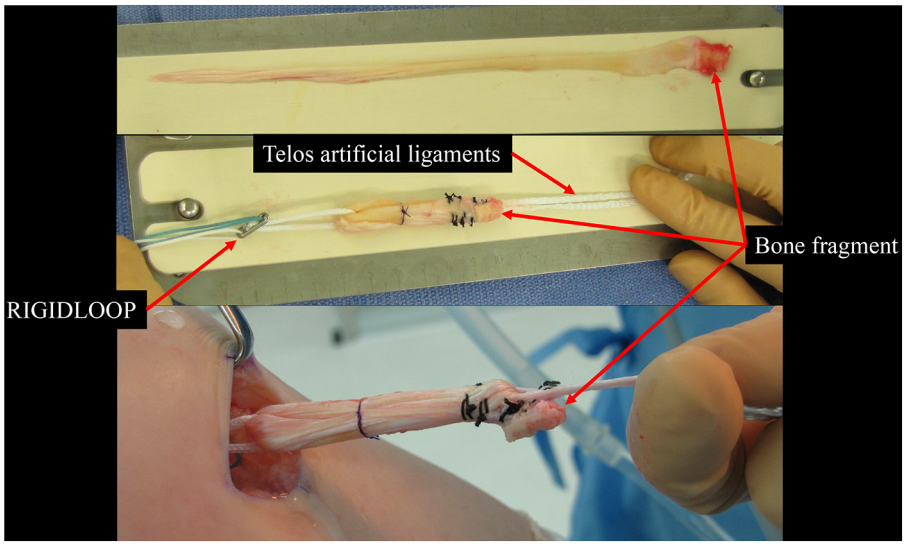

Fig 4. The STT is arranged into a 4-fold loop with an approximate 8-mm diameter. One end of the stump is sutured with 0 Surgilon, and 8 sutures for fixation are placed. A RIGIDLOOP is attached to the looped end of the graft for the femoral fixation. A Telos artificial ligament is connected to the other sutured end of the graft for the tibial fixation. (STT, semitendinosus tendon.)

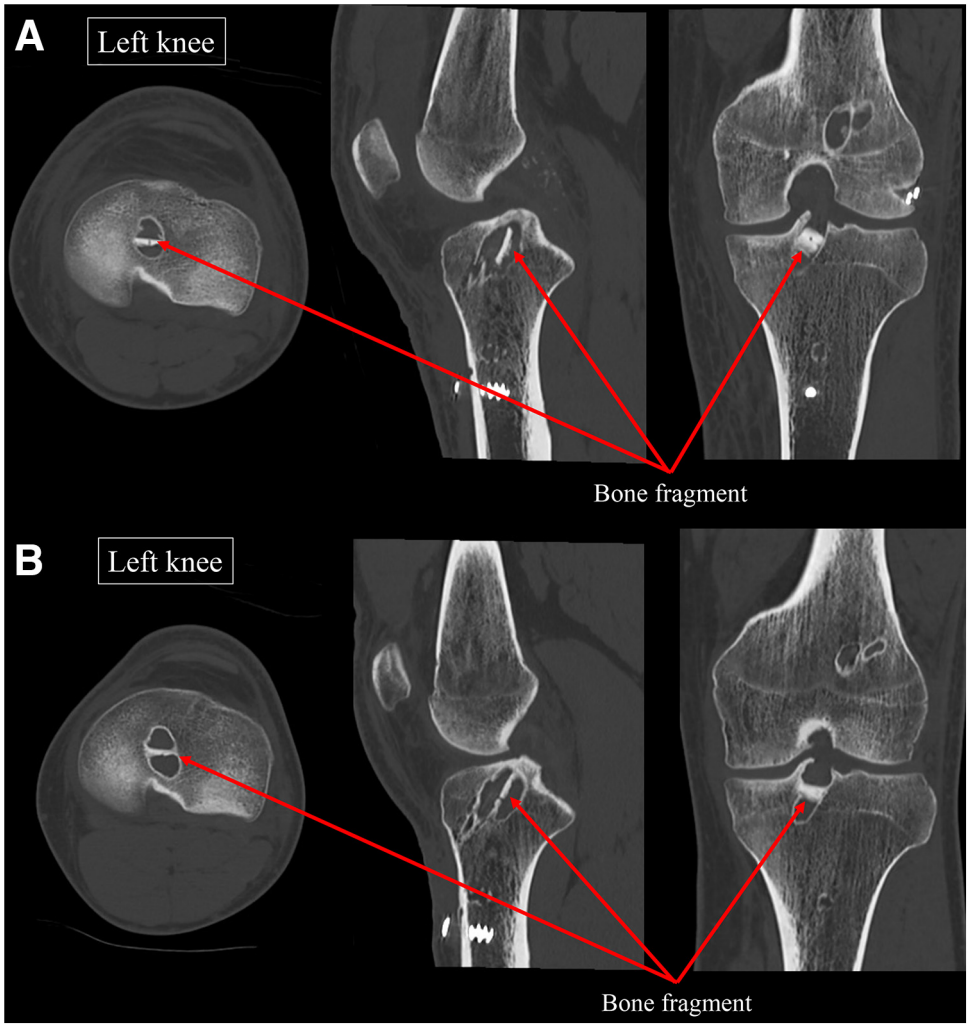

Fig 5. (A) Postoperative CT images (A, transverse view, B, sagittal view, C, coronal view) indicating that the posterior wall of the tibial tunnel can be shifted forward by the bone fragment, which is touching the side wall of the tibial tunnel. (B) CT images at 6 months after surgery (A, transverse view; B, sagittal view; C, coronal view) showing that bone union between the tibial tunnel and bone fragment was achieved. (CT, computed tomography.)

invasive than ACL reconstruction using BTB and 2-stage revision ACL reconstruction. This technique may be useful for revision ACL reconstruction.

For ACL revision surgery in cases with tunnel enlargement, 2-stage revision ACL reconstruction has been reported whereby bone collected from the ipsilateral iliac crest[5] or the anterior tibial metaphysis[6] in the first surgery is transplanted into the tibial tunnel. There are surgical indications for large tunnel expansion, but the disadvantage is that multiple surgeries are required. In addition, there is an extended period of 3 months between the first and second surgery.

BTB grafts often are used to fill the enlarged bone tunnel[2] and are found in the tibia as well as the femur. Due to the variation in tendon length, it is often difficult to align bone fragments to the expanding area of the tibial tunnel. The width of the bone fragment is limited to approximately 10 mm, and it must be fixed with a thick screw when the tibial tunnel is significantly enlarged. There are also problems such as pain at the tendon collection site during kneeling. Additional complications such as osteoarthritis of the patellar femoral joint as well as patellar tendon rupture and fracture in elderly patients also have been reported.[7]

Using this procedure, bone fragments of approximately 10 mm^2 can be collected, which is sufficient for mild tunnel expansion. If the gracilis tendon also is collected, a bone fragment with a width of 15 to 20 mm^2 can be used in cases in which the tibial tunnel is severely enlarged. Larger bone fragments can make it difficult for the graft to pass through the tibial tunnel; therefore, the width of the bone fragment should be slightly smaller than the width of the tunnel for smooth passage of the transplanted tendon. Bone fragments are only taken from the attachment of the STT, and the procedure for making the transplanted tendon is the same as that of the primary ACL reconstruction with STT.

In unsuccessful ACL-reconstruction procedures, it is often found that the tibial tunnel widens posteriorly

Table 1. Advantages and Disadvantages of Revision Anterior Cruciate Ligament Reconstruction Using STT With Bone Fragment

Advantages
The position of the bone fragment can be finely adjusted by adjusting the length of the tendon.
No specific instruments are required.
Easier than collecting BTB.
Disadvantages
This technique is not suitable for an enlarged femoral tunnel.
As bone fragments are collected from the attachment part of the STT, it can only be applied to cases in which the enlargement of the tibial tunnel is up to approximately 10-12 mm.

BTB, bone–patellar tendon–bone; STT, semitendinosus tendon.

over time. With the arthroscopic technique, it is easy to adjust the length of the transplanted tendon and it is possible to adjust the position of the bone fragment to the enlarged site of the tibial bone tunnel. The value of this method is represented best in cases in which the tibial tunnel is severely enlarged. In addition, this method can be applied in cases in which the femoral tunnel is enlarged by recreating the femoral tunnel. During revision ACL reconstruction, the femoral tunnel often is misaligned when created through the tibial tunnel. In such cases, it is possible to approach the posteromedial portal or use outside-in techniques to create a bone tunnel that is independent of the initial tunnel.[8,9] This surgical procedure is simple and minimally invasive compared with surgery using BTB grafts and 2-stage surgery during revision ACL reconstruction (Table 1).

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