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CURRENT CONCEPTS REVIEW

Popliteal Cyst: Etiology, Diagnosis and Management, a Current Concept Review

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Abstract

A popliteal cyst, also referred to as a Baker's cyst, is among the most common cystic lesions encountered around the knee joint in orthopedic practice, resulting from distension of the gastrocnemius–semimembranosus bursa within the popliteal fossa and is typically filled with synovial fluid. Magnetic resonance imaging (MRI) is widely used to detect and characterize these cysts. Various invasive and non-invasive therapeutic strategies have been described for the management of Baker's cysts. This review summarizes the clinical presentation, diagnostic evaluation, and current management approaches for popliteal cysts.

Level of evidence: V

Keywords: Arthroscopy, Baker's cyst, Knee, Popliteal cyst

Introduction

Popliteal cysts, commonly referred to as Baker's cysts, are frequently observed in individuals older than 50 years and are often associated with intra-articular pathologies, including osteoarthritis, meniscal tears, and rheumatologic conditions such as gout.[1-3] The development of these cysts is typically attributed to enlargement of the gastrocnemius–semimembranosus bursa, located in the medial aspect of the popliteal fossa [Figure 1][4]. An enlarged bursa may lead to pain, stiffness, or limitation of full knee flexion.[5] As symptoms often resolve spontaneously, most cases can be managed conservatively.[6] However, symptomatic cysts that are refractory to conservative management may require surgical intervention.[7]

This review provides a comprehensive overview of the epidemiology and etiology of popliteal cysts in adults, as well as their clinical manifestations, diagnostic imaging modalities, and differential diagnoses. In addition, it presents a comparative evaluation of available treatment strategies, ranging from conservative management to surgical interventions.

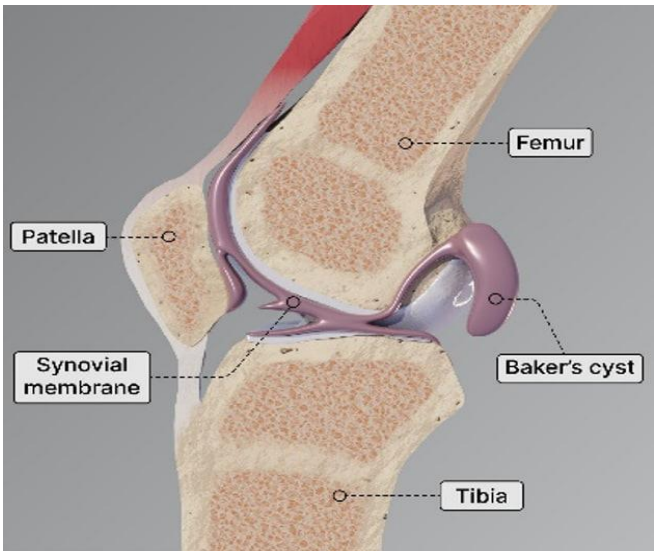

Fig. 1 Baker's cyst, appears as an expanding bursa in the popliteal fossa, usually the fluid-filled gastrocnemius-semimembranosus bursa

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Main body

Epidemiology and Etiology

Popliteal cysts were first described by Robert Adams in 1840 as an expansion of the bursa beneath the medial head of the gastrocnemius muscle, communicating with the knee joint through a valvular opening.[1] Radiological investigations in adults presenting with knee pain have demonstrated a prevalence of popliteal cysts of approximately 25.8%. However, rates as high as 40% have been reported in osteoarthritic populations. [8 9] The prevalence of popliteal cysts increases further when asymptomatic cases are included, as fewer than half of individuals with ultrasonographically confirmed cysts exhibit characteristic clinical findings on physical examination.[10]

The most common causes of popliteal cysts include osteoarthritis and rheumatoid arthritis, and less frequently, trauma, infections, and other inflammatory conditions. Several mechanisms have been proposed for the development of a popliteal cyst, including expansion of the gastrocnemius–semimembranosus bursa, which communicates with the knee joint; rupture of the posterior articular capsule with subsequent cyst formation over time; and herniation of the posterior capsule secondary to persistently elevated intra-articular pressure.[10,11] The anatomical valvular mechanism at the cyst–joint interface facilitates unidirectional flow of synovial fluid, thereby promoting fluid accumulation and contributing to cyst development. [7, 11]

Clinical Presentation

Patients with popliteal cysts typically present with nonspecific discomfort in the posterior aspect of the knee. They may report localized swelling or a palpable mass in the popliteal region, often accompanied by a sensation of tightness that may lead to a reduced range of motion of the knee joint. [4 12] Swelling may become more apparent when the patient is standing with the knee fully extended. Increased physical activity frequently exacerbates pain and swelling, further limiting joint mobility. [13] Popliteal cysts are commonly associated with intra-articular knee pathologies, such as meniscal tears and osteoarthritis. In such cases, clinical manifestations of the underlying pathology—such as joint locking—may occur concurrently with, or even overshadow, symptoms attributable specifically to the cyst.[1,14]

On physical examination, a mass is typically palpable on the medial aspect of the popliteal fossa.[15,16] Palpation is best performed with the knee in full extension, as knee flexion compresses the cyst and facilitates the return of synovial fluid into the joint space, thereby reducing the size of the cyst and making it less appreciable on examination.[17] Many patients with Baker's cysts remain asymptomatic, and clinical evaluation of the popliteal fossa may fail to detect the lesion reliably. Consequently, physical examination alone is insufficient for identifying asymptomatic cysts, and ultrasonography is a valuable adjunct that improves diagnostic accuracy.[16]

Although most patients with a popliteal mass remain asymptomatic, a minority may develop symptoms due to compression of structures within the popliteal fossa, including the popliteal vessels, which can lead to lower-limb ischemia. Several studies have reported cases of tibial nerve entrapment neuropathy secondary to popliteal cysts. In some instances, the enlarging cyst may extend posterolaterally, resulting in compression of the common peroneal nerve. [2] In rare cases, superior extension of the cyst may cause compression of the sciatic nerve. [18] Nonetheless, a subset of patients may develop persistent nerve-related symptoms that do not resolve with conservative management. [6,19-21]

Popliteal cysts are typically associated with chronic clinical presentations; however, complications such as cyst rupture, hemorrhage, compartment syndrome, or infection may render them acutely symptomatic [Table 1]. [17,22] Patients with a ruptured Baker's cyst may present with inflammation, unilateral calf swelling, and pain. [23-25] A ruptured popliteal cyst may mimic the clinical features of deep vein thrombosis (DVT) and has therefore been termed pseudo-thrombophlebitis in several studies.[2,26] In addition, cyst rupture may occasionally be associated with concurrent popliteal venous thrombosis[26]. Accurate differentiation between these conditions is essential, as coexistence of cyst rupture and deep vein thrombosis has also been reported. In patients receiving anticoagulant therapy, cyst rupture may result in significant hemorrhage and subsequent compartment syndrome. Thus, clinicians should maintain a high index of suspicion for compartment syndrome in cases of ruptured popliteal cysts, particularly in patients undergoing anticoagulant treatment. [27]

Several conditions should be considered in the differential diagnosis of a popliteal mass, some of which may be related to synovial pathology associated with popliteal cysts. [28] These include benign and malignant neoplasms, such as adipose, osseous, synovial, and hamartomatous lesions; various cystic entities, including ganglion cysts, meniscal cysts, pes anserine bursitis, and cruciate ligament cysts; and vascular conditions such as deep vein thrombosis (DVT) and popliteal artery aneurysm. Pigmented villonodular synovitis, although rare, should also be considered in the differential diagnosis. [25,29-32]

Diagnostic Imaging

Clinical diagnosis of Baker's cysts can be challenging; therefore, imaging modalities play a crucial role in the evaluation of patients with suspected lesions. Imaging techniques used in the assessment of suspected Baker's cysts include plain radiography, contrast arthrography,

ltrasonography, and magnetic resonance imaging (MRI). Contrast arthrography is an invasive procedure that exposes patients to ionizing radiation. Given that ultrasonography and MRI provide diagnostic accuracy comparable to that of arthrography, the latter is no longer routinely recommended. [33]

Table 1. Summarization of the proposed therapeutic methods based on the used articles

First Author (year)	Country	Study population/setting	Approach	limitations
Hommel (2017)	Germany	15% of Baker's cysts had resolved one year after TKA 44% remained symptomatic in those patients with a preoperatively symptomatic Baker's cyst	Total knee arthroplasty **without** direct cyst treatment	potential symptom overlaps with hamstring tightness and the absence of patellar resurfacing
Nha (2021)	Republic of Korea	none of the patients had clinical recurrence 16.7% experienced persistent pain or sensory changes, but recovered completely	Arthroscopic cystectomy and internal drainage	Small sample size Arthroscopic detection of valve lesions and wall thickness is subjective and operator-dependent Recurrence was assessed clinically
Stroiescu (2023)	Ireland	None reported a return to pre-procedural severity Two patients received no further intervention (including pain relief) The swelling returned in 3 patients; however, this was not painful A single patient found minimal relief in symptoms and proceeded to Total Knee Arthroplasty	In uncomplicated cysts, aspiration and intracystic injections	small cohort limited follow-up period no comparison group
Ohishi (2015)	Japan	popliteal cyst disappeared completely in 41.4% of subjects reduced in size in 55.2% of subjects 75.9% disappeared or were reduced to less than 10% of the volume before surgery	Arthroscopic cyst decompression	small sample size no control group
Zhang (2021)	China	The results showed that the cyst disappeared in 25 cases and shrank in 13 cases in the CWR group the cyst disappeared in 22 cases, shrunk in 12 cases, and persisted in one case in the CWP group	Cyst wall resection	small sample group limited follow-up period
Tofte (2017)	United States	In this series, the cysts resolved with revision of the TKA and did not require further treatment	Cysts following primary TKA should be observed, and if symptomatic, injection/aspiration or surgical excision.	It is possible that not all asymptomatic popliteal cysts were detected on exam. Small sample size
Bandinelli (2012)	Italy	The content of baker cyst was homogeneously anechoic in 35/40 patients; only, in 3/40 and 2/40 patients showed minimal hyperechoic elements and synovial hypertrophy	US-guided aspiration and steroid injection	Limited follow-up period
Köroğlu (2012)	Turkey	The baker cyst volumes in the simple BC subgroup (24/32) were remarkably decreased 6 (75%, 6/8) complex cysts in the complex BC subgroup (8/32) relapsed by recovering more than 50% of their volumes before the procedure	Cyst aspiration with ultrasound-guided corticosteroid injection	The study was not blinded; only one radiologist performed US, percutaneous treatment, and follow-up short follow-up period
Acebes (2005)	Spain	hypertrophy of the cyst wall in 43% cases	intra-articular Steroid injection	N/A
Gu (2019)	China	the cysts disappeared or reduced in size in all 24 cases	Arthroscopic methods, using double posteromedial portals and a figure-of-four position	no control group with an open approach The number of cases and the follow-up are also insufficient
Rupp (2002)	Germany	In 5 of the 16 patients, the popliteal cysts had disappeared Eleven cysts had persisted	arthroscopic treatment	N/A

Table 1. continued

Ko (2004)	South korea	No recurrence was found Pain was reported for longer than 72 hours in 4 cases One case developed a mild hematoma at the site of the excised cyst	A cystoscopic excisional debridement of the popliteal cyst	N/A
Pankaj (2016)	India	Six patients achieved Grade 0 status Five had a minimal limitation of range of motion accompanied by occasional pain (Grade 1). One patient had no change in clinical grading.	Arthroscopic decompression using a posteromedial portal, along with management of intra-articular pathologies	small number of patients short follow-up
Calvisi (2007)	Italy	the cyst had disappeared in 14 patients (64%) dimensionally reduced in 6 patients (27%) persisted in 2 patients (9%)	Arthroscopic treatments	the absence of a control group undergoing conservative treatment the lack of pre-operative ultrasonography scans

Radiography and Arthrography

Although plain radiographs have limited utility in detecting soft tissue abnormalities, they remain widely used because of their accessibility and low cost. [34, 35] Compared with MRI and ultrasonography, radiographs are superior in demonstrating cyst wall calcification and the presence of intra-cystic gas, whether related to infection or iatrogenic causes. [34, 35] In addition, knee radiographs are valuable for identifying underlying joint pathologies associated with cyst formation, including osteoarthritis and rheumatoid arthritis. [36]

Historically, arthrography was a commonly used technique for the diagnosis of Baker's cysts. [4] The procedure can be performed using either single-contrast (iodinated contrast medium) or double-contrast (iodinated contrast combined with air) techniques. Following intra-articular injection of contrast material, opacification of the cyst provides clear evidence of communication between the cyst and the knee joint cavity. [34] Spot radiography or fluoroscopy is subsequently used to visualize contrast medium or gas within the cyst. [1] However, the limitations of this procedure—particularly its invasive nature and the risk of contrast extravasation—have led to a shift toward less invasive imaging modalities, such as ultrasonography and MRI.[4]

Ultrasound

As an initial imaging modality for suspected Baker's cysts, traditional arthrography has largely been replaced by ultrasonography in many clinical settings30. The popliteal fossa is well suited to ultrasonographic evaluation because of its superficial location and the absence of overlying osseous structures. [34] Although ultrasonography cannot adequately assess intra-articular structures, gray-scale imaging can readily visualize popliteal cysts, including those with calf extension, and demonstrate the various morphologic patterns related to the anatomy of the gastrocnemius–semimembranosus bursa35. The cystic cavity may contain intra-articular loose bodies, which appear as hyperechoic foci with posterior acoustic shadowing. [34] Cysts detected by ultrasonography typically range from 5 mm to 4 cm, with most measuring 1–2 cm. False-negative results have been reported and are usually attributable to echogenic cyst debris, small lesion size, or cyst rupture35. Despite its low cost, noninvasiveness, rapid acquisition, and portability, ultrasonography has limited ability to detect meniscal or ligamentous injuries and does not provide comprehensive evaluation of the intra-articular components of the knee. [34,37]

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is the most reliable modality for detecting soft tissue abnormalities. It can identify potential underlying causes and differentiate popliteal cysts from parameniscal cysts. [36,38] The multiplanar imaging capability of MRI, without exposing patients to ionizing radiation, makes it a valuable tool for evaluating a wide range of knee pathologies. [39] The reported prevalence of Baker's cysts on MRI ranges from 4.7% to 19%28. In 87–98% of cases, MRI examinations of popliteal cysts demonstrate an association with one or more intra-articular lesions, such as inflammatory arthritis, meniscal tears, or degenerative joint disease. [40] On MRI, popliteal cysts typically appear as well-defined, ellipsoid structures with uniformly low signal intensity on T1-weighted images and high signal intensity on T2-weighted sequences. Axial MRI images may further demonstrate communication between the cyst and the subgastrocnemius bursa [Figure 2]. [41] High-signal-intensity fluid within the surrounding soft tissues and fascial planes may suggest leakage or rupture of a popliteal cyst. [42] The primary limitations of MRI include higher cost and limited availability compared with other imaging modalities.

Although ultrasonography is an appropriate initial modality for excluding alternative differential diagnoses, confirming the presence of a cyst, and assessing its internal

characteristics and relationship to surrounding structures, MRI remains the preferred method for comprehensive evaluation of the intra-articular components of the knee when detailed assessment is required. [34]

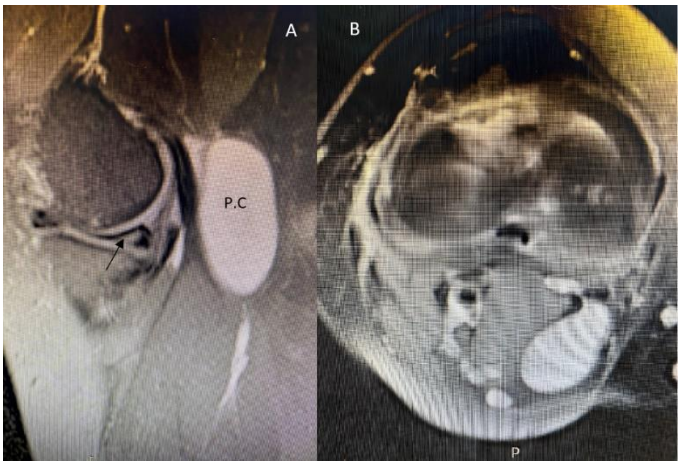

Fig. 2 (A) A sagittal magnetic resonance imaging (MRI) scan of a popliteal cyst (P.C) in T2 view, showing the posteromedial portion. The arrow indicates the meniscal tear. (B) Axial magnetic resonance imaging of a popliteal cyst.

Treatment and Outcomes

The therapeutic approach depends on the severity of symptoms [Table 1]. Treatment is generally not required for asymptomatic Baker's cysts that are incidentally diagnosed. [35] Symptomatic cysts are initially managed with non-surgical treatment for at least six weeks. However, the presence of neurovascular compression may necessitate more aggressive intervention.[1]

Baker's cysts associated with mild, chronic symptoms are typically managed conservatively with nonsteroidal anti-inflammatory drugs (NSAIDs), analgesics, and percutaneous aspiration42. Because most cysts are secondary to intra-articular structural abnormalities, degenerative changes, or inflammatory disorders, identification and treatment of the underlying pathology are essential for optimal management and may, in some cases, require surgical intervention. [34,36]

Ultrasound-guided aspiration followed by corticosteroid injection is considered an effective and safe treatment option for patients with symptomatic popliteal cysts. [35,43] Numerous studies have demonstrated the beneficial effects of intra-articular corticosteroid injections in patients with osteoarthritis, including significant pain reduction and improvement in joint function, particularly during inflammatory exacerbations. [44 45] Acebes et al. reported a substantial reduction in knee pain four weeks after ultrasound-guided cyst aspiration combined with a single corticosteroid injection in patients with osteoarthritis. They also observed a decrease in cyst wall thickness in 43% of cases, with complete resolution of the cyst in 7% of patients. [46]

The indications for surgical treatment of Baker's cysts have been relatively consistent across published reports. Earlier studies recommended surgical intervention for large, symptomatic cysts. [47] Ahn et al. proposed surgery for: (1) patients with symptomatic knee pain associated with a cyst and a concomitant intra-articular lesion; and (2) cysts larger than 5 cm that failed to decrease in size after three or more aspiration attempts. [48] Similarly, Gu et al. recommended surgery for symptomatic cysts that were unresponsive to at least six months of conservative management. [49] In the absence of standardized management guidelines, Tofte et al. suggested a practical treatment algorithm based on clinical experience: initiating with observation, progressing to ultrasound-guided aspiration and/or injection for symptomatic cases, and reserving surgical excision for patients who do not respond to these measures. [4].

Arthroscopic management is an established treatment option that allows surgeons to perform extensive debridement, excision of the valvular mechanism, synovectomy, and/or cystectomy in patients with complex or persistent Baker's cysts, particularly those with rheumatoid arthritis. [50] Historically, open excision of the cyst was frequently performed; however, it carries a higher risk of neurovascular injury, requires a longer recovery period compared with arthroscopic treatment, and is associated with an increased likelihood of postoperative complications. Moreover, recurrence may occur because the open approach addresses only the cyst itself without treating the underlying intra-articular pathology or the unidirectional valvular mechanism[42]. The presence of concomitant intra-articular lesions significantly increases the risk of recurrence if these underlying conditions remain untreated. [51] Therefore, the primary objective of arthroscopic intervention is to identify and manage the associated intra-articular pathology. [41,52,53]

There remains ongoing debate about whether complete excision of the cyst wall is necessary during surgery and the extent to which residual cyst wall tissue contributes to postoperative recurrence. [42] Kongmalai et al. described a safe arthroscopic technique for managing popliteal cysts. In their minimally invasive approach, methylene blue was injected into the cyst to identify the valvular opening, and the thickened valve was then manipulated to create free communication between the joint and the bursa without complete removal of the cyst wall. Intra-cystic debridement was also performed to reduce the risk of recurrence. [51] Pankaj et al. evaluated twelve patients with Baker's cysts treated by arthroscopic decompression while preserving the cyst wall. Favorable clinical outcomes were reported, with only one patient showing no clinical improvement over 24 months of follow-up. [54] Calvisi et al. proposed an all-

inside arthroscopic suture technique to close the communication with the bursa via anterolateral and posteromedial portals. Among 22 patients with symptomatic popliteal cysts, 96% experienced clinical improvement, and MRI demonstrated complete cyst resolution in 64% of cases. [55]

Treatment in special cases

Rheumatoid arthritis

Rheumatoid arthritis (RA) represents the second most common condition associated with popliteal cysts (20.6%), following osteoarthritis (50.6%). Management of Baker's cysts in patients with RA is generally conservative and primarily focused on medical therapy. [56] In cases of cyst rupture, ultrasound-guided aspiration of inflammatory fluid may be performed47. Given that both the formation and rupture of Baker's cysts are closely related to local inflammatory processes, adjunctive local treatment may be more effective than systemic therapy alone. [57] In selected cases of recurrent or large ("giant") Baker's cysts, surgical cystectomy combined with knee synovectomy may be required. [56,58]

Popliteal cysts after primary total knee arthroplasty

Although popliteal cysts following primary total knee arthroplasty (TKA) are relatively uncommon, they may persist and substantially impair postoperative function. Hommel et al. evaluated 102 patients undergoing TKA and reported that preoperative Baker's cyst–related symptoms were present in 71% of patients, decreasing to 31% at one-year follow-up. Complete cyst resolution was observed in 15% of cases, while the remaining cysts showed significant size reduction. In comparison, Rupp et al. reported a higher cyst-resolution rate of 31% at a mean follow-up of 2.1 years in a series of 16 patients. However, resolution in that study occurred only in knees with absent or minimal osteoarthritic changes, whereas cysts persisted in cases with more advanced degeneration. The authors further noted that intra-cystic steroid injection appears effective in patients with osteoarthritis (OA), although its role after TKA has not been investigated. They explicitly advised against open cyst excision during arthroplasty because of the reported risk of wound complications and postoperative calf swelling that may mimic deep vein thrombosis (DVT). [49]

Complications

Recent case series and systematic reviews have provided greater clarity regarding the incidence of complications and comparative risks associated with different surgical approaches. In a pooled analysis of arthroscopic treatment for popliteal cysts, patients who underwent cyst-wall resection had a recurrence rate of 0% (0/186). In contrast, the cyst-wall-preservation group had a recurrence rate of 8.0% (10/125). However, the postoperative complication rate was higher in the resection group (6.5% vs. 1.6%), including hematoma formation, portal-site infection, persistent swelling or pain, and technical debridement errors. [59] In a separate comparative study of surgical techniques, patients treated with arthroscopic internal drainage had a recurrence rate of 3.1% at one-year follow-up. In contrast, those who underwent open excision demonstrated a recurrence rate of 40.0%. [60] From a non-surgical perspective, symptomatic popliteal cysts managed conservatively or with aspiration/injection remain at risk for rupture or leakage. In a large observational cohort, reported clinical manifestations among symptomatic cases included thrombophlebitis (≈13%), knee effusion (≈32%), palpable mass or swelling (≈76%), pain (≈32%), and buckling or locking (≈11%). [61]

Given the variability in risk profiles and clinical outcomes across treatment modalities and cyst characteristics, a risk-stratified management strategy is recommended. For small, minimally symptomatic cysts without evidence of neurovascular compromise, conservative management and observation are appropriate. In contrast, large, recurrent, or symptomatic cysts—particularly those associated with intra-articular pathology—may warrant arthroscopic intervention, with or without cyst-wall resection. The decision should balance the lower recurrence risk associated with cyst-wall resection against its higher perioperative complication rate. When open excision is performed, patients should be counseled regarding the increased risk of recurrence and postoperative complications and monitored closely for evidence of recurrence or procedure-related morbidity.

Conclusion

Enlargement of the gastrocnemius–semimembranosus bursa within the popliteal fossa may result in the formation of a popliteal cyst, a common benign condition. Conservative management remains the first-line treatment. However, when the cyst is secondary to intra-articular pathology, addressing the underlying condition is essential for optimal outcomes. Arthroscopic techniques are generally considered the preferred surgical approach in appropriately selected patients. Finally, careful evaluation of differential diagnoses—particularly malignant lesions—is imperative, as such conditions may also present with popliteal fossa enlargement and require alternative management strategies

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