

# Surgical Approach to Pigmented Villonodular Synovitis and Synovial Osteochondromatosis in Pathological Expansion of the Popliteus Bursa



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**Abstract:** We orthopaedic surgeons are not familiar with the popliteus bursa. It is defined as the expansion in the synovial membrane of the posterolateral part of the knee that lies between the lateral meniscus and the tendon of the popliteus muscle. The popliteus bursa extends approximately 1 cm distal to the joint line and has 4 borders; the medial border is the peripheral margin of the lateral meniscus, the lateral border is the popliteus tendon, and the superior and inferior borders are formed by 2 fascicles. We very rarely observe cystic lesions that expand more distally, such as pigmented villonodular synovitis (PVNS) and synovial osteochondromatosis. We consider the distally expanded bursa as the pathologic expansion of the popliteus bursa. When this expansion is involved with PVNS, it may be the cause of recurrence of PVNS in the knee joint. Synovial osteochondromatosis in this expansion may cause pain in the posterolateral corner of the knee and may become a source of free bodies in the knee joint. In such conditions, these lesions should be surgically excised. The purpose of this Technical Note is to describe a surgical approach to the pathologic expansion of the popliteus bursa.

We rarely observe cystic lesions such as pigmented villonodular synovitis (PVNS) (Fig 1) and synovial osteochondromatosis (Fig 2) medial to the fibular head and between the popliteus muscle and posterior surface of the tibia. These lesions can be clearly observed on magnetic resonance images (MRI) (Figs 1A and 2B) and air arthrograms or computed tomograms (CT) after air arthrography (Figs 1, B and C and 2C). The air arthrogram indicates that these cystic lesions communicate with the knee joint cavity (Figs 1C and

2C). Accordingly, when these cystic lesions are involved with PVNS or synovial osteochondromatosis, they may cause recurrence in the knee joint<sup>1</sup> or pain in the posterolateral corner of the knee and become a source of free bodies in the knee joint, respectively. These lesions should be surgically excised in such conditions. The purpose of this Technical Note is to describe our typical surgical approach to these cystic lesions. We also discuss a mechanism for the pathogenesis of these lesions.

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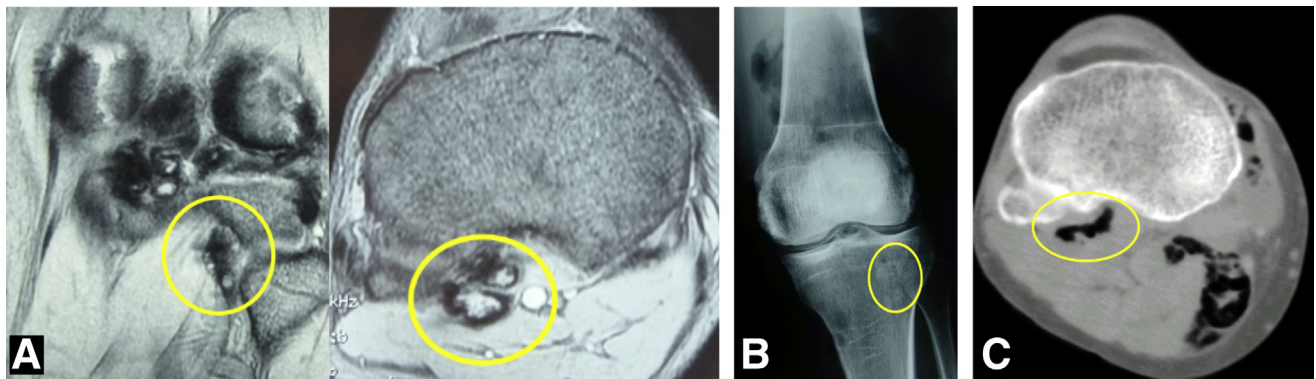
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## Surgical Technique

### Patient Positioning and Anesthesia

Epidural and general anesthesia are usually used. After the induction of general anesthesia in the supine position, a tourniquet (Portable Tourniquet System PTSII; Delfi Medical, Vancouver, British Columbia, Canada) is secured on the upper thigh. Next, the patient is placed in a prone position on the operating table, and the leg is then prepared and draped in sterile fashion. The tourniquet is inflated to approximately 250 mm Hg, and a sterilized soft bump is placed under the ankle joint to moderately flex the knee during the procedure.

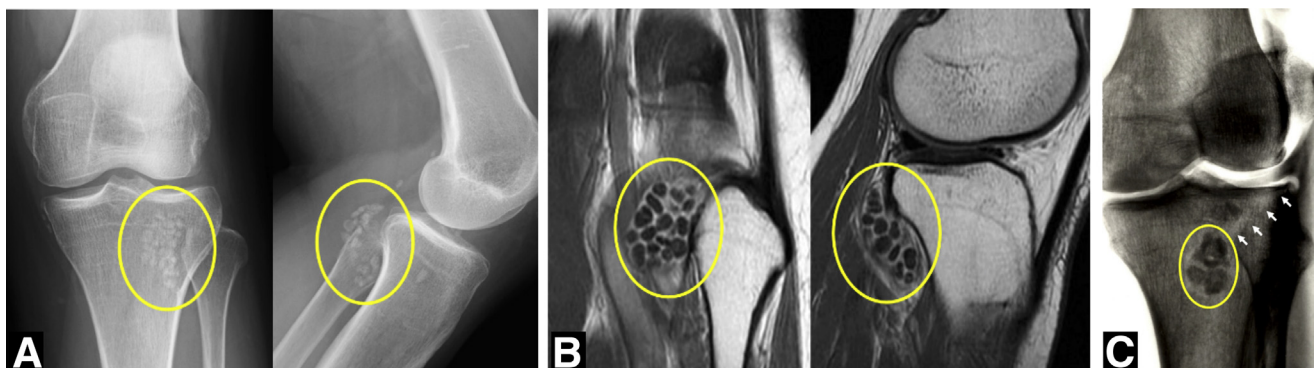


**Fig 1.** Pigmented villonodular synovitis in the cystic lesions (yellow circles) of the left leg that exist medial to the fibular head and between the popliteus muscle and the posterior surface of the tibia. Coronal (left side) and axial (right side) views of magnetic resonance images (A), air arthrogram (B), and computed tomography scan after air arthrography (C) are shown.

### Surgical Technique

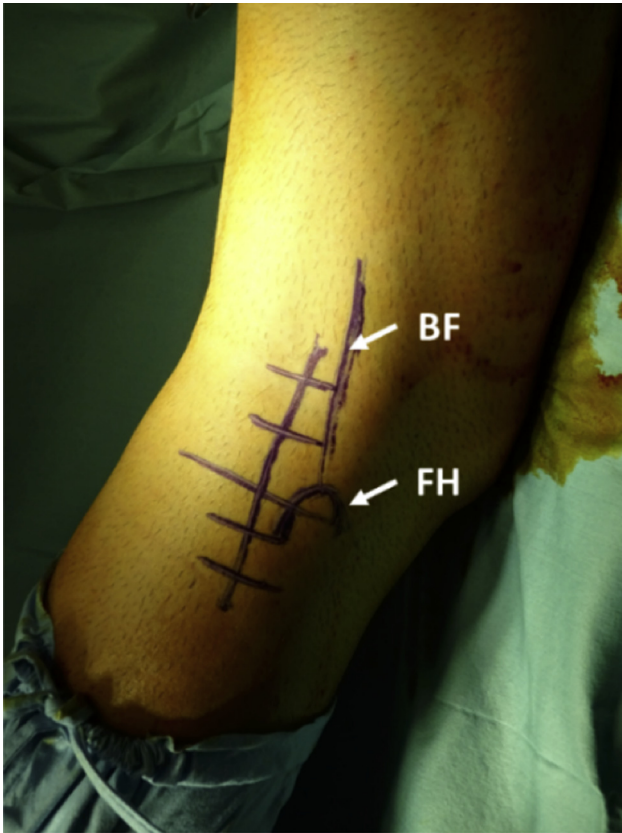
Herein, we present a case of PVNS of the right knee. The biceps femoris tendon and the fibular head are useful anatomic references for the skin incision. The skin incision begins 4 to 5 cm proximal to the fibular head at the medial border of the biceps femoris tendon and continues distally 4 to 5 cm distal to the fibular head. Because the lesion is usually located just medial to the fibular head, the center of the incision is set at the medial side of the fibular head (Fig 3). After the skin and subcutaneous fatty tissue are retracted, the deep fascia is then incised just medial to the biceps femoris tendon to identify the peroneal nerve, which runs downward along the medial border of the biceps femoris tendon. The peroneal nerve should be distally traced to the fibular neck. The peroneal nerve is mobilized from the surrounding soft tissue and protected using a rubber tape (SURG-I-LOOP; Scanlan International, Saint Paul, MN). After blunt dissection is performed between the peroneal nerve and the lateral head of the gastrocnemius muscle, the latter is medially retracted using muscle retractors (Langenbeck Retractor; Mizuho, Tokyo, Japan) to expose the soleus

muscle which originates from the fibular head (Fig 4). This retraction prevents the popliteal neurovascular structures from injury. When the lateral gastrocnemius bursa (the bursa around the femoral origin of the lateral head of the gastrocnemius muscle)<sup>2</sup> is involved in PVNS cases, blunt dissection between the peroneal nerve and the lateral head of the gastrocnemius muscle should be proximally extended to approach this bursa. This approach becomes easier by moderately flexing the knee and relaxing the lateral head. Next, retract the lateral head more medially to better expose the popliteus muscle on the medial side of the soleus muscle. Moderately flexing the knee and relaxing the lateral head also make the retraction of the lateral head easier. Because the cystic lesion is usually palpated beneath the popliteus muscle belly, it can be exposed by blunt dissection of the muscle belly along its fibers. It is not difficult to detect the lesion because it is usually well capsulized. In the present case of PVNS, the lesion had already appeared from the lateral margin of the popliteus muscle (Fig 5). Before excising the lesion, it is recommended to detect and ligate the communication path to the popliteus bursa with 2 nonabsorbable



**Fig 2.** Synovial osteochondromatosis (yellow circles) of the left leg. Plain radiograms (A), coronal (left side) and sagittal (right side) views of magnetic resonance images (B), and air arthrogram (C) are shown. The air arthrogram shows that this synovial osteochondromatosis lesion communicates with the knee joint cavity via the popliteus bursa (white arrows).





**Fig 3.** (Right leg) A straight skin incision is made from the medial border of the biceps femoris tendon to the medial side of the fibular head. (BF, biceps femoris muscle; FH, fibular head.)

sutures. On completion of the procedure, closure of only the deep fascia, subcutaneous fatty tissue, and skin is required.

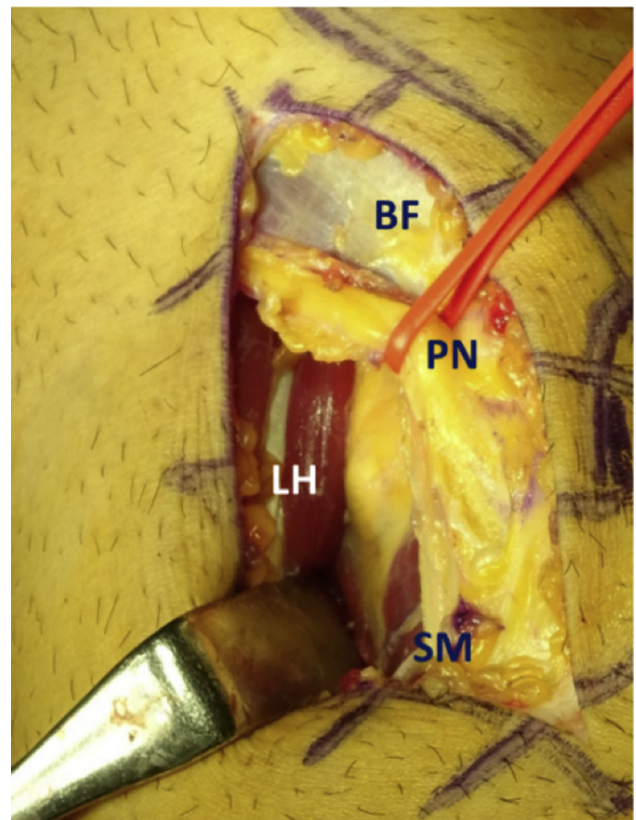
### Discussion

The above-described approach is indicated for cystic lesions such as PVNS and synovial osteochondromatosis beneath the popliteus muscle and medial to the fibular head. To our knowledge, there have been no descriptions of a surgical approach for treating these extremely rare lesions. This Technical Note aims to provide useful information to orthopaedic surgeons to treat these cystic lesions.

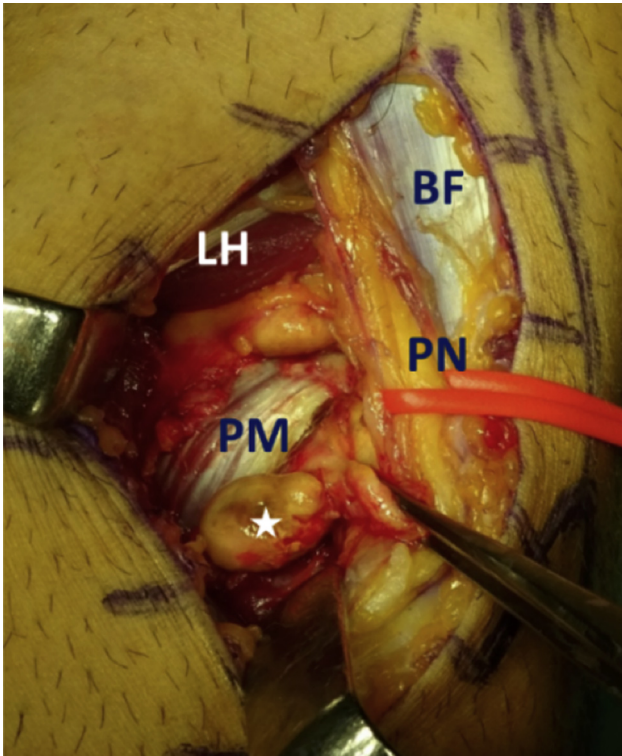
We summarize the risks and limitations of this technique and how to address them in [Table 1](#). First, injury to the popliteal neurovascular structures should be avoided. It is mandatory to retract the lateral head of the gastrocnemius muscle medially together with the neurovascular structures to help expose the soleus muscle and avoid this injury. Second, injury to the anterior tibial artery is a possible iatrogenic complication of this approach. Excessive distal exploration is unnecessary because these cystic lesions are located beneath the popliteus muscle and just medial to the

fibular head; the anterior tibial artery usually branches from the popliteal artery a few centimeters distal to the fibular head and runs laterally beneath the soleus muscle. Last, when the lateral gastrocnemius bursa is involved in PVNS cases, proximal extension of the blunt dissection between the peroneal nerve and the lateral head of the gastrocnemius muscle is required.

Next, pearls and pitfalls are described in [Table 2](#). For avoiding damage to the peroneal nerve during this procedure, the peroneal nerve should be distally traced to the fibular neck and protected in the early stages of this procedure. Because the gastrocnemius muscle becomes tense in the knee-extended position, a moderate knee-flexed position is preferred when retracting the lateral head of the gastrocnemius muscle medially to sufficiently expose the popliteus muscle. When the lateral gastrocnemius bursa is involved in PVNS cases, tracing and protecting the peroneal nerve proximally at the early stage of this procedure are also important; thus the knee-flexed position is recommended to relax the gastrocnemius muscle. Even if the cystic lesion is distally expanded, excessive distal dissection between



**Fig 4.** (Right leg) After the peroneal nerve is identified, the lateral head of the gastrocnemius muscle is retracted medially to expose the soleus muscle that originates from the fibular head. (BF, biceps femoris muscle; LH, lateral head of gastrocnemius muscle; PN, peroneal nerve; SM, soleus muscle.)



**Fig 5.** (Right leg) The popliteus muscle can be seen on the medial side of the soleus muscle. In the presented case, the lesion (white asterisk) has already appeared from the lateral margin of the popliteus muscle. (BF, biceps femoris muscle; LH, lateral head of gastrocnemius muscle; PM, popliteus muscle; PN, peroneal nerve.)

the soleus and popliteus muscle puts the anterior tibial artery at a great risk for injury. For avoiding this, it is safer to first approach the lesion just medial to the fibular head, before exposing the distal part of the lesion.

There are 2 advantages of this technique over the conventional central approach to the popliteal fossa, which carries the risk of injury to popliteal neurovascular structures. First, this cystic lesion can be approached without a chance of interacting with popliteal neurovascular structures. Second, the lateral gastrocnemius bursa can be exposed using the same approach by proximal elongation. However, there are 2

**Table 1.** Risks and Limitations of This Technique and Possible Solutions

Risks and limitations	
Injury to the popliteal neurovascular structures	
Injury to the anterior tibial artery	
Approach to the lateral gastrocnemius bursa	
Solutions	
Retracting the lateral head of the gastrocnemius muscle medially	
Avoiding excessive distal exploration	
Proximal extension of the blunt dissection between the peroneal nerve and the lateral head of the gastrocnemius muscle	

disadvantages that should be addressed. One is that it may be more difficult to expose the lesion using this procedure compared with the central approach to the popliteal fossa because sufficient medial retraction of the lateral head of the gastrocnemius muscle may be difficult especially in well-muscled patients. The other is the risk of peroneal nerve injury during exploration. Because the location of the peroneal nerve is just beneath the deep fascia and is posterior to the biceps femoris tendon, the deep fascia should be carefully incised as to not touch the peroneal nerve (Table 3).

Although cystic lesions beneath the popliteus muscle and medial to the fibular head are well depicted on MRI, air arthrography is necessary to show whether they communicate with the knee joint cavity. When they do communicate with the knee joint cavity, it is possible that PVNS will invade the joint cavity, or free bodies made by osteochondromas will spread into the joint cavity from these lesions. Therefore we believe that air arthrography or computed tomography after air arthrography can provide useful preoperative information.

The pathogenesis of cystic lesions medial to the fibular head and between the popliteus muscle and the posterior surface of the tibia has not yet been clarified. Mosby's Medical Dictionary<sup>3</sup> defines the popliteus muscle as expansion in the synovial membrane of the knee which lies between the lateral meniscus and the tendon of the popliteus muscle. Cohn and Mains<sup>4</sup> stated that the capsule and synovial lining of the knee joint extend approximately 1 cm distal to the joint line, and the popliteus muscle becomes tendinous and is separated from the joint cavity by a thin layer of capsule and synovium at this distal extension of the joint cavity. They defined this region as the popliteus bursa. Pavlov and Goldman<sup>5</sup> stated that the popliteus bursa has four borders: the medial border is the peripheral margin of the lateral meniscus, the lateral border is the popliteus tendon, and the superior and inferior borders are formed by two fascicles representing the peripheral

**Table 2.** Pearls and Pitfalls of This Technique

Pearls	
To avoid the damage to the peroneal nerve, it must be traced distally to the fibular neck and protected at the early stage of this procedure.	
A moderate knee-flexed position is preferable when retracting the lateral head of the gastrocnemius muscle medially to sufficiently expose the popliteus muscle.	
To approach the lateral gastrocnemius bursa, tracing and protecting the peroneal nerve proximally at the early stage of this procedure is important. The knee-flexed position is recommended to relax the gastrocnemius muscle.	
Pitfalls	
Even if the cystic lesion expands distally, excessive distal dissection between the soleus and popliteus muscle is dangerous for injury to the anterior tibial artery.	

**Table 3.** Advantages and Disadvantages of This Technique

## Advantages

- The cystic lesion can be approached without any chance of meeting the popliteal neurovascular structures.
- The lateral gastrocnemius bursa can be exposed using the same approach.

## Disadvantages

- Sufficiently retracting the lateral head of the gastrocnemius muscle medially may be difficult, especially in well-muscled patients.
- There is a risk of peroneal nerve injury during exploration.

attachments of the lateral meniscus. Incidentally, the name of the subpopliteal recess is synonymous with that of the popliteus bursa. Recently studies<sup>2,6,7</sup> have also described popliteus bursa or subpopliteal recess as normal bursae or recesses about the knee, arguing that the location of this bursa is between the popliteus tendon and lateral femoral condyle or the posterior horn of the lateral meniscus. The cyst that we describe here apparently differs from those described previously<sup>2-7</sup> because it extends far from the joint line. Jones<sup>8</sup> reported a chondroma removed from beneath the popliteus muscle on the posterior surface of the proximal part of the tibia. Extra-articular bodies were found within definite sacs lined with synovial membrane, and they were thus considered to likely be abnormally placed bursae. As shown on an air arthrogram, this cyst communicates with the knee joint cavity via the popliteus bursa. Chhabra and Cerniglia<sup>2</sup>

demonstrated that normal bursae can become distended from direct or repetitive trauma or as a result of local or systemic inflammatory changes. Therefore we consider that this cyst is a pathologic expansion of the popliteus bursa under certain pathologic conditions, such as PVNS or synovial osteochondromatosis.

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