

## Arthroscopic approach to the posterior compartment of the knee using a posterior transseptal portal

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### Abstract

Arthroscopic surgery of the posterior compartment of

the knee is difficult when only two anterior portals are used for access because of the inaccessibility of the back of the knee. Since its introduction, the posterior transseptal portal has been widely employed to access lesions in the posterior compartment. However, special care should be taken to avoid neurovascular injuries around the posteromedial, posterolateral, and transseptal portals. Most importantly, popliteal vessel injury should be avoided when creating and using the transseptal portal during surgery. Purpose of the present study is to describe how to avoid the neurovascular injuries during establishing the posterior three portals and to introduce our safer technique to create the transseptal portal. To date, we have performed arthroscopic surgeries *via* the transseptal portal in the posterior compartments of 161 knees and have not encountered nerve or vascular injury. In our procedure, the posterior septum is perforated with a 1.5-3.0-mm Kirschner wire that is protected by a sheath inserted from the posterolateral portal and monitored from the posteromedial portal to avoid popliteal vessel injury.

**Key words:** Arthroscopic surgery; Knee; Posterolateral portal; Posteromedial portal; Transseptal portal

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**Core tip:** Arthroscopic surgery in posterior compartment of the knee *via* the transseptal portal is less invasive to the patient compared to open surgery for access to the back of the knee. However, special care should be taken to avoid neurovascular injury when creating the three posterior portals. We have not encountered neurovascular injury with our procedure for creating a posterior transseptal portal in 161 treated knees, and conclude that it is safe and reliable.

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## INTRODUCTION

Prior to introduction of the posterior transseptal portal, arthroscopic surgery for lesions located in the posterior compartment of the knee was difficult because both the cruciate ligaments and curvature of the femoral condyles obstructed the advance of the arthroscope or other instruments to the back of the knee. Additionally, posterior lesions such as a posterior periphery or posterior horn of the medial meniscus might be missed when using an anterior approach alone<sup>[1,2]</sup>. Trans-notch views from anterior portals have allowed us to obtain clear views of the posterior compartment<sup>[1-3]</sup>. However, a particular "blind zone" on the medial meniscus that could not be viewed remained even with a 70-degree arthroscope<sup>[4,5]</sup>. The treatment of lesions located in the posterior compartment introduces further difficulty. The addition of posteromedial and posterolateral portals together with a 70-degree arthroscope facilitated treatment procedures for posterior lesions<sup>[2,6-9]</sup>. Nevertheless, the cruciate ligaments, femoral condyles, and prominence of the tibial spine limited the maneuverability of the arthroscope or other instruments advanced through the intercondylar notch from the anterior portals<sup>[1,3]</sup>. Ideally, either the posteromedial or posterolateral portal would be used as a viewing portal, while the other would be used as a working portal. However, the posterior compartment of the knee is divided into two compartments by a posterior septum comprising a thin synovial membrane between the posterior cruciate ligament (PCL) and the posterior capsule. In 1997, Kim first reported arthroscopic surgery in the posterior compartment of the knee through two posterior portals created after perforating the posterior septum<sup>[10]</sup>. Since then, many authors have demonstrated their techniques for transseptal portal creation<sup>[10-12]</sup>. However, important neurovascular or tendon structures lie just posterior to the posteromedial, posterolateral, and transseptal portals. Special care must be taken to avoid injuries to those structures<sup>[13,14]</sup>. To date, arthroscopic surgeries *via* transseptal portal have been employed more frequently along with broadening indications for arthroscopic surgery for posterior lesions of the knee, including synovectomy<sup>[15]</sup>, meniscectomy<sup>[16]</sup>, repair of the posterior horn of the medial meniscus<sup>[17-20]</sup>, PCL reconstruction<sup>[21]</sup>, PCL avulsion fracture fixation<sup>[22]</sup>, loose body removal<sup>[23-26]</sup>, cystic lesion removal<sup>[27-29]</sup>, posterior capsular release<sup>[30]</sup>, repair of posterior capsular tears<sup>[31]</sup>, and synovectomy of a prosthetic knee<sup>[32]</sup>. We have also performed arthroscopic surgery *via* the transseptal portal to approach lesions located in the posterior compartment of the knee since 2006. In this paper, we present the techniques for creating posteromedial, posterolateral, and transseptal portals

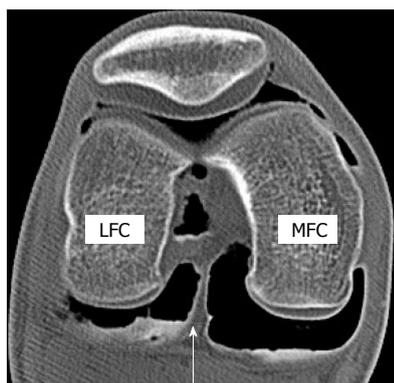
and for avoiding neurovascular injuries around the portal site reported by several authors as well as those performed at our institute.

## ANATOMY AND CLINICAL RELEVANCE

The triangular posterior septum borders the dorsal aspect of the PCL anteriorly, femoral intercondylar notch superiorly, and posterior capsule posteriorly and divides the posterior compartment into the posteromedial and posterolateral compartments<sup>[11,12]</sup> (Figure 1). The septum comprises adipose tissue surrounded by a synovial membrane that contains blood vessels and nerve endings<sup>[33]</sup>. The medial genicular artery, which originates from the popliteal artery, enters the proximal portion of the septum, which accordingly features a richer vasculature than the distal portion. Mechanoreceptors are also abundant in the proximal septum<sup>[33]</sup>. Therefore, recommendations regarding limited resection or penetration of the septum indicate that this procedure should be performed at the distal portion, just behind the PCL, rather than at the proximal or femoral side to reduce bleeding while creating the transseptal portal. Immediately behind the septum, the popliteal artery lies outside of the posterior capsule<sup>[34-36]</sup>. The popliteal artery lies approximately 10 mm laterally to the septum<sup>[15,37]</sup>. Regarding the posteromedial portal, a sartorial branch of the saphenous nerve is located immediately inferoposteriorly to the portal site (Figure 2A). The common peroneal nerve and long head of the biceps femoris are immediately posterior to the posterolateral portal site, whereas the lateral collateral ligament and popliteal tendon are immediately anterior to this site<sup>[36,38-41]</sup> (Figure 2B).

## ESTABLISHMENT OF THE TRANSSEPTAL PORTAL

In 1997, Kim first introduced an arthroscopic approach to lesions located in posterior compartment of the knee *via* the transseptal portal. According to Kim's technique, the posterior septum was perforated *via* the posteromedial portal using a blunt obturator with a sheath<sup>[10]</sup>. Ahn *et al.*<sup>[11]</sup> described a limited resection of the septum using a shaver introduced from the anteromedial portal through the intercondylar notch, which was viewed from the posteromedial portal. Louisia *et al.*<sup>[12]</sup> penetrated the septum from the medial to lateral direction using a blunt obturator, which was followed by a skin incision to create a posterolateral portal. These authors demonstrated a "back and forth" technique in which each posterior portal is used alternately for the arthroscope and other instruments placed through the transseptal portal. Kim *et al.*<sup>[15]</sup> penetrated the septum in the posterolateral to posteromedial direction to create a transseptal portal for complete synovectomy in a patient with rheumatoid arthritis.

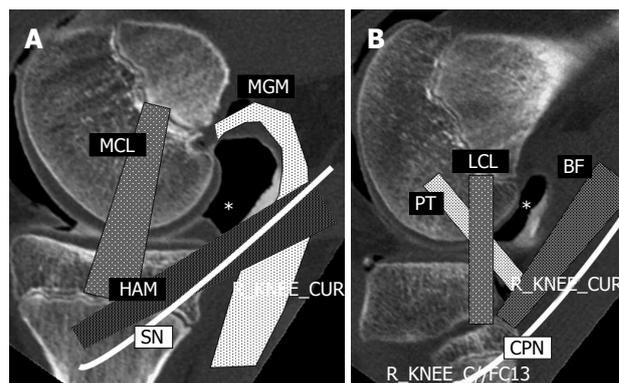


**Figure 1** Axial image of double contrast arthrography of the knee. The white arrow indicates a posterior septum that borders the posterior cruciate ligament anteriorly and posterior capsule posteriorly. Note that posteromedial compartment is larger than posterolateral compartment. LFC: Lateral femoral condyle; MFC: Medial femoral condyle.

## RISKS INVOLVING NERVES AND VESSELS

Special care should be taken to avoid popliteal neurovascular injuries during transseptal portal creation and subsequent arthroscopic surgery *via* this portal. The posterior compartment, which is enlarged upon knee flexion, is enlarged to an even greater extent during arthroscopic surgery under irrigation pressure<sup>[34]</sup>. The distances between the PCL and popliteal artery at different knee positions were measured in cadavers<sup>[34,35,38,41]</sup>. A flexion of 90 degrees resulted a greater distance (17-29 mm) between the PCL and popliteal artery than that observed at 30 degrees of flexion. As the popliteal neurovascular bundle lies laterally to the septum, posterolateral capsule injuries should be avoided during surgery<sup>[12,37]</sup>. Perforation of the septum in the posterolateral to the posteromedial direction, as described by Kim *et al.*<sup>[15]</sup>, is a safer technique. Arthroscopic procedures in the posteromedial compartment are easier than those in the posterolateral compartment because the former is 1.5 times larger and bulges a bit more posteriorly under irrigation pressure during surgery relative to the latter<sup>[15,37]</sup> (Figure 1). Fortunately, popliteal vessel injuries during arthroscopic surgery *via* the transseptal portal have not yet been reported in the literature.

Care should be taken not only to avoid popliteal vessel injury when creating the transseptal portal, but also to avoid neurovascular injury when creating the posteromedial and posterolateral portals<sup>[35-38,40,41]</sup>. Oglivie-Harris *et al.*<sup>[13]</sup> reported five complications related to the posteromedial portal that involved the saphenous nerve and vein. McGinnis *et al.*<sup>[40]</sup> reported a so-called "anatomical soft spot", which is surrounded by the posterior edge of the medial condyle of the femur, hamstrings, and medial tibial plateau, as a safe area in which to place the posteromedial portal. The posteromedial portal could be created more safely with the knee at a flexion of 90 degrees than in an extended

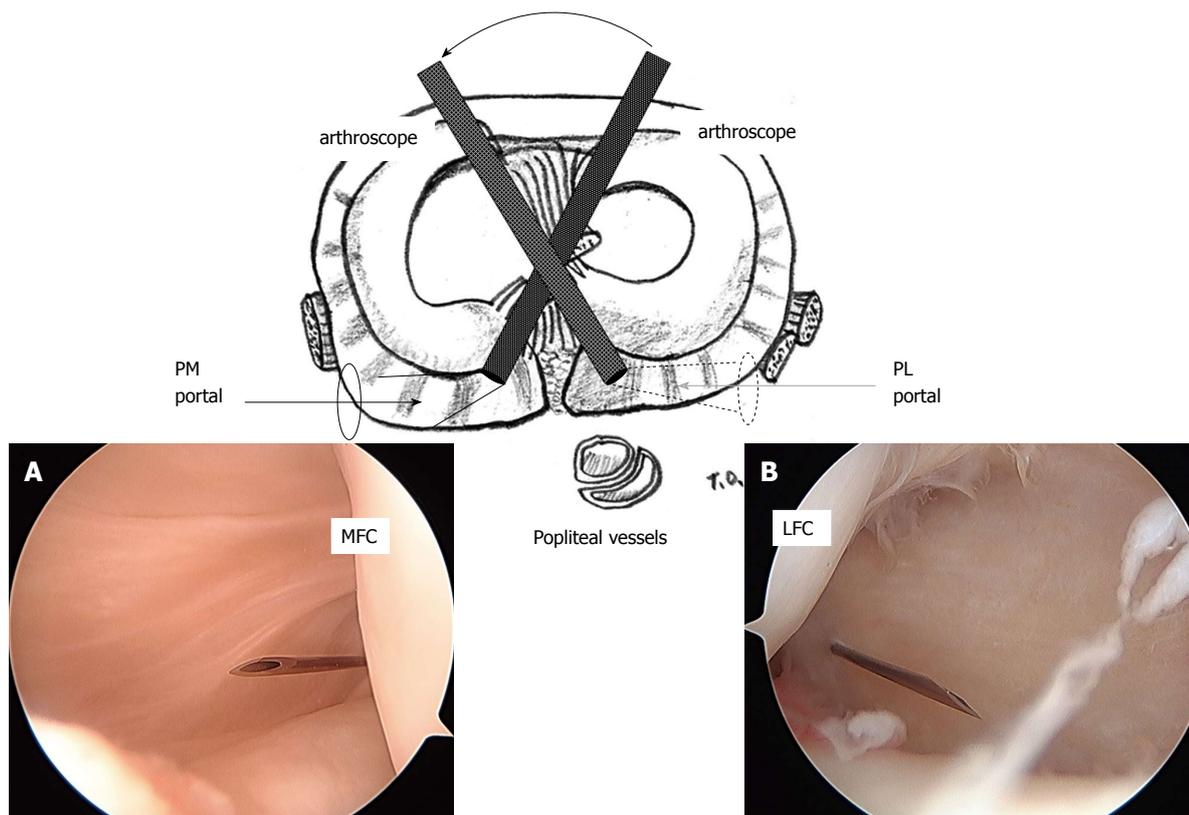


**Figure 2** Sagittal images of double contrast arthrography at the levels of the medial (A) and lateral (B) femoral condyle of the knee. Posteromedial (A) and posterolateral (B) sites are indicated by asterisks (\*). The portal site is surrounded by important structures. MCL: Medial collateral ligament; MGM: Medial head of the gastrocnemius muscle; HAM: Hamstrings; SN: Saphenous nerve; LCL: Lateral collateral ligament; PT: Popliteus tendon; BF: Biceps femoris; CPN: Common peroneal nerve.

position because the saphenous nerve and vessels move more posteriorly in the former position<sup>[36,38,41]</sup>. The mean distance between the posteromedial portal site and saphenous nerve is 22-26 mm at a 90-degree flexion<sup>[36,38,41]</sup>. The distance between the posterolateral portal site and common peroneal nerve at a 90-degree knee flexion is relatively wide: 40 mm as reported by Pace *et al.*<sup>[41]</sup>, and 25.4 mm according to Ahn *et al.*<sup>[21]</sup>. When creating a posterolateral portal, palpation of the fibular head as an identifiable landmark is recommended if the posterolateral capsule is not visible in the intercondylar posterior view<sup>[38]</sup>. However, excess knee flexion (*e.g.*, > 120°) is not acceptable because this reduces the distance between the common peroneal nerve and posterolateral portal to a greater extent<sup>[36]</sup>.

## OUR TECHNIQUE

In our method, the patient is placed under spinal or general anesthesia and the knee is flexed beyond 90 degrees on the operating table using a footrest and lateral post. As a precaution, a tourniquet is applied but not inflated. No arthropump is used. The procedure begins with the creation of the posteromedial and posterolateral portals through the anterior two portals according to the approach reported by Schreiber<sup>[9]</sup>, although our method uses a 30-degree rather than 70-degree arthroscope. The arthroscope is introduced into the posteromedial compartment through the intercondylar notch from the anterolateral portal. If osteophytes block the advance of the arthroscope through the intercondylar notch, knee extension facilitates the advance to the posteromedial compartment. A 23-gauge spinal needle is subsequently inserted just behind the posterior medial condyle and 5 mm above the tibial articular surface under guidance from a cutaneous trans-illumination arthroscopic light, as described by Schreiber<sup>[9]</sup> (Figure 3A). If a condition such as obesity prevents identification of the posterior



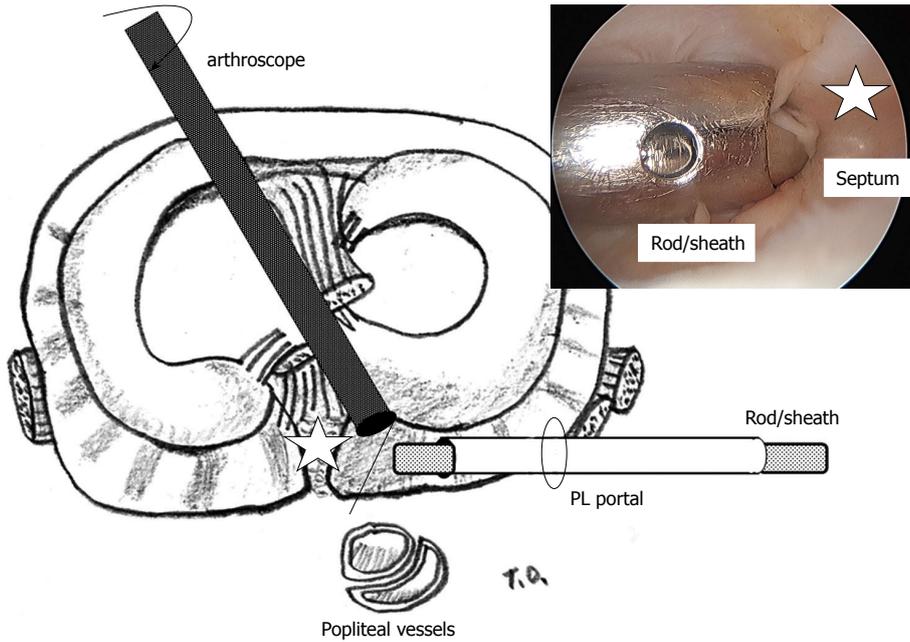
**Figure 3** Arthroscopic view of the posteromedial (A) and posterolateral (B) compartment through the intercondylar notch from the anterolateral (A) and anteromedial (B) portals. A 23-gauge spinal needle is inserted just posterior to the medial (A) and lateral (B) femoral condyle at 5 mm above the tibial articular surface. PM: Posteromedial; PL: Posterolateral; MFC: Medial femoral condyle; LFC: Lateral femoral condyle. (Permission for reproduction was obtained from Nankodo Co., Ltd.).

edge of the medial femoral condyle, a 23-gauge spinal needle is first inserted to the medial aspect of the femoral condyle first, and the needle insertion site is then moved posteriorly to identify the posterior edge of the medial femoral condyle. The cutaneous transillumination arthroscopic guide helps to avoid injuries of the saphenous nerve and adjacent vein<sup>[9]</sup>. The entry point skin and capsule are incised with a No. 11 knife just anterior to and along with the 23-gauge needle. The posteromedial portal opening is subsequently maintained with a hemostat. Next, an arthroscope is introduced into the posterolateral compartment through the intercondylar notch from the anteromedial portal. A posterolateral portal is then created in the same manner as the posteromedial portal, using a 23-gauge spinal needle to determine the posterolateral portal site (Figure 3B). Palpation of the common peroneal nerve and fibular head may help to avoid common peroneal nerve injuries. Next, a switching rod with a sheath is inserted through the posterolateral portal to the septum. The camera head of the 30-degree arthroscope is turned to the septum so the operator can confirm that the tip of the rod is attached to the septum (Figure 4). The rod is then removed while the sheath is kept in place. The sheath is pushed into the septum, and the arthroscope is inserted into the posteromedial portal. While maintaining a view of the medial side of the septum using the

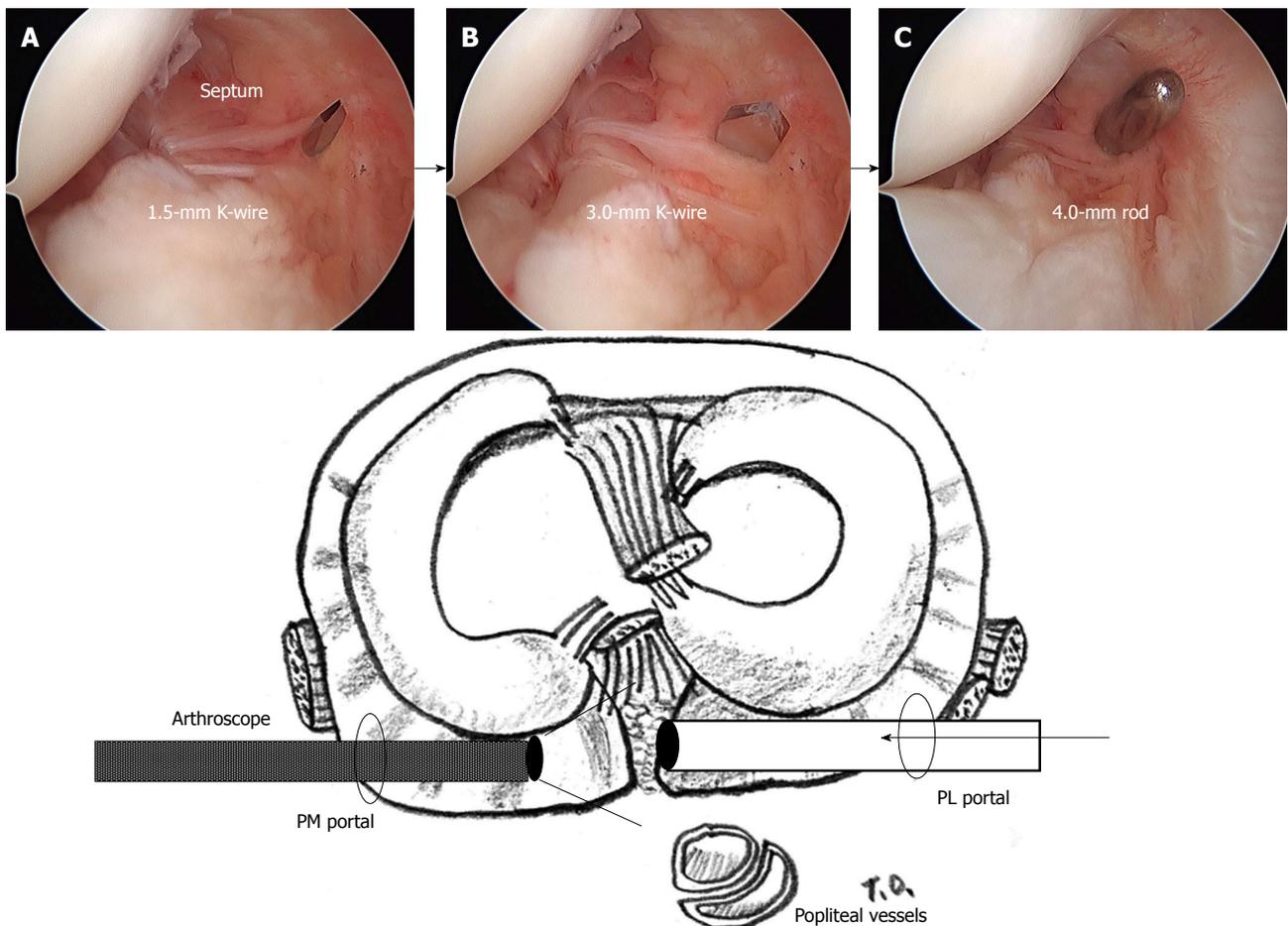
arthroscope introduced through the posteromedial portal, 1.5-mm (Figure 5A) and 3.0-mm Kirschner wires (Figure 5B) are sequentially pushed to the septum from the posterolateral portal through the sheath while in close contact with the posterior femoral condyle, after which the septum is perforated. The sheath is expected to protect the posterolateral capsule. The Kirschner wires are pushed several times into the septum to enlarge the initial hole and allow the switching rod to pass easily through the septum (Figure 5C). The switching rod is then inserted from the posterolateral portal to the posteromedial portal *via* the transseptal portal. Once the transseptal portal has been created, the arthroscope and instruments can be easily interchanged through the two posterior portals using the posterior “back and forth” approach described by Louisia *et al*<sup>[12]</sup> (Figure 6). It is not necessary to remove the septum with a motorized shaver.

### OUR EXPERIENCE OF THR TECHNIQUE

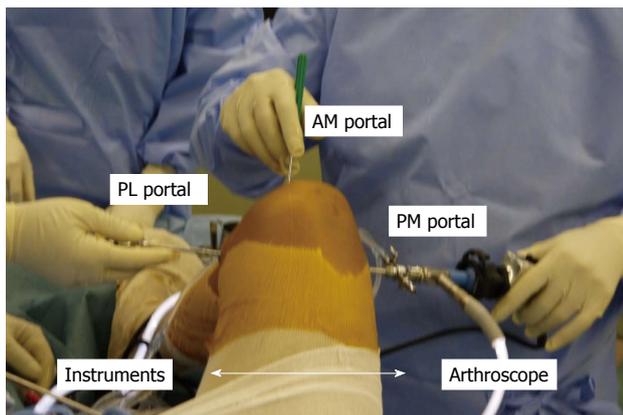
Using our procedure, we performed arthroscopic surgery for lesions in the posterior compartments of 161 knees between December 2006 and March 2015 (Figure 7). Some of these cases were reported elsewhere to demonstrate the use of the transseptal portal<sup>[42-47]</sup>. The arthroscopic procedures conducted using our



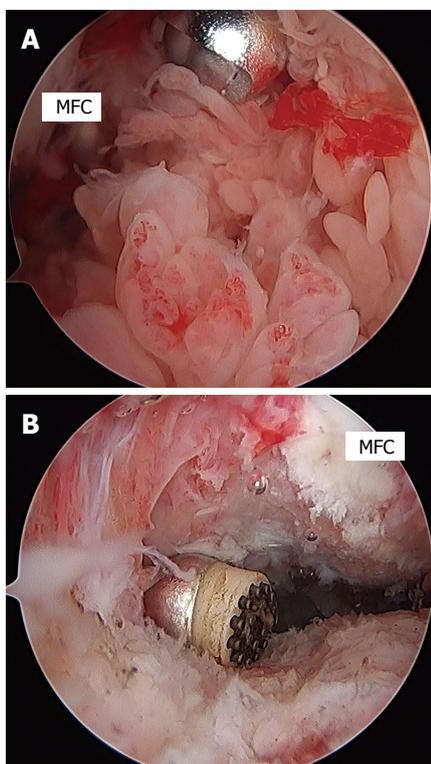
**Figure 4** Rod with a sheath is inserted from the posterolateral portal. The camera head of the 30-degree arthroscope is turned toward the septum so that the operator can confirm attachment of the tip of the rod to the septum (white star). PL: Posterolateral. (Permission for reproduction was obtained from Nankodo Co., Ltd.).



**Figure 5** Arthroscopic views from the posteromedial portal. While maintaining a view of the medial side of the septum using an arthroscope introduced through the posteromedial portal, 1.5-mm (A) and 3.0-mm Kirschner wires (B) are pushed sequentially to the septum through the sheath from the posterolateral portal, finally, a 4.0-mm switching rod is passed through the septum (C). PM: Posteromedial; PL: Posterolateral. (Permission for reproduction was obtained from Nankodo Co., Ltd.).



**Figure 6** Image taken during an operation involving the posterior transseptal portal. One of the posterior two portals is used as a viewing portal; the other is used as a working portal. Anterior portals can be also used as working portals. PM: Posteromedial; PL: Posterolateral; AM: Anteromedial.



**Figure 7** Arthroscopic views of the posterior compartment of the knee in a patient with rheumatoid arthritis. The posteromedial compartment was filled with synovial villi prior to synovectomy. A shaver is introduced from the posterolateral portal through the transseptal portal (A). An arthroscopic view from the posterolateral portal through the transseptal portal after synovectomy (B). A radiofrequency device is introduced from the posteromedial portal. MFC: Medial femoral condyle.

established transseptal portal technique are listed in Table 1. Postoperative complications were encountered in four knees (2.5%), including superficial infection of the posteromedial portal in two knees, subcutaneous hematoma in one knee, and deep infection of the posterolateral portal in one knee. Treatment for the latter case required open debridement of the affected knee. No

**Table 1** List of procedures using our transseptal portal technique

Procedure	n
Synovectomy	57
Meniscal resection	20
Thermal shrinkage	1
Resection of PCL ganglion	1
Meniscal cyst decompression	1
Popliteal cyst decompression	53
Repair of PCL avulsion fracture	5
Free body resection	5
Repair of the posterior horn of the medial meniscus	5
PCL reconstruction	2
Probing only	11

PCL: Posterior cruciate ligament.

popliteal neurovascular, peroneal nerve, or saphenous nerve injuries or postoperative deep vein thromboses occurred in any knee during these operations.

### ADVANTAGES OF OUR TECHNIQUE

We have modified the procedures reported in previous papers<sup>[10-12,15]</sup> as follows. First, the knee is flexed beyond 90 degrees on the operating table, with a footrest placed at the heel, so that the popliteal vessels move posteriorly. Flexion beyond 90° is better achieved when the lower leg is not suspended from the side of the table. Moreover, the operator can work freely when the lower leg is on the operating table, as this provides more available space for working around the knee (Figure 6). Second, we perforated the septum while protecting the posterolateral capsule with a sheath to avoid popliteal vessel injury, as a popliteal neurovascular bundle is located just lateral to the septum (Figure 4). Finally, septum perforation using only a rod or blunt obturator might be difficult and could confer the risk of posterior rod or blunt obturator slippage, as the septum is very elastic and easily stretched. It is therefore safer to perforate the septum initially with a 1.5-mm Kirschner wire to determine the proper placement, followed by a 3.0 mm Kirschner wire to enlarge the hole and subsequent switching rod placement, rather than rod placement alone (Figure 5). However, the operator should ensure that the tip of the Kirschner wire is properly positioned just behind the PCL and is not directed towards the posterior capsule. It is essential that the operators use an arthroscope introduced through the opposite portal to maintain direct visibility of the tip of the Kirschner wire or the switching rod as it passes through the perforated septum.

### CONCLUSION

An arthroscopic approach *via* a transseptal portal for posterior lesions of the knee confers several advantages upon patients and operators, including less invasive technique compared to the open surgery for access to

the back of the knee. However, the risk of neurovascular injuries should be considered. It is important for operators to understand the anatomy around the posterior three portals.

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