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Anatomical reconstruction of the Posterolateral Corner of the knee preserving dynamic function of the popliteus tendon complex

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ABSTRACT

Almost cases of Posterolateral Corner (PLC) injuries are combined injuries involving the anterior or posterior cruciate ligament. Although numerous techniques of PLC reconstruction have been reported, it is unknown whether these techniques reconstruct PLC sufficiently. The anatomy of PLC is complex of tendon-muscle and ligament. The major structures are the fibular collateral ligament (FCL) and the Popliteus Tendon Complex. The latter comprises the popliteus tendon-muscle and the popliteo-fibular ligament (PFL). The FCL and PFL are static stabilizers, whereas the popliteus tendon-muscle is a dynamic stabilizer. The most of current PLC reconstructions statically restore all component parts, therefore not true "anatomically". We describe an operative technique to reconstruct PLC anatomically. Our technique preserves dynamic stability of the popliteus tendon-muscle and reconstructs the PFL and FCL selectively.Semitendinosus tendon is harvested, and almost used for the anterior or posterior cruciate ligament reconstruction. Gracilis tendon or contralateral semitendinosus tendon is used for PLC. Femoral bone tunnel for FCL is prepared at anatomical insertion. Fibular bone tunnel is prepared to connect PFL insertion with FCL insertion. One end of the graft is sutured to the popliteus tendon. The other end is passed though the fibular tunnel, and fixed at the femoral tunnel. The interference screws are used at each tunnel. One half of the graft composes PFL part, the other half composes FCL part.

Advantages of this technique are preservation of dynamic popliteus tendon-muscle function, and simplifying preparation.

1. Introduction

Posterolateral corner (PLC) injuries of the knee occur as a result of high energy trauma. Almost cases are combined injuries involving the anterior cruciate ligament (ACL) or the posterior cruciate ligament (PCL).[1,2] Numerous reconstruction techniques have been reported previously, and meliorated with slight variations.[3–11] However, almost reports suggested the normal PLC stability was not restored sufficiently. The anatomy of PLC is complex of tendon-muscle and ligament. The major structures are the fibular collateral ligament (FCL) and the Popliteus Tendon Complex. The latter comprises the popliteus tendon-muscle and the popliteo-fibular ligament (PFL).[12–14] Therefore, the PLC comprised of popliteus tendon-muscle is a "dynamic" stabilizer. Almost reported techniques restore statically all component parts, not true "anatomically" although they have been reported as anatomical reconstruction.[3,4,8,11]

In this article, we describe an operative technique to reconstruct PLC anatomically. This technique is nearer to anatomical structures than reported reconstruction techniques.[3–11] Reconstruction of only PFL and FCL portion result in preservation of dynamic popliteus tendon-muscle function.

Abbreviations: PLC, posterolateral corner; ACL, anterior cruciate ligament; PCL, posterior cruciate ligament; FCL, fibular collateral ligament; PFL, popliteo-fibular ligament; MRI, magnetic resonance imaging; ST tendon, semitendinosus tendon; ITB, iliotibial band; PLLA, poly-L-lactic acid; ROM, range of motion.

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2. Illustratve case

A 38-year-old lady presented with right knee instability. She injured during handball that occurred twenty years ago, and underwent the ACL reconstruction six weeks after the injury. She was not able to return to sports because apprehension and giving way of the knee occurred frequently. The giving way gradually deteriorated, and has occurred during a walk recently.

Physical examination at presentation showed no ballottement, no tenderness, a positive Lachman test, a positive anterior drawer test, and a negative posterior drawer test. In addition, she had a positive dial test at 30°flexion of the knee, a negative dial test at 90°flexion, 3+ instability (no end point) to varus stress at 20°flexion.

Magnetic resonance imaging (MRI) showed the complete ACL tear and the PLC injury with disruption of FCL. The popliteus tendon-muscle was showed continuity (Fig. 1A). The PFL tear was suspected because of no continuity. We must beware MRI diagnostic accuracy of PFL is generally low. The fluoroscopic stress views showed 3+ instability to varus stress at the 20°flexion (Fig. 1B). The examination findings were consistent with a complete disruption of ACL and PLC. In this illustrative case we focus only on the reconstruction of PLC.

3. Surgical techniques

Once satisfactory general anesthesia is attained, both knees are examined clinically and with fluoroscopic stress views to confirm the instability pattern.

Arthroscopy is initiated with anterolateral and anteromedial portals. First of all, we perform the ACL and/or PCL reconstruction as well as any meniscal or cartilage treatment, if these are required. In this case we reconstructed the ACL.

The semitendinosus (ST) and/or Gracilis (G) tendon is harvested using a tendon stripper for ACL and/or PCL reconstruction. Then, we usually harvest the ipsilateral G tendon or the contralateral ST tendon for PLC reconstruction. The graft length of at least 14 cm is required. In this case we did contralateral ST tendon.

A curved lateral incision centered over the fibular head and the lateral epicondyle of the femur is used. Further incision is performed down to the deep layer to expose the iliotibial band (ITB) and the biceps femoralis muscle. The peroneal nerve is first identified and protected throughout the procedure. ITB is split longitudinally to expose FCL and popliteus tendon-muscle (Fig. 2A). The former is took off at the femoral insertion. Preparation of the tunnels starts at the lateral femoral condyle to reconstruct FCL (Fig. 2B). A guide pin is inserted at the anatomical insertion of FCL. The tunnel is made to match the diameter of the graft. The next, bone tunnel is prepared at the fibular head (Fig. 2B). The biceps femoralis muscle is split or raised to the proximal side, to expose the fibular head. We perform dissection to expose the insertion of FCL and PFL. A guide pin is passed to connect the both insertions. The tunnel is made using cannulated reamer to match the diameter of the graft. The end of the graft is sutured to the popliteus tendon with non-absorbable sutures. The other end is passed through the fibular tunnel from posterior to anterior (Fig. 3A). The graft is fixed in the fibular tunnel with a poly-L-lactic acid (PLLA) interference screw 5 mm in diameter. Then the knee is held in 90°flexion and neutral rotation, and the graft is pulled with 10–15 N of force using a ligament tensioner. The graft end for FCL is passed into the femoral tunnel at the lateral femoral condyle, and fixed with a PLLA interference screw 5mm in diameter (Fig. 3B). Then the knee is held in 90°flexion and neutral rotation, and the graft is pulled with the same force. After fixation of all the graft we verify full extension/flexion, and improvement of the knee stability for external rotation and varus in 30°/90°flexion of the knee. Finally, the separated original FCL is secured to FCL portion of the graft with non-absorbable sutures (Fig. 3B). A closure of all the fascial intervals, subcutaneous tissue, and skin is performed.

4. Postoperative program

The knee is placed in a knee brace locked in slightly flexion for 3 weeks. Afterwards the postoperative program is followed the normal cruciate ligament reconstruction. The rehabilitation brace is used for 12 weeks postoperatively. Range of motion (ROM) exercise is started 1 week later. ROM from 0° to 90°is permitted during 4 weeks. From 4 weeks, ROM is not restricted. Partial weight bearing is permitted at 2 weeks postoperatively. After the 6 weeks, progressive weight bearing, closed-kinetic chain strengthening, and proprioception exercises are started.

A. B.

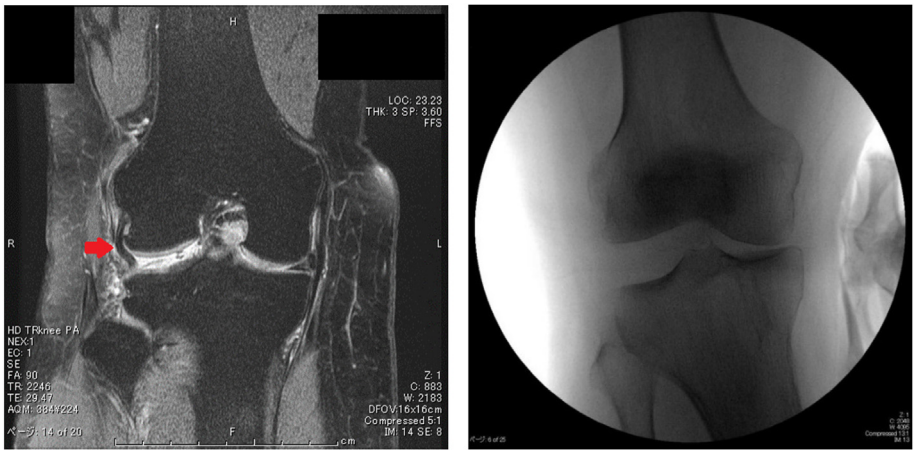

Fig. 1. A. MRI showed disruption of FCL. The popliteus tendon was showed the continuity (red arrow). The PFL tear was suspected because of no continuity. We must beware that MRI cannot confirm the PFL tear frequently.
B. Both knees are examined with fluoroscopic stress views to confirm the instability pattern. In this case, there is 3+ instability (no end point) to varus stress at 20°flexion of the affected knee. . (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

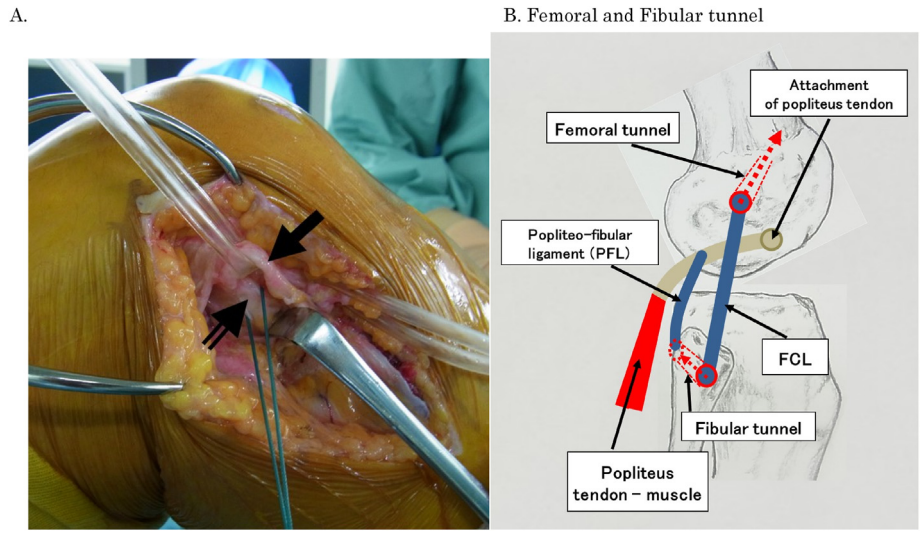

Fig. 2. A. ITB is split longitudinally to expose the attachments of FCL (➡) and the Popliteus Tendon (⇒). The former become loose in almost cases, then took off at the femoral insertion.
B. Femoral and Fibular tunnel
The first, bone tunnel is prepared at the lateral femoral condyle to reconstruct FCL. A guide pin is inserted at the anatomical insertion of FCL. The tunnel is made to match the diameter of the graft.
The next, bone tunnel is prepared at the fibular head. A guide pin is passed to connect both FCL and PFL insertion. The tunnel is made using cannulated reamer to match the diameter of the graft.

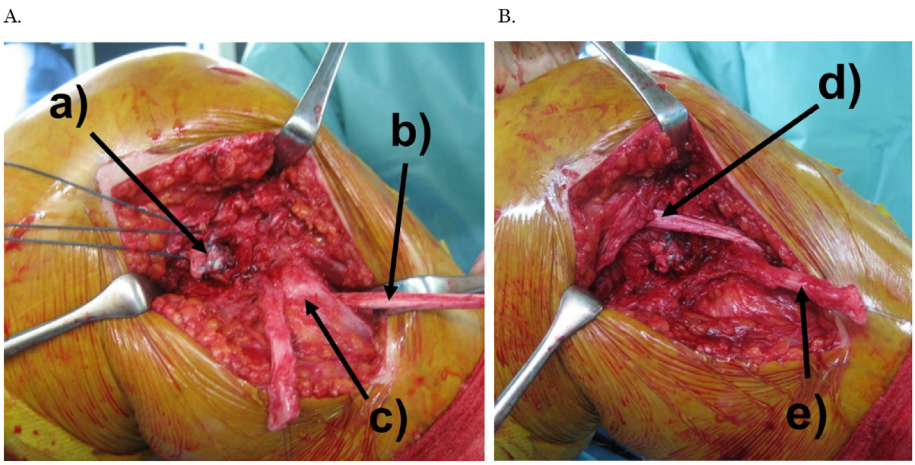

Fig. 3. A a) The graft end for PFL is sutured to the popliteus tendon with non-absorbable sutures.
b) The other end is passed through the fibular tunnel from posterior to anterior.
c) The graft is secured in the fibular tunnel with a PLLA interference screw 5 mm in diameter.
B.d) The graft end is passed into the femoral tunnel prepared at the lateral femoral condyle. It is fixed with a PLLA interference screw 5mm in diameter.
e) The separated original FCL is secured to FCL portion of the graft with non-absorbable sutures.

5. Discussion

Reconstruction of the PLC is important to help restoring knee stability. Patients have significant disability and limitation of their quality of life if untreated or improperly treated. Most reports recommend surgical reconstruction of PLC in combination with ACL or PCL reconstruction.[6,7,10,15–17] Although numerous techniques of PLC reconstruction have been described, these have been not established satisfactory results.[1,2,5–7,10] The FCL and the Popliteus Tendon Complex (popliteus tendon-muscle and PFL) are included in the major structures of the PLC.[12–14] The Popliteus tendon-muscle is a dynamic stabilizer, in contrast the others are static stabilizers. Currently several techniques were reported as "anatomical" PLC reconstruction.[3,8,11] However, in these reconstruction techniques, the Popliteus tendon-muscle are restored "statically" with tendon graft, or "not" restored (FCL portion only restored). In the former, the tendon graft is connected the femoral insertion of popliteus tendon with the fibular head or the posterolateral side of the tibia. The PFL naturally connects the popliteus musculotendinous junction with the backside of the fibular head. Our technique reconstructs PFL and FCL faithfully, and preserves the popliteus tendon-muscle (Fig. 4A). Then the Popliteus Tendon Complex would function more similarly to the natural.

We know the PLC is the principle structure for resisting external rotatory and varus instability, although it was found by the cadaver study.[15–17] The popliteus muscle contracts in walking,[18] therefore nobody knows the dynamic stability of PLC during an ambulation. The PLC function may be underestimated, therefore static

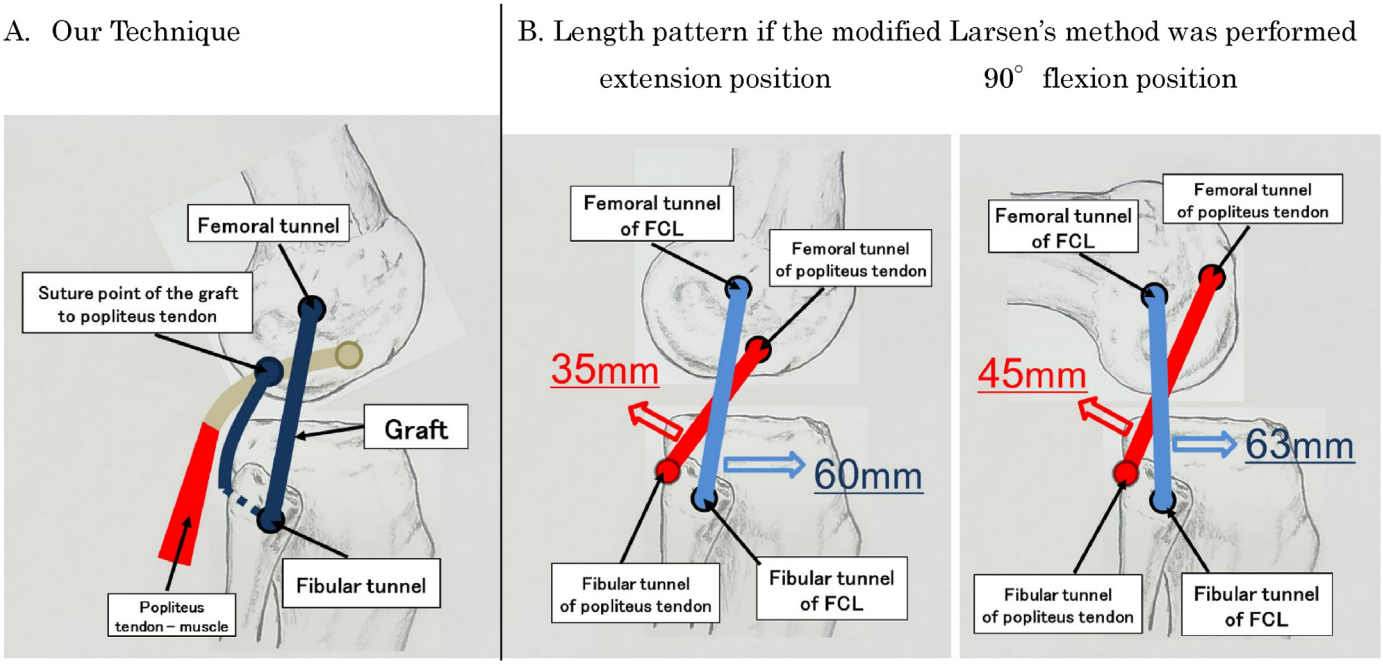

Fig: 4. A. This showed the schema. Our technique preserves the Popliteus Tendon and reconstructs faithfully PFL and FCL.
B. In this case, we measured graft length patterns of FCL and Popliteus Tendon portion if the modified Larsen's method was performed. The figures showed the knee at extension and 90°flexion. The distance of FCL portion (blue line) is 60 mm at extension of the knee, 63 mm at 90°flexion (blue line), the difference of these distances is 3 mm. The other hand, the distance of Popliteus Tendon portion (red line) is 35mm at extension of the knee, 45 mm at 90°flexion (red line). The difference is 10mm. . (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

reconstructions would not sufficiently work to withstand dynamic external rotation stress.

Moreover, we do not recommend "static" reconstructions because of the length pattern discrepancy of the graft. In this case, we measured graft length patterns of FCL and Popliteus Tendon portion if the modified Larsen's method[3,4,19] was performed (Fig. 4B). The distance of FCL portion is 60 mm at extension of the knee, 63 mm at 90°flexion, the difference of these distances is 3 mm. The other hand, the distance of Popliteus Tendon portion is 35mm at extension of the knee, 45 mm at 90°flexion. The difference is 10 mm, considerably large. According to those results, the Popliteus Tendon Complex would not work natively if this technique is performed. For example, tight tension of the graft would result in knee contracture or graft rapture, and loose tension result in instability of the knee. Some different surgeons have reported that insertion of Popliteus Tendon portion is prepared at the posteromedial aspect of the tibia like Laprade's method. Their techniques also would have large discrepancy from a tendency of our results.

Our technique has limitations. It is necessary the popliteus tendon remains for our technique. However, it does not usually matter because the complete rupture of Popliteus Tendon occurs much less frequently, in contrast FCL or FPL mostly.[20] In addition, MRI findings demonstrate whether the popliteus tendon is contiguous or not, hence we could comprehend these conditions preoperatively. Almost cases are indication for our technique.

6. Conclusions

We describe an operative technique to reconstruct PLC anatomically. Our technique preserves the dynamic Popliteus tendon-muscle function by restoring PFL and FCL selectively. Careful planning and accurate reconstruction of PLC could help restoring static and dynamic knee stability, and providing satisfactory clinical outcomes.

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Declaration of competing interest

The authors declare no conflicts of interest associated with this manuscript.

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