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Case Report

Bilateral Anterior Cruciate Ligament Tear Combined with Medial Meniscus Posterior Root Tear

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The case of an individual with a bilateral anterior cruciate ligament (ACL) tear combined with a medial meniscus (MM) posterior root tear is described. A 34-year-old Japanese man with bilateral ACL rupture that occurred > 10 years earlier was diagnosed with bilateral ACL tear combined with MM posterior root tear (MMPRT). We performed a transtibial pullout repair of the MMPRT with ACL reconstruction. The tibial tunnels for the MM posterior root repair and ACL reconstruction were created separately. Postoperatively, a good clinical outcome and meniscal healing were obtained. Our surgical technique may thus contribute to anatomical MM posterior root repair and ACL reconstruction.

Key words: bilateral anterior cruciate ligament tear, medial meniscus posterior root tear, pullout repair, case report

The meniscus roots are crucial for the prevention of meniscus extrusion and for the maintenance of the hoop tension under an axial load [1,2]. Meniscal root tears are defined as radial tears within 1 cm of the meniscal root insertion or an avulsion of the insertion of the meniscus. These injuries change the joint loading due to failure of the meniscus to convert axial loads into hoop stresses, resulting in joint overloading and degenerative changes in the knee. Lateral meniscus (LM) posterior root tear (PRT) is usually traumatic in nature and is strongly associated with an anterior cruciate ligament (ACL) rupture [3-5]. Several studies have demonstrated that the incidence rate of LMPRT combined with ACL tear is 8.0-9.8% [6,7]. In contrast to LMPRT, the cause of a medial meniscus (MM) PRT is often degenerative, and MMPRT is commonly seen in middle-aged women [8]. Chronic and repetitive knee flexion motion under weight-bearing may lead to excessive pressure on the MM posterior root (MMPR) and its subsequent impingement and degeneration [6,9]. There have been few reports regarding MMPRT combined with ACL rupture. Using magnetic resonance imaging (MRI) findings, Brody *et al*. observed that 3% of the reported cases of MMPRT were associated with an ACL rupture [6]. The incidence of MMPRT associated with ACL injury has thus been reported to be low.

To the best of our knowledge, a case of bilateral ACL rupture combined with MMPRT has not been reported. We provide the present case report to describe the surgical treatment and the healing and functional status of a case of bilateral ACL rupture combined with MMPRT. We also describe the problems regarding the treatment of bilateral ACL rupture combined with MMPRT, including the location of each

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tibial tunnel and the procedure order that was encountered.

Case Report

This report was approved by our Institutional Review Board, and informed consent for the case's publication was obtained from the patient and his family. A 34-year-old Japanese man injured his right knee via a contact injury while playing football 15 years prior to his present admission. He was diagnosed with right ACL rupture but underwent no medical treatment. The same patient injured his left knee by twisting it 13 years prior to admission. He visited our hospital, because his left knee pain had worsened.

The initial clinical examination showed no effusion of the knee and tenderness over the posteromedial joint line. The Lachman test and pivot shift test yielded positive results. Plain radiographs showed no abnormal findings, and the posterior tibial slope (PTS) was 7° in the left knee and 8° in the right knee. MRI indicated a bilateral ACL rupture combined with MMPRT because the positive cleft sign, ghost sign, and giraffe neck sign were observed in both knees (Fig. 1).

Left knee surgery. Surgery was first performed on the left knee, because the patient experienced more severe pain in this knee. The patient was placed in the supine position with a tourniquet. Standard anterolateral (AL) and anteromedial (AM) portals were used for the arthroscopic visualization of the ACL and MMPR and their anatomical attachment by using a 30° arthroscope. The presence of the ACL rupture and type 2C MMPRT [10] was identified through the AM portal (Fig. 2A, B).

Repair of the MMPRT. Synovial tissues around the posterior cruciate ligament were debrided with a motorized shaver and a radiofrequency device. An MMPRT aiming guide (Smith & Nephew, Andover, MA, USA) [11] was placed at the anatomical insertion of the MMPR located approximately 9.6 mm posterior and 0.7 mm lateral to the apex of the medial tibial eminence [10]. A 2.4-mm guide pin was inserted using the aiming device at an angle of 55° to the articular surface. A tibial tunnel was created with a 4.0-mm cannulated drill.

A FasT-Fix all-inside meniscal suture device (Smith & Nephew) was inserted through the superior surface of the MMPR segment. The needle was punctured into the meniscus by using the horizontal mattress suture technique through the AM portal, and the knot of the inserted FasT-Fix was fastened by the knot pusher. The uncut free-end of the suture was retrieved through the AM portal and was preserved until cortical fixation of the tibia (Fig. 2C).

ACL reconstruction. For double-bundle reconstructions with semitendinosus autografts, an outside-in technique was used. The femoral tunnel was created using an AL portal entry femoral aimer and an Acufex direction elite ACL drill guide system (Smith & Nephew) in the figure-of-nine position [12]. Femoral tunnels were created with a 6-mm-diameter reamer for the AM bundle and a 5-mm-diameter reamer for the posterolateral (PL) bundle. The tibial aiming guide was set at 45° for the AM bundle and 55° for the PL bundle. Tibial tunnels were created with a 6.0-mm-diameter reamer for the AM bundle and a 5.5-mm-diameter reamer for the PL bundle.

The two bundles were passed from the tibial tunnel to the femoral tunnel by using two leading sutures with the EndoButton fixation device (Smith & Nephew)

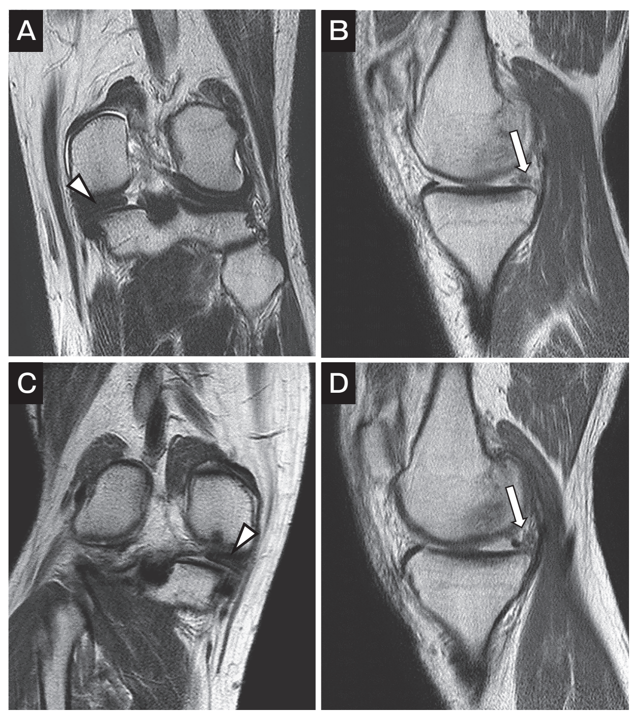

Fig. 1 Preoperative coronal and sagittal MRI of the left knee (A, B) and right knee (C, D) of the patient, a 34-year-old man. *Arrowheads* denote the positive giraffe neck sign (A, C), and *arrows* show the positive ghost sign (B, D).

(Fig. 2D). Tibial fixation was performed with the knee flexed at 20° by using double-spike plates (DSPs) (Meira, Aichi, Japan), with an initial tension of 20 N for the PL bundle and 30 N for the AM bundle and MMPR pullout suture.

Right knee surgery. Two months after the first surgery, surgery on the patient's right knee was performed for an ACL injury and type 2B MMPRT (Fig. 2E, F). The procedures were similar to those used for the left knee, with the exception of the following. The first was that the modified Mason-Allen suture technique was used for the MMPR pullout repair to ensure a more secured fixation (Fig. 2G) [13]. In this technique, No. 2 Ultrabraid (Smith & Nephew) was passed through the MMPR with a Knee Scorpion suture passer (Arthrex, Naples, FL, USA). The Ultrabraid was tensioned throughout the AL portal. Subsequently, the insertion of the FasT-Fix system was conducted through the AM portal. The first suture needle was inserted into the MMPR, and the second needle was aimed to bridge the root across the Ultrabraid.

Second, a bone-patellar tendon-bone (BTB) graft for ACL reconstruction was used, because the tibial subluxation was severe due to chronic ACL deficiency (Fig. 2H). The tibial tunnel was created with a 7.5-mm-diameter reamer, and the femoral tunnel was created with an 8.0-mm-diameter reamer. Tibial fixation was performed using DSPs with the knee flexed at 20° with a tension of 30 N for the BTB graft and the MMPR pullout suture. Figure 3 shows the postoperative radiographs of both knees.

Postoperative protocol. The patient began knee range-of-motion exercises and partial weight bearing at 2 weeks postoperatively [14]. Full weight bearing was permitted at 1 month, running was permitted at 5 months, and a return to sports was permitted at 8 months postoperatively.

Treatment outcome. We performed a second-look arthroscopy at 18 months after the patient's right knee surgery. The reconstructed ACL in the left knee showed good stability (Fig. 4A). The degree of healing of the MMPR repair was determined using Furumatsu's criteria [15]. The bridging tissue of the left MMPR was broad, and the stability and synovial coverage on the repaired site were fair (Fig. 4B). The left MMPR healing score was thus 8 out of 10 points.

The reconstructed graft in the right knee looked like a normal ACL (Fig. 4C). The bridging tissue of the right

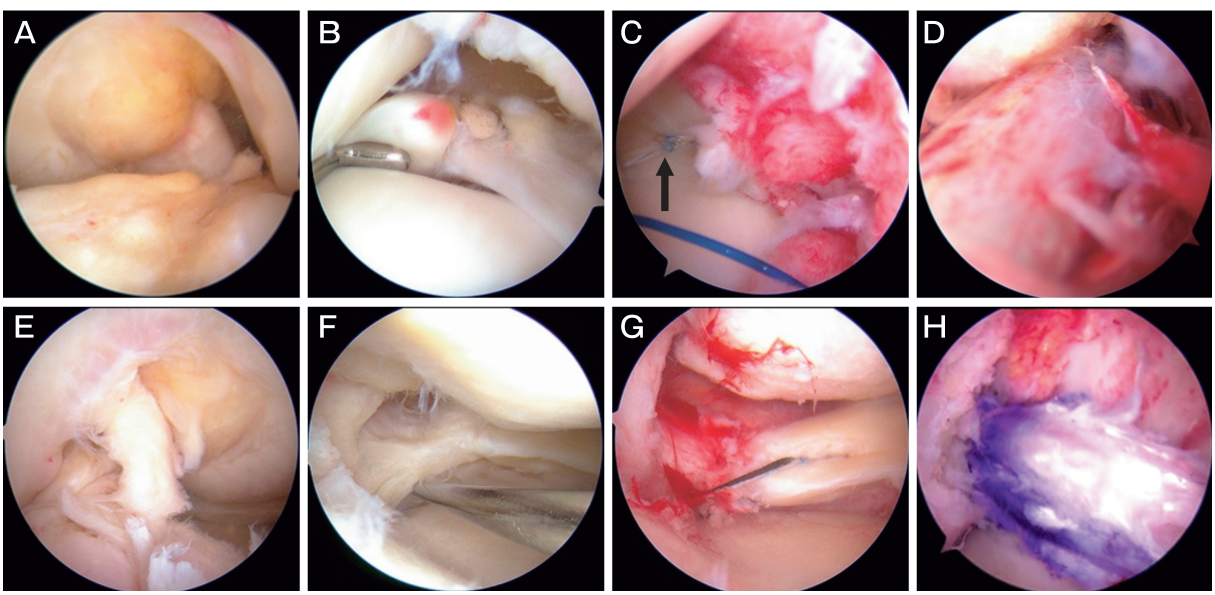

Fig. 2 Arthroscopic findings of the MMPR pullout repair and ACL reconstruction in the left (A–D) and right (E–H) knees. A, A ruptured and atrophic ACL was observed; B, The MMPR was detached from the posterior attachment and classified as LaPrade type 2C; C, The uncut free-end of the FasT-Fix suture (*black arrow*) was pulled out from the tibial tunnel by the suture relay technique; D, Double-bundle ACL reconstruction with the semitendinosus tendon in the left knee; E, The ruptured ACL; F, Scar-like tissue formed in the cavity caused by the MMPRT, which was classified as LaPrade type 2B; G, Pullout repair of MMPRT with a modified Mason-Allen suture technique; H, Right ACL reconstruction with a BTB graft.

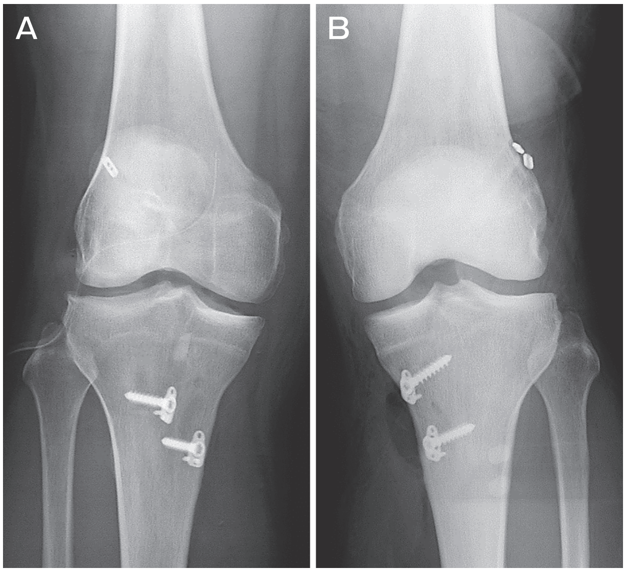

Fig. 3 Postoperative anteroposterior radiograph of the patient's (**A**) right knee, and (**B**) left knee.

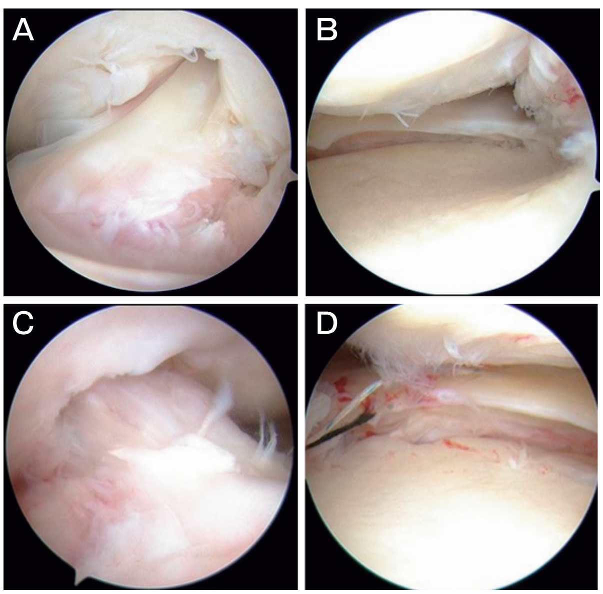

Fig. 4 Arthroscopic findings at the second-look arthroscopy in the left knee (**A**, **B**) and right knee (**C**, **D**). **A**, The reconstructed ACL; **B**, The MM posterior horn was stabilized and was partially covered by synovial tissue. The anteroposterior width of the bridging tissue was broad; **C**, The reconstructed ACL; **D**, The stability of the MMPR was good, and the synovial coverage was poor.

MMPR was broad. The stability was good and the synovial coverage on the repaired site was poor (Fig. 4D); thus the right MMPR healing score was also 8 out of 10 points. The No. 2 Ultrabraid was ruptured

Table 1 Clinical and radiographic preoperative and final follow-up parameters

	Preoperative	Final follow-up
Lysholm knee score	83	94
Tegner activity scale	4	5
IKDC score	59	83
KOOS		
Pain	82	94
Symptoms	71	79
Activities of daily living	82	97
Sport and recreation	37	45
Knee-related QOL	38	43
Total	87	92
Pain score (VAS)	7	0
Kellgren-Lawrence grade (right/left)	1/1	1/1

IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; QOL, quality of life; VAS, visual analogue scale.

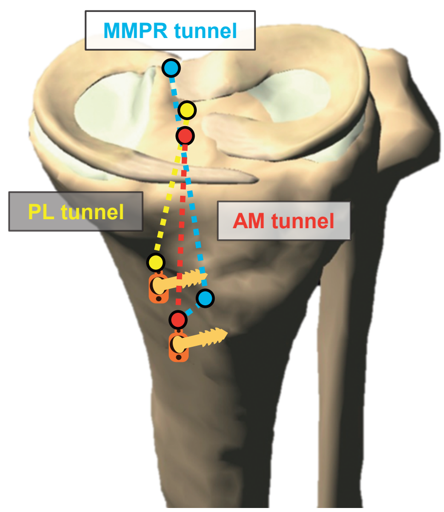

Fig. 5 Illustration of the tunnel location of the MMPR, AM, and PL bundles. These tunnels were created separately. The AM bundle and MMPR pullout suture were fixed together by a DSP.

and removed from the MMPR. At the final follow-up performed at 2 years after the first operation, the clinical outcome had improved compared to the preoperative status (Table 1).

Discussion

An important finding in this case report was the previously unreported complication of MMPRT following bilateral ACL rupture. The incidence of MMPRT combined with ACL rupture has been reported to be low [6], and accordingly there are very few published studies that discuss the injury mechanism and repair process of MMPRT in an ACL-deficient condition. Although no consensus exists regarding such issues, our patient achieved an improvement in the clinical outcome and favorable MMPR healing and ACL reconstruction with our surgical technique.

Biomechanically, the MM is tightly attached to the tibia and is much less mobile than the LM [16,17]. The MM thus works as a secondary stabilizer of the knee against anterior displacement of the tibia and is subjected to anteroposterior shear force in the ACL-injured knee [14,18]. Older age, male sex, increased body mass index, prolonged time from injury, and higher PTS were revealed as significant factors for the development of MM tears [19,20]. The cause of an MMPRT combined with an ACL rupture is not clear, but a potential explanation is that complex translational and rotational stress over a long period may induce a degenerative MMPRT [21].

There are few published studies that discuss the surgical technique used in this condition, and no consensus exists. An MMPRT is reported to be functionally equivalent to total meniscectomy of the MM, and an MMPRT leads to accelerated degeneration of the articular cartilage of the knee joint by disrupting meniscal functions [2,22]. A symptomatic MMPRT should therefore be treated with arthroscopic meniscal repair techniques as soon as possible following the diagnosis of the MMPRT if the patient meets the surgical indications for MMPR repair [1]. Recent biomechanical studies reported that the repaired MMPR restored the peak contact pressure close to the normal level [2,23,24].

Many techniques have been developed to repair MMPRTs, and several of the techniques have shown good clinical and radiographic outcomes [25,26]. Ahn *et al.* reported that pullout repair for MMPRT cases had better clinical results than the conservative treatment [27]. Based on the findings of previous reports, we suggest that adding MMPR repair to ACL reconstruction could protect the knee articular cartilage and improve the clinical outcomes. Chernchujit *et al.* described the treatment of MMPRT and LMPRT combined with ACL rupture [28]. They performed a repair simultaneously from the MM to the LM and then proceeded to ACL reconstruction. We also performed MMPR repair following ACL reconstruction. The advantage of this order of procedures is that we can obtain good visualization of the anatomical landmark of the MM posterior attachment and a working space for MMPR repair.

In the present case, the tibial tunnels for ACL reconstruction and MMPR repair were created separately (Fig. 5). The advantage of this procedure is the restoration of the knee kinematics by anatomical ACL reconstruction and MMPR repair. A kinematic study reported substantially altered tibiofemoral motion after ACL reconstruction, which caused a shift in the cartilage compartments, leading to the progression of early osteoarthritis (OA) [29]. An anatomically repaired MMPR and reconstructed ACL will contribute to the prevention of the progression of post-traumatic OA. In addition, the presence of growth factors and possibly bone marrow mesenchymal stem cells during femoral-tibial tunnel preparation in ACL reconstruction and tibial transosseous drilling in MMPR pullout repair may promote and enhance healing [30].

In our patient's case, we selected the transtibial pullout technique for his MMPRT. The current trends of MMPR repair are suture anchors and pullout repairs if the patient meets the indications [1]. It has been reported that radiographic and clinical outcomes were similar between pullout repair and suture anchor techniques for the treatment of MMPRT [31,32]. We have reported a new MMPR repair technique by using the FasT-Fix all-inside device [33], which can easily be worked into a narrow working space. Easy access to the tear site and strong grasping could be also obtained using this device. We also applied the modified Mason-Allen suture technique for the right MMPRT, which allows the strong grasping and fixation of the MMPR without the creation of a posteromedial portal [13]. The MMPR healing score of each knee was 8 points, and good meniscal healing was obtained using a combination of these techniques.

In conclusion, this is the first report of a bilateral chronic ACL rupture combined with MMPRT. A good clinical outcome was obtained by combining anatomical ACL reconstruction with MMPR pullout repair. A long-term follow-up of the patient is needed to scrutinize whether the reconstructed ACL and repaired MMPR effectively prevent later degenerative changes in the meniscus and articular cartilage.

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