



A Case Series on Arthroscopic Valvectomy of Symptomatic Popliteal Cysts in Elderly Patients Using a Modified Gillquist Maneuver

Carmelo L. Braganza, MD, FPOA, Julius Loren B. Dominado, MD, Leinard F. Palpal-Latoc, MD

Department of Orthopaedics, Veterans Memorial Medical Center, Quezon City, Philippines

ABSTRACT

The primary objective of this study was to assess the outcomes of arthroscopic management of popliteal cysts using the modified Gillquist maneuver for visualization. The original Gillquist maneuver was originally developed to gain access to the posterior knee compartment. However, there were drawbacks, including blind arthroscope insertion, which could potentially lead to unnecessary trauma to the knee and the risk of arthroscope damage. The modified Gillquist maneuver was introduced to overcome these limitations, offering the advantage of direct visualization during arthroscope insertion into the posterior compartment through either the anterolateral or anteromedial portals. This single-institution case series focused on a cohort of five patients aged over 60 diagnosed with unilateral popliteal cysts. These individuals underwent arthroscopic valvectomy using the modified Gillquist maneuver. The results of the procedure were highly encouraging, providing symptomatic relief for all five patients. Significant improvements were observed in clinical metrics, including the Numeric Rating Scale (NRS), Rauschnig and Lindgren Criteria, Lysholm Score, and Knee Range of Motion during a follow-up period of up to 24 months. These promising outcomes highlight the potential efficacy of the modified Gillquist maneuver as a viable surgical approach for managing popliteal cysts in the elderly population.

Keywords. popliteal cysts, Baker's cyst, arthroscopy, Gillquist, knee

INTRODUCTION

Popliteal cysts, more commonly known as Baker's cysts, are fluid-filled masses found at the posterior aspect of the knee. They were initially described by Adams in 1840 and further studied by Baker in 1877.^{1,2} These cysts develop due to a connection between the knee joint and a bursa located between the tendons of the gastrocnemius and semitendinosus muscle.³ In approximately 50% of individuals, there is a one-way valve formed by these tendons in the knee. This valve opens when the knee is flexed and closes during knee extension. The difference in pressure within the knee joint between partial flexion and extension allows fluid to flow into both the knee joint and the bursa.⁴ Gastrocnemius-semimembranosus bursa enlargement due to muscle contractions and joint capsule herniation into the popliteal fossa are two other factors that contribute to cyst formation.⁵ The prevalence rate of popliteal cysts varies depending on the method of diagnosis. A study that used ultrasound to identify Baker's cysts in individuals with posterior knee pain found an incidence rate of 25%.⁶ Another study that used magnetic resonance imaging (MRI) reported incidence rates ranging from 5% to 18%.⁷

The clinical presentation of Baker's cyst varies. Some patients may not experience any symptoms and may only discover the cyst incidentally during a knee examination or imaging procedures like MRI. Others may exhibit symptoms such

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Corresponding author: Leinard F. Palpal-Latoc, MD
Department of Orthopaedics
Veterans Memorial Medical Center
North Avenue, Diliman, Quezon City
E-mail: leinardp@gmail.com



as posterior knee pain, tightness, or discomfort. They might display Foucher's sign, where the mass is larger or firmer during knee extension and less so during knee flexion. Some patients might also show Homan's sign, which is calf pain upon dorsiflexion of the foot. If the cyst ruptures, patients may experience sharp pain, swelling, redness, and a sensation resembling fluid running down the calf.⁵ During a physical examination, a physician may observe a prominent, fluid-filled mass at the popliteal region. This swelling might be more pronounced when the knee is extended and less so when the knee is flexed.

Various imaging methods can help diagnose a popliteal cyst. MRI remains the preferred and most accurate method for diagnosis, as it not only confirms the presence but also distinguishes it from other conditions and identifies any additional soft tissue irregularities.⁸ On the other hand, ultrasound can serve as a more economical screening or diagnostic tool when an in-depth examination of the joint's interior is not deemed necessary.⁹

Treatment can be categorized into two main approaches: non-operative and operative management. Non-operative treatments include nonsteroidal anti-inflammatory drugs (NSAIDs), activity modification and rest, physical therapy, aspiration, and steroid injections. However, if the popliteal cyst persists or recurs, surgical intervention may be necessary, which can be done through either open excision or arthroscopy.⁴

Open excision of the popliteal cyst has been associated with a high rate of recurrence, emphasizing the need to address underlying intra-articular issues. A meta-analysis conducted by Han et al. found that arthroscopic treatment of popliteal cysts, both with and without cyst removal, yielded relatively better outcomes with low recurrence rates. Interestingly, the study also found that although arthroscopic treatment with cystectomy led to a lower recurrence rate, it was associated with a higher rate of complications compared to the group that did not have cyst removal.¹⁰

Rauschnig in 1980 first described using the criteria to describe the knee symptoms of patients with popliteal cysts.¹¹ In 1982, Lysholm developed a scoring scale that monitored functional outcomes of patients who underwent a form of knee ligament surgery.¹² These scores have been used to evaluate outcomes in patients with symptomatic popliteal cysts who underwent arthroscopic cystectomy and valve excision.¹³ Malinowski et al., concluded that there was an improvement in the postoperative Rauschnig and Lindgren Criteria and Lysholm in patients who underwent arthroscopic cystectomy and valve excision of the symptomatic popliteal cyst.

In 1979, Gilquist et al., proposed a transpatellar tendon portal as an alternative to Johnson's posteromedial portal. This transpatellar tendon portal enables the surgeon to assess the posteromedial ligaments and eliminates the need for a secondary portal, unlike the posteromedial portal.¹⁴

The modified Gilquist maneuver involves using either the anterolateral or the anteromedial portal for arthroscope insertion. Lee et al. summarized the sequence of the modified Gilquist maneuver in six steps in 2019.¹⁵

The first step involves placing the knee in 90 degrees of flexion and positioning the arthroscope in the anteromedial portal to visualize the intercondylar notch. In the second step, the switching stick is inserted through the anterolateral portal between the lateral border of the medial femoral condyle and the medial border of the posterior cruciate ligament. It is advanced until the switching stick enters the posteromedial compartment, ensuring direct visualization to minimize the risk of iatrogenic injury. For the third step, the camera and trocar are removed from the anteromedial portal and separated. In the fourth step, the trocar sleeve is reintroduced over the switching stick in the anterolateral portal, serving as a guide to the posteromedial compartment. In the fifth step, the switching stick is withdrawn from the trocar sleeve. In the sixth step, the camera is reinserted through the trocar sleeve in the anterolateral portal to visualize the posteromedial compartment.

This modification minimizes trauma to the surrounding structures within the knee joint and provides the benefit of direct visualization of the instrument in the posteromedial compartment.¹⁵

SURGICAL TECHNIQUE

Under regional or epidural anesthesia, the patient was positioned supine with the affected lower limb flexed at the knee to a 90-degree angle (Figure 1). The surgeon and the assistant were positioned on the side of the affected extremity. The arthroscopy towers were placed on the opposite side of the surgeon. The scrub nurse, scrub trolley, and graft preparation trolley were positioned at the end of the operating table (Figure 2). The procedure involves utilizing three portals: the anteromedial, the anterolateral, and the posteromedial.



Figure 1. Position of the patient on the operating table.

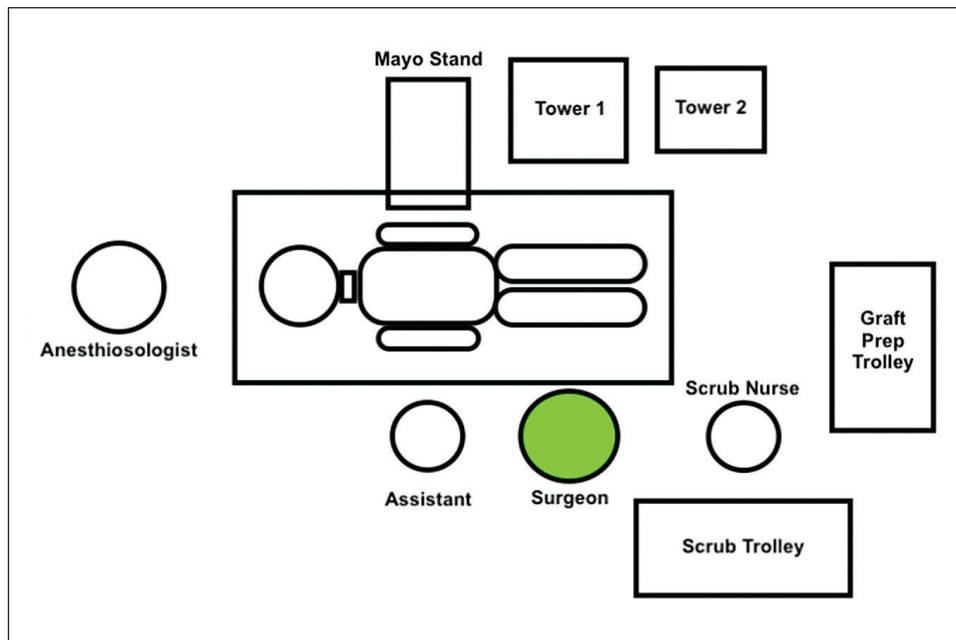


Figure 2. Operating room set-up.

To create the anterolateral portal, transverse incisions were made in the skin approximately 1 cm lateral to the lateral margin of the patellar tendon and 1 cm superior to the joint line. For the anteromedial portal, incisions were made at or 1 cm medial to the medial margin of the patellar tendon and 1 cm superior to the joint line. A 30-degree arthroscope was employed for the procedure, with a 70-degree arthroscope prepared as an alternative if necessary.

Initially, diagnostic arthroscopy was conducted through the standard anterolateral and anteromedial portals. Subsequently, the posterior compartment of the knee was visualized using the modified Gillquist maneuver.

To minimize potential harm to surrounding structures and to facilitate the precise placement of the camera for direct visualization of the posteromedial compartment, a modified Gillquist maneuver was employed. This maneuver involved flexing the knee to a 90-degree angle and introducing the arthroscope through the anterolateral portal to view the intercondylar notch.

Once the region was cleared of soft tissue, a switching stick was inserted through the anteromedial portal, between the lateral edge of the medial femoral condyle and the inner edge of the posterior cruciate ligament (PCL), and advanced to the posteromedial compartment. The posteromedial compartment was identified by the posterior transverse synovial infold (PoTSI), a transverse infold overlying the medial head of the gastrocnemius (Figure 3).¹⁶ Subsequently, the camera and trocar were withdrawn through the anterolateral portal, and a cannula was threaded over the switching stick located at the anteromedial portal. The camera was then inserted into the anteromedial portal, enabling further examination of the posterior compartment.

The posteromedial portal was established by locating a specific soft region between the medial collateral ligament, the medial head of the gastrocnemius muscle, and the tendon of the semimembranosus defined by Lanham et al., as 2.5 cm inferior and 2.5 cm posterior to the medial femoral epicondyle, with the knee in 90 degrees of flexion.¹⁷ An 18-gauge needle was carefully positioned at this identified soft spot and was visualized intraoperatively (Figure 4). A longitudinal incision was made in the direction of the previously placed cannula, and the portal was created while being directly guided by transillumination.

A blunt trocar was then introduced into the posteromedial portal. The capsular fold and the valve-like connection between the cyst and the knee joint were identified. Once the capsular fold was pinpointed, an obturator was inserted to open the valve, and valvulectomy was done with a shaver. The successful completion of the valvulectomy was confirmed by observing a release of light-yellow fluid from the cyst noted to be oily and thick, as well as the visualization of the medial head of the gastrocnemius through the anterolateral portal (Figure 5). This transformed the previously one-way valve into a two-way valve. Any intra-articular issues were subsequently managed following established protocols.

CASES

Patient A was an 83-year-old woman complaining of chronic intermittent posterior knee pain at the posterior aspect of her right knee for three years with a progressively enlarging posterior knee fluctuant mass that is prominent upon knee extension. We noted a palpable posterior knee mass, with a positive Foucher's sign and a negative Homan's sign. Ultrasound revealed a popliteal cyst, and radiographs confirmed the presence of concurrent knee osteoarthritis

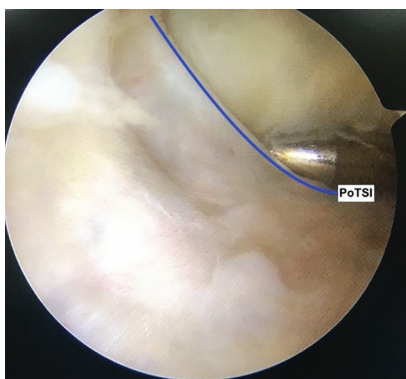


Figure 3. Intraoperative visualization of the placement of the trocar along the Posterior Transverse Synovial Infold (PoTSI).



Figure 4. Intraoperative visualization of an 18-gauge needle within the posteromedial compartment of the knee.



Figure 5. Intraoperative visualization of the egress of the light-yellow fluid from the cyst.

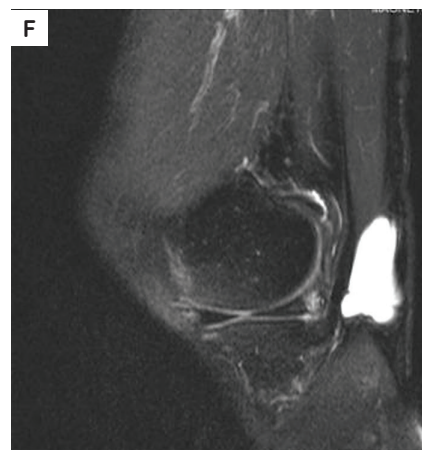
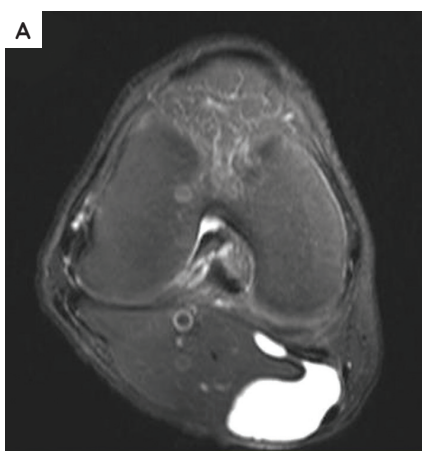


Figure 6. 68-year-old male presenting with posterior knee pain and popliteal mass on the left knee. T2 weighted magnetic resonance images (MRI) cross section presenting a popliteal mass at the posteromedial aspect of left knee (A-B), T1 weighted MRI cross section presenting a popliteal mass at the posteromedial aspect of left knee (C). T2 weighted MRI sagittal section presenting a popliteal mass (D-F).

(Kellgren and Lawrence III). Initially, the patient was recommended non-surgical management, including NSAIDs and physical therapy. However, as time passed, the patient experienced worsening knee pain, leading to a gradual restriction in daily activities, particularly those involving knee movement and flexion. Eventually, the pain became so severe that the patient was unable to perform basic household

tasks for an extended period. At the initial consultation, the patient rated their pain on the Numeric Rating Scale as 7 out of 10, and their condition was classified as Grade 2 according to the Rauschnig and Lindgren Criteria. Subsequently, the patient was advised to undergo arthroscopic debridement, synovectomy, and valvulectomy to address the popliteal cyst in their right knee. After the procedure, the patient was

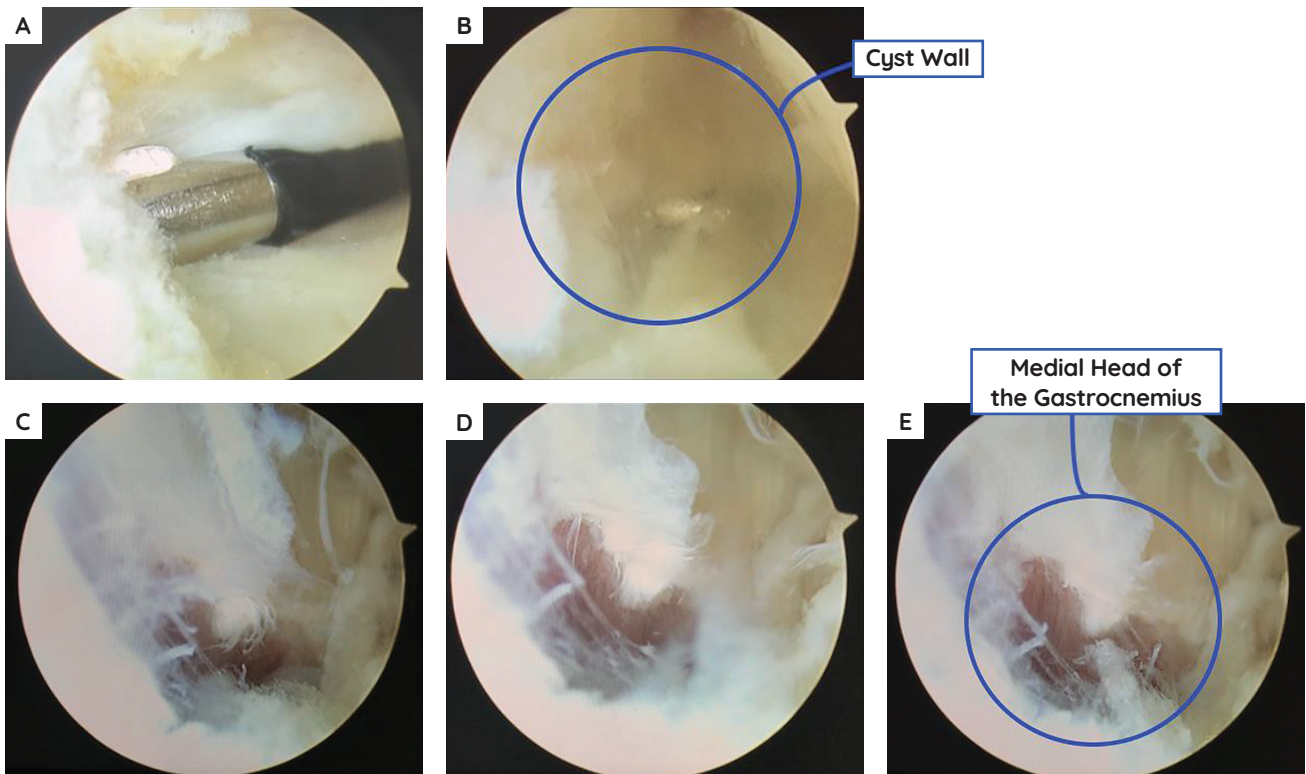


Figure 7. View from anteromedial portal. Insertion of shaver from the posteromedial portal from the posteromedial compartment towards the knee joint (A); Egress of light yellow fluid from the popliteal cyst towards the knee joint upon initiation of valvectomy (B); Enlargement of the communication between the posteromedial compartment and knee joint (C-E); Visualization of the gastrocnemius from the anteromedial viewing portal.

instructed to start bearing weight on the knee immediately on the first day postoperatively. They were also prescribed a regimen of progressive knee range of motion exercises and exercises to activate and strengthen the quadriceps muscles and their outcomes were subsequently monitored (Table 1).

Patient B was a 63-year-old man who came in for a 4-year history of a palpable mass at the posterior aspect of the right knee accompanied by posterior knee pain upon knee flexion of more than 90 degrees. The mass was full on knee extension and soft on flexion. The patient had a positive Foucher's sign and a negative Homan's sign. An MRI revealed a popliteal cyst and chondromalacia patellae in the right knee. Initially, the patient was advised to undergo physical therapy and take NSAIDs to relieve the pain. Over time, there was a gradual increase in the size of the palpable mass, accompanied by occasional pain even when at rest. During the most painful episodes, the patient reported a pain level of 8 out of 10 on the NRS. This discomfort eventually led to the patient being unable to perform their job. Subsequently, the patient underwent arthroscopic debridement, valvectomy of the popliteal cyst, and chondroplasty of the patella in the right knee. Starting on the first day after the operation, the patient was advised to bear weight on the knee immediately and begin a series of progressive range of motion exercises and the postoperative outcomes were monitored during the follow up period (Table 1).

Patient C was a 68-year-old man complaining of a 2-year history of posterior right knee pain and limitation of knee flexion beyond 90 degrees due to a popliteal mass accompanied by dull pain during flexion. The patient had a negative Homan's sign and a positive Foucher's sign. An MRI revealed the existence of a popliteal cyst in the right knee and chondromalacia in the patellofemoral region (Figure 6). Initially, the patient was recommended to undergo physical therapy and prescribed NSAIDs as a form of treatment. Despite diligently following the physical therapy regimen, the patient experienced a gradual increase in pain, eventually reaching a pain level of 8 out of 10 on the NRS, accompanied by limitations in their daily activities. Subsequently, the patient underwent arthroscopic debridement, chondroplasty of the patella, and valvectomy of the popliteal cyst in the right knee (Figure 7).

Patient D was a 61-year-old man complaining of a 10-year history of posterior right knee mass with no limitation in range of motion until two months before surgery. He had a positive Foucher's sign and a negative Homan's sign. An MRI revealed a popliteal cyst measuring 7.2 x 2.4 x 4.1 cm in size. The presence of this cyst resulted in restricted knee flexion, preventing the patient from bending their knee beyond 90 degrees. Additionally, the patient experienced pain, which reached a level of 6 out of 10 on the NRS, significantly impeding their ability to walk. Consequently, the patient underwent arthroscopic valvectomy to remove the popliteal cyst from their right knee.

Table 1. Demographics

Outcome		Pre-operative	3 months	6 months	9 months	12 months	24 months
Numeric Rating Scale (NRS)	A	7/10	3/10	2/10	2/10	2/10 (intermittent)	2/10 (intermittent)
	B	8/10	2/10	2/10	1/10 (intermittent)	1/10 (intermittent)	1/10 (intermittent)
	C	8/10	2/10	2/10	1/10	n/a	n/a
	D	6/10	3/10	2/10	n/a	n/a	n/a
	E	6/10	2/10	2/10	n/a	n/a	n/a
Rauschnig and Lindgren criteria	A	Grade II	Grade 0	Grade 0	Grade 0	Grade 0	Grade 0
	B	Grade III	Grade 0	Grade 0	Grade 0	Grade 0	Grade 0
	C	Grade III	Grade I	Grade I	Grade 0	n/a	n/a
	D	Grade III	Grade I	Grade I	n/a	n/a	n/a
	E	Grade II	Grade I	Grade 0	n/a	n/a	n/a
Lysholm score	A	35	68	74	68	82	82
	B	38	84	88	88	92	92
	C	37	82	84	82	n/a	n/a
	D	34	81	82	n/a	n/a	n/a
	E	38	82	82	n/a	n/a	n/a
Knee range of motion	A	Active: 5°-100° Passive: 5°-110°	Active: 5°-110° Passive: 5°-120°	Active: 5°-110° Passive: 5°-120°	Active: 5°-115° Passive: 5°-120°	Active: 5°-115° Passive: 5°-120°	Active: 5°-115° Passive: 5°-120°
	B	Active: 5°-90° Passive: 0°-100°	Active: 5°-100° Passive: 0°-110°	Active: 5°-105° Passive: 0°-115°	Active: 5°-110° Passive: 0°-120°	Active: 5°-110° Passive: 0°-120°	Active: 5°-110° Passive: 0°-120°
	C	Active: 5°-90° Passive: 5°-100°	Active: 5°-100° Passive: 0°-110°	Active: 5°-105° Passive: 0°-110°	Active: 5°-110° Passive: 0°-115°	n/a	n/a
	D	Active: 5°-90° Passive: 0°-105°	Active: 5°-100° Passive: 0°-110°	Active: 5°-115° Passive: 0°-125°	n/a	n/a	n/a
	E	Active: 5°-110° Passive: 5°-115°	Active: 5°-115° Passive: 5°-120°	Active: 5°-120° Passive: 0°-130°	n/a	n/a	n/a

Patient E was a 63-year-old woman complaining of a 1-year history of a palpable posterior left knee mass with accompanying pain and limitation in knee flexion beyond 110 degrees. There was a palpable 6 x 4 cm mass within the popliteal region (Figure 8A). The patient had a positive Foucher’s sign and a negative Homan’s sign. An ultrasound of the posterior aspect of the left knee confirmed the presence of a popliteal cyst measuring 5.7 x 4.1 x 3.3 cm. The patient experienced discomfort, with a pain level reaching 6 out of 10 on the NRS, and the noticeable growth of the palpable popliteal mass. Consequently, the decision was made to undergo arthroscopic valvectomy to remove the popliteal cyst from the left knee. Six months postoperatively, there was no noted recurrence of the palpable posterior left knee mass (Figure 8B) and no post-operative wound healing complications (Figure 9). The patient presented with an improving knee range of motion (Figure 10).

DISCUSSION

In our series, the cases involved arthroscopic procedures to enlarge the connection between the popliteal cyst and the knee joint while simultaneously addressing intra-articular issues, all without removing the cyst wall. Although open excision of the popliteal cyst is an option for surgical treatment, some studies suggest higher rates of recurrence.^{4,11}

Literature is inconclusive regarding the optimal treatment for popliteal cysts due to a lack of high-quality evidence.

Current surgical techniques primarily focus on enlarging the communication between the cyst and the knee joint and addressing intra-articular problems. According to the same study, this procedure has a success rate of 96.7%. The study also identified the potential need for cyst wall resection which yields a slightly higher success rate.¹⁸ More extended follow-up studies are required to determine the clear advantage of cyst wall resection over procedures that do not involve cyst wall removal.

Arthroscopic management is also a viable treatment option because it is minimally invasive, associated with fewer complications, and allows for early rehabilitation.¹⁹ This approach also enables cyst decompression while simultaneously addressing knee joint issues. The main goal of the surgery is to convert the one-way valve into a two-way valve, allowing trapped fluid within the cyst to pass into the knee joint where the fluid can be reabsorbed. Surgical failures have previously been attributed to the inability to convert the unidirectional flow of fluid between the two compartments.²⁰

The patients in our series underwent valvectomy to enlarge the communication between the two compartments. The success of this procedure is determined by directly visualizing the medial gastrocnemius through the anteromedial portal and observing a release of light-yellow fluid from the cyst. A study by Ahn et al. found that a 5mm widening of the valve is sufficient to convert the unidirectional flow into a bidirectional flow.²¹

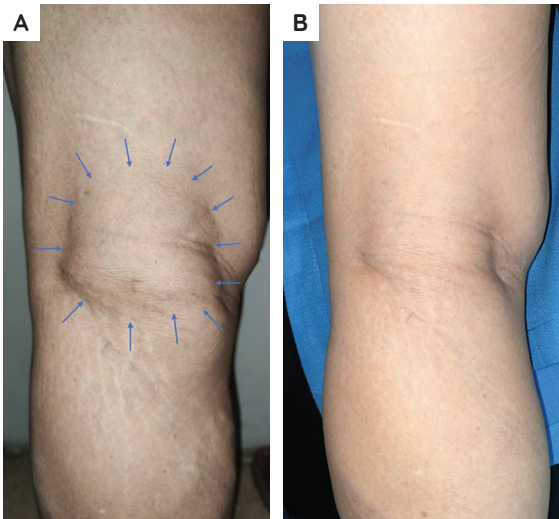


Figure 8. Examination of the popliteal region of Patient E. Preoperatively, presence of a 6 x 4 cm palpable mass on the popliteal region of the left knee (A). Postoperatively, at 6 months follow-up, there was no recurrence of the palpable mass on the popliteal region of the left knee (B).

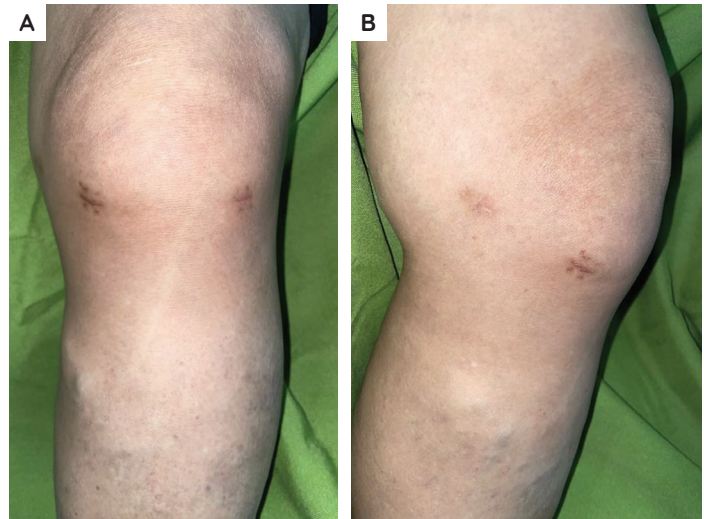


Figure 9. Postoperative examination of the postoperative site of Patient E at 6 months follow up. Postoperative anteromedial and anterolateral incision sites (A). Postoperative posteromedial incision site (B).

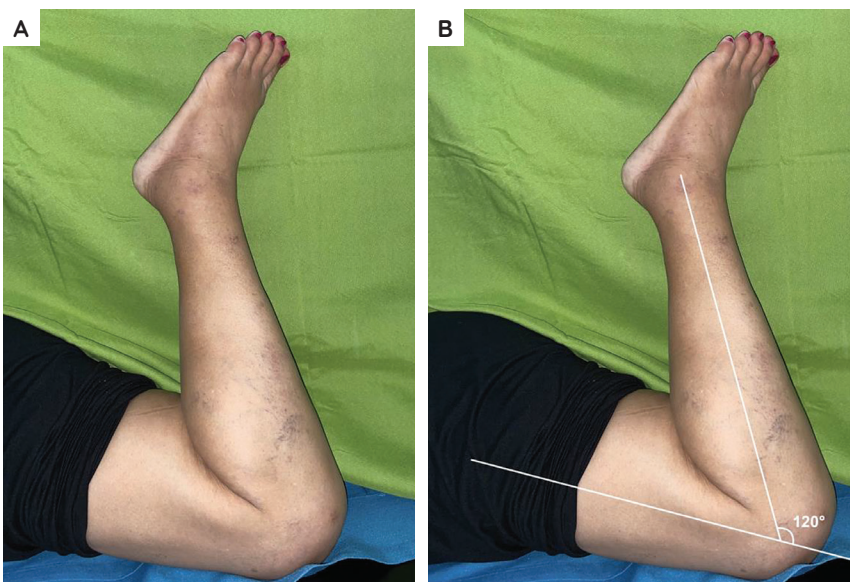


Figure 10. Postoperative examination of Patient E at 6 months follow up. Active range of motion of the left knee without the measurement (A). Improvement of the range of motion with the active knee flexion of 120° measured with a goniometer and confirmed with a digital application (B).

In our surgical approach, we incorporated a modification of the Gillquist maneuver. The original method involved creating a portal through the patellar tendon and inserting the arthroscope between the medial femoral condyle and the posterior cruciate ligament to access the posteromedial compartment. This maneuver was performed blindly and had a history of causing hardware issues, such as camera breakage, which could compromise the procedure.¹⁵

In our technique, we employ both an anterolateral and an anteromedial portal. We use a switching stick to guide the arthroscope into the posteromedial compartment, and this is done under direct visualization provided by the camera. The advantage of using a switching stick lies in the tapered design and smaller caliber compared to the trocar used for placement. This minimizes the risk of trauma as the arthroscope is

passed from the anteromedial portal to the posteromedial compartment.

Furthermore, our approach prioritizes the placement and visualization of the posteromedial compartment via the anteromedial portal. This method allows unobstructed access to the compartment and offers easier visualization using a 30-degree scope, eliminating the need to traverse any midline structures, such as the anterior cruciate ligament, as required when visualizing from the anterolateral portal.

The results from our series demonstrated favorable outcomes when evaluating patients' progress at 3, 6, 9, 12, and 24 months post-surgery (Table 2). These positive outcomes were reflected in improvements in the NRS, Lysholm score, and Rauschnig and Lindgren Criteria.

Table 2. Outcome measures (NRS, Rauschnig and Lindgren, Lysholm Score, Knee Range of Motion) of patients A to E

Patient	Age	Gender	Symptomatic duration (year)	Diagnostic modality
A	83	Female	3	Ultrasound
B	63	Male	4	Magnetic Resonance Imaging
C	68	Male	2	Magnetic Resonance Imaging
D	61	Male	10	Magnetic Resonance Imaging
E	63	Female	1	Ultrasound

The success observed in our series can be attributed to the surgical focus mentioned earlier, which primarily involves enlarging the valve to convert the valve from a unidirectional to a bidirectional one. Additionally, our series also addressed any intra-articular issues present in the patients. After surgery, the rehabilitation process centered on exercises aimed at improving the range of motion and strengthening the quadriceps. Importantly, all patients showed improvement in their Numeric Rating Scale, Rauschnig and Lindgren Criteria grade, Lysholm Score, and Knee Range of Motion.

Patient A had a slightly worse Lysholm score compared to patients B and C. This difference can be attributed to the concurrent presence of osteoarthritis in patient A, which likely influenced their pain levels and activity-related measurements within the outcome assessment.

This case series has certain limitations, including the small number of patients enrolled and the short follow-up period of between 9 and 24 months. This shorter follow-up period was a result of patients' decreased compliance with follow-up appointments, largely influenced by the disruptions caused by the COVID-19 pandemic.

Our case series could serve as a framework for a more extensive study. Such a study could specifically investigate the efficacy of utilizing the anteromedial portal for visualizing the posteromedial compartment and the benefits of employing a switching stick to minimize camera placement-related trauma.

CONCLUSION

A definitive standard treatment for popliteal cysts has yet to be established due to the absence of high-quality evidence demonstrating the clear advantages of one approach over another. However, the literature recognizes that arthroscopic management of popliteal cysts appears to be both minimally invasive and effective.

The primary objective of surgical management is to convert the unidirectional valve into a bidirectional one while simultaneously addressing any intra-articular issues, to reduce the likelihood of recurrence. In our case series, we used a modified Gillquist maneuver using a switching stick to minimize tissue trauma during the procedure. Additionally, we adopted the anteromedial portal as the primary viewing portal, providing straightforward access to the posteromedial compartment without the need to navigate obstructive midline

structures, which would be the case with an anterolateral viewing portal.

Notably, our case series yielded positive outcomes as evidenced by improvements in the Numeric Rating Scale, Rauschnig and Lindgren Criteria, Lysholm Score, and Knee Range of Motion. Although our series had a limited number of patients, this study may serve as a foundational reference point for future research endeavors focusing on this technique.

ETHICAL CONSIDERATION

Patient consent forms were obtained before manuscript submission.

STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

AUTHORS DISCLOSURE

The authors declared no conflict of interest.

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