

POPLITEAL CYSTS

A Systematic Review of Nonoperative and Operative Treatment

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Abstract

Background: Treatment methods for popliteal cysts have varied over the past several decades and have posed challenges to providers as recurrences were frequent. With greater understanding of relevant anatomy, both operative and nonoperative treatment methods have evolved to appropriately target relevant pathology and improve outcomes. The purposes of this review were to outline the evolution of treatment methods and to qualitatively summarize clinical outcomes.

Methods: We performed a systematic review on treatments for popliteal cysts to include publications from 1970 to 2019. Other inclusion criteria consisted of studies with ≥ 10 patients enrolled, studies with a patient age of ≥ 16 years, studies with an adequate description of the treatment technique, and studies with a Level of Evidence of IV or higher. The review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, and literature quality was assessed using a modified Coleman methodology score.

Results: Thirty studies met inclusion criteria in this review. Nine studies discussed nonoperative treatment, and 21 studies discussed operative treatment. Eight of the 9 nonoperative treatment studies utilized corticosteroid injections. The most recent studies have advocated for ultrasound-guided intracystic injection with possible cyst fenestration. Most operative studies utilized an arthroscopic approach to enlarge the communication with the joint space. However, alternative treatment techniques are still utilized.

Conclusions: The current literature on the treatment of popliteal cysts indicates that intracystic corticosteroid injection with cyst fenestration is an effective nonoperative treatment method. Arthroscopic surgical procedures with enlargement of the communication have been most widely studied, with positive results; however, further studies are needed to confirm superiority over other treatment methods.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Popliteal cysts, also known as Baker cysts, result from accumulation of synovial fluid within a bursa in the posteromedial aspect of the knee. This bursa, the gastrocnemius-semimembranosus bursa, normally relieves friction between the gastrocnemius and semimembranosus

tendons. When this bursa becomes enlarged, it can result in pain, tightness, or inability to fully flex the knee joint. Popliteal cysts represent the most common cystic lesion of the knee¹. Cysts can be acute or chronic, and most arise in the setting of an additional intra-articular pathology².

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The gastrocnemius-semimembranosus bursa is unique because it communicates directly with the knee joint, resulting in the flow of synovial fluid from the intra-articular space into the bursal sac³. This feature of the gastrocnemius-semimembranosus bursa is believed to cause the formation of popliteal cysts. A series of studies investigating popliteal cyst formation and the communication between the knee joint and the bursa revealed the presence of a transverse opening in the posteromedial aspect of the joint capsule. This opening has a valve-like function that results in the unidirectional flow of synovial fluid from the joint space into the bursal sac⁴. Thus, in the setting of excess synovial fluid production from an intra-articular knee pathology, this unidirectional flow can result in distention and swelling of the bursa, forming a popliteal cyst. Although many popliteal cysts are found incidentally and are asymptomatic, large popliteal cysts can cause dysfunction and may require treatment.

The initial treatment strategies for symptomatic popliteal cysts consist of conservative management and monitoring of symptoms⁵. If symptoms do not improve, many different treatment options have been outlined in the literature, both nonoperative and operative. Nonoperative interventions consist primarily of corticosteroid injections to decrease inflammation and joint effusion, whereas operative treatments consist of addressing the underlying intra-articular pathology as well as the cyst itself via a variety of techniques. Because of the variety of management strategies, definitive treatment methods have not been established in the literature. This study will serve to provide an updated systematic review of the literature for the operative and nonoperative treatment of popliteal cysts to help to develop evidence-based guidelines for the management of popliteal cysts and to inform the selection of the proper technical approach to prevent recurrence and minimize morbidity.

Materials and Methods

We performed a systematic review of the literature on the treatment of popliteal cysts from the last 50 years. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to conduct the review⁶. PubMed, Cochrane Library, and Scopus databases were searched using the following search terms “(popliteal cyst OR baker’s cyst) AND (arthroscopic OR excision OR surgery OR non-operative OR treatment OR aspiration OR injection).” At the end of our screening process, references of selected articles were reviewed for potential studies missed in our initial search. Identified studies were loaded into the Rayyan Qatar Computing Research Institute (QCRI) online software, which removed duplicates. Studies were assigned a Level of Evidence using the grading tool from the Oxford Centre for Evidence-Based Medicine (OCEBM)⁷. Our search included studies published between the dates January 1, 1970, and April 1, 2019.

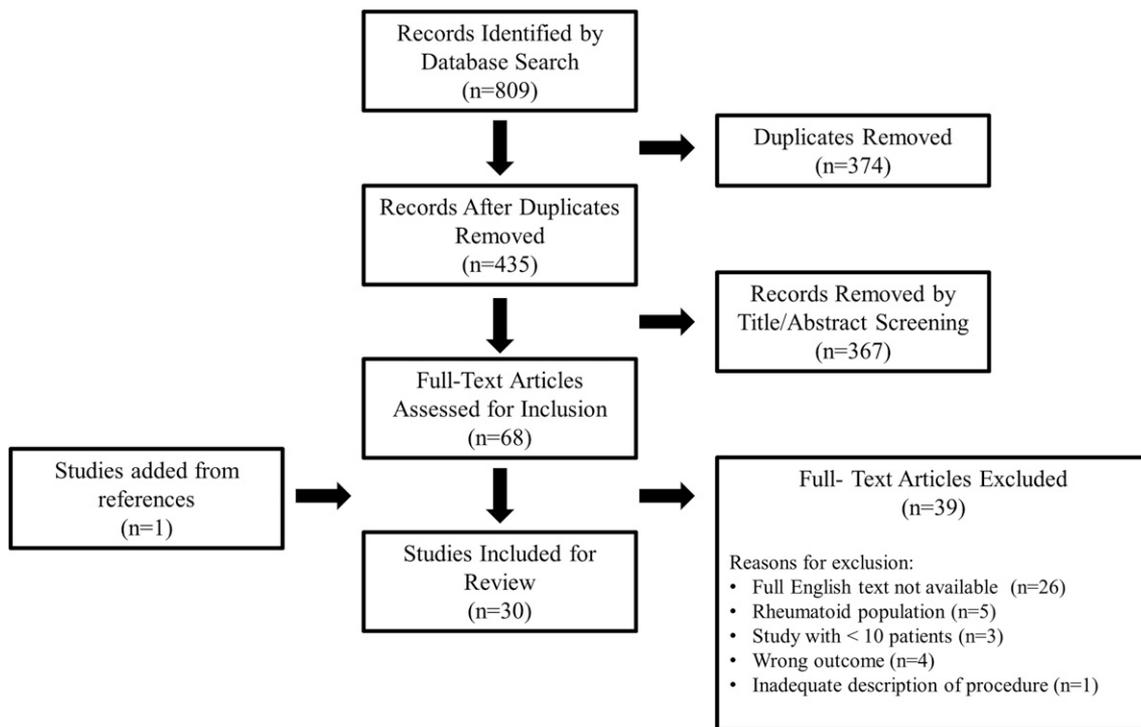


Fig. 1
PRISMA flowchart for the study data.

TABLE I Nonoperative Study Characteristics*

Study	Procedure Description	Coleman Score	No. of Knees	Age† (yr)	Follow-up† (mo)	Recurrences‡	Outcome Measures
Hautmann ¹⁸ (2019)	Radiation therapy	71	20	65	9	NA	WOMAC, NRS, Knee Society score
Cakmakci ¹³ (2017)	Aspiration and intracystic corticosteroid injection	54	26	53.2	6	NA	Ultrasound, reflux venous blood flow
Çağlayan ¹⁴ (2016)	Aspiration and intracystic corticosteroid injection	75	52	57.5	0.75	NA	RLC, WOMAC, VAS, ultrasound
Smith ¹⁶ (2015)	Aspiration, fenestration, and intracystic corticosteroid injection	64	47	55.6	20	6 (13)	WOMAC, ultrasound
Di Sante ¹⁷ (2012)	Intracystic corticosteroid injection and horizontal therapy	74	60	70.6	1	NA	WOMAC, VAS, ultrasound
Köroğlu ¹⁵ (2012)	Aspiration, fenestration, and intracystic corticosteroid injection	70	32	59	6	6 (19)	VAS, ultrasound
Bandinelli ¹² (2012)	Intra-articular compared with intracystic corticosteroid injection	73	40	62	2	NA	RLC, ultrasound
Di Sante ¹¹ (2010)	Aspiration and intracystic corticosteroid injection	69	26	69.6	1	NA	WOMAC, VAS, ultrasound
Acebes ¹⁰ (2006)	Intra-articular corticosteroid injection	65	30	68	1	NA	VAS, ultrasound

*NA = not available. †The values are given as the mean. ‡The values are given as the number of patients, with the percentage in parentheses.

Inclusion criteria were studies that had a Level of Evidence of IV or higher reporting clinical outcomes of specific treatment methods, either operative or nonoperative, for popliteal cysts; ≥ 10 patients; studies with a patient age of ≥ 16 years; and studies with an adequate description of the treatment technique provided. Studies were excluded if patients with rheumatoid arthritis were exclusively examined; if they were in non-English languages; and if they were reviews, biomechanical studies, or

technical reports. Outcomes included for qualitative analysis were functional knee outcomes, Rauschnig and Lindgren classification (RLC), pain scores, radiographic follow-up, and recurrence⁸. Quality assessment was performed using a modified version of the Coleman methodology score⁹. Each study was assigned a value between 0 and 100. Our PRISMA methodology is summarized in Figure 1.

Results

Nonoperative Management

A total of 9 studies utilized nonoperative treatments (Table I). The first study published evaluating the efficacy of corticosteroid injections was by Acebes et al. in 2006¹⁰. In this prospective study, 30 participants with osteoarthritis complicated by popliteal cysts received an intra-articular corticosteroid injection. The cyst itself was not punctured or aspirated. Clinical and sonographic parameters were recorded at baseline

and at 4 weeks after the injection. Visual analog scale (VAS) pain scores decreased from 5.8 to 4.3, range of motion improved, and cyst size decreased on ultrasound. Of the 30 patients in this study, 2 had complete resolution of the cyst. No patient experienced an increase in cyst size; however, follow-up was only limited to 4 weeks after the intervention. A subsequent study by Di Sante et al. examined intracystic injections¹¹. Following ultrasound-guided aspiration, an intracystic corticosteroid injection was administered. Twenty-six patients included in this study demonstrated a decrease in VAS pain scores from 6.2 to 4.48 at 1 week and 4.32 at 4 weeks. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) decreased from 5.54 at baseline to 4.35 at 1 week and 4.62 at 4 weeks. Cyst volume decreased substantially as well. Bandinelli et al. prospectively studied 40 patients with popliteal cysts by comparing intracystic injections with intra-articular injections¹². Following cyst aspiration, 20 patients received an intracystic corticosteroid injection and 20 patients received an intra-articular

injection. Cysts were examined via ultrasound and clinical outcomes were assessed at 2, 4, and 8 weeks after injection. Both groups showed improvement, but, at 4 and 8 weeks, the intracystic group demonstrated significantly lower RLC scores and decreased cyst volume compared with the intra-articular group. On average, the RLC improved from 2.6 to 0.25 in the intracystic injection group compared with 2.6 to 0.4 in the intra-articular group ($p < 0.05$). Two additional studies, by Cakmakci et al.¹³ and Çağlayan et al.¹⁴, showed outcomes for intracystic corticosteroid injection. Cakmakci et al. found that cyst size decreased from 22.3 mL to 4.8 mL on average at 6 months in 26 patients. In their study, Çağlayan et al. found a reduction in the RLC from 2.58 to 0.79 in 52 patients.

Köroğlu et al. prospectively analyzed the efficacy of intracystic corticosteroid injections, but additionally classified cysts as either simple or complex on ultrasound assessment¹⁵. A cyst was complex if it demonstrated septations or synovial thickening. Simple cysts were anechoic with a thin synovial

wall. This study included 32 patients, 8 of whom had complex cysts.

Ultrasound-guided aspiration was performed, and, if the cyst was complex, it was punctured from several different levels to ensure evacuation and an intracystic corticosteroid injection was performed. All 32 patients underwent 1-week, 1-month, and 6-month evaluations. At the 6-month evaluation, cyst volume decreased from 28.77 to 9.35 mL on average and VAS scores decreased from 7.9 to 3.0. However, 6 patients experienced recurrence. All 6 of these patients had complex cysts prior to treatment. A subsequent study by Smith et al. showed a similar result in 47 patients, with 6 recurrences in patients with complex cysts or advanced osteoarthritis¹⁶.

Although studies on corticosteroid injections have been the most widely reported, other nonoperative treatments have been described. Di Sante et al. outlined a randomized controlled study examining horizontal therapy with intracystic injection¹⁷. Horizontal therapy uses cutaneous electrodes around the knee to deliver stimulating

TABLE II Open Operative Management Study Characteristics*

Study	Brief Operative Description	Coleman Score	No. of Knees	Age† (yr)	Follow-up‡ (mo)	Recurrences‡	Outcome Measures
Yang ³⁵ (2017)§	Open excision	82	25	54.2	13.7	10 (40)	Incision healing, VAS, RLC, Lysholm score, MRI
Hughston ²¹ (1991)	Open excision	50	25	39.5	71.6	2 (8)	Excellent, good, fair, poor
Rauschnig ²² (1980)	Open closure	61	15	42.7	22.4	3 (20)	RLC, arthrography
Rauschnig ⁸ (1979)	Open excision	51	41	46.8	48	21 (51.2)	Incision healing, RLC, arthrography
Vahvanen ²⁰ (1973)	Open excision	57	42	48	36	6 (14.3)	Recurrence, radiography, arthrography
Childress ¹⁹ (1970)	Open excision	43	22	NA	NA	0	Recurrence, pain

*NA = not available. †The values are given as the mean. ‡The values are given as the number of patients, with the percentage in parentheses. §This is a comparative study comparing open and arthroscopic excisions.

frequencies. Patients received ten 30-minute treatments over a 2-week period following corticosteroid injection. In 60 patients, horizontal therapy with corticosteroid injection yielded lower pain scores than corticosteroid injection alone at 4 weeks after the intervention. Another study by Hautmann et al. outlined the effect of photon radiation therapy for popliteal cysts¹⁸. In the 20 patients in the study, the numeric rating scale (NRS) pain scores decreased from 6.5 to 3.0 at 6 weeks and 2.0 at 9 months. A complete response, defined by a popliteal cyst with <1 mL of fluid on ultrasound, was observed in 43% of patients at the long-term follow-up.

Operative Management

Open Operative Management

A total of 6 of the 21 operative management studies utilized an open operative technique (Table II). Childress documented the results of 22 patients undergoing open excision¹⁹. An S-shaped incision was used followed by blunt dissection and excision of the cyst. The opening to the joint was then sutured and scarified, and the medial aspect of the gastrocnemius was sutured to the posterior capsule. The semimembranosus tendon was plicated over the medial aspect of the gastrocnemius. There were no reports of recurrent cysts, pain, or limited motion despite the alteration of the gastrocnemius muscle. It is unclear if underlying intra-articular pathologies were addressed in this cohort. Vahvanen investigated 42 patients treated with open excision²⁰. In this series, the cyst was excised and the communication with the joint space was closed with suture. For large cysts, gastrocnemius-semimembranosus fascia was used to reinforce the closure. In 10 patients, a synovectomy was performed. In total, there were 6 recurrences, all in patients without a synovectomy. All patients with recurrences showed signs of osteoarthritis.

Rauschnig and Lindgren documented the results of open excision of 41 popliteal cysts⁸. Twenty-nine cysts had

symptomatic improvement, whereas 12 cysts did not show improvement. Additionally, there were 21 cases of recurrent cysts. Of note, in only 3 cases was an additional intra-articular pathology treated. From the results of this study, the authors advocated against using open excision of popliteal cysts unless the associated intra-articular pathology cannot be treated and the cyst is very symptomatic. Hughston et al. also studied open excision of popliteal cysts in 25 patients²¹. Intra-articular pathology was identified and was corrected in 23 of the 25 patients. Clinical outcomes were excellent in 12 knees, good in 8 knees, fair in 3 knees, and poor in 2 knees.

The first study that differed from the traditional open excisional approach was a second study by Rauschnig²². In this study, 8 patients underwent simple closure of the opening to the joint capsule alone via a medial incision, and another 7 patients underwent closure with an additional capsuloplasty with a flap from the gastrocnemius tendon. The cyst was not excised in either group. Associated intra-articular pathologies were addressed in 12 of the 15 patients. There were 3 recurrences with simple closure alone and no recurrences in those with additional capsuloplasty.

Arthroscopic Management

A total of 15 of the 21 operative studies utilized arthroscopic management (Table III). With the advent of arthroscopic surgical techniques and a deeper understanding of the pathoanatomy of popliteal cysts, there was a movement toward less invasive surgical techniques. The study by Rupp et al. examined the effect of treating associated intra-articular pathologies arthroscopically without addressing the popliteal cyst itself²³. In 16 patients at a mean follow-up of 2.1 years, 5 popliteal cysts had disappeared, but 11 others persisted. Ten of the 11 patients with persistent cysts had osteoarthritis with grade-III or IV chondral lesions. None of the 5 patients with resolved cysts demonstrated grade-III or IV lesions. The authors concluded that addressing

the source of the joint effusion is sufficient to resolve the symptoms of the popliteal cysts. However, in cases of osteoarthritis, this effusion is particularly difficult to control, and an arthroscopy alone will not resolve symptomatic popliteal cysts.

Calvisi et al. investigated the efficacy of arthroscopic closure of the opening to the popliteal cysts²⁴. After cyst aspiration, a posteromedial portal was established and entry to the opening was sutured closed. Associated intra-articular pathologies were treated subsequently. In 22 patients at a 2-year follow-up, the RLC decreased from 2.14 to 0.55 on average. Cysts completely disappeared in 14 patients and were reduced in 6 patients, and 2 patients had recurrences. Sansone and De Ponti investigated outcomes from arthroscopic enlargement of the joint communication². Via standard arthroscopic portals, intra-articular pathologies were found and were addressed in all 30 patients. Subsequently, a blunt instrument was introduced into the opening of cyst in the posteromedial compartment. Any structures obstructing the newly formed opening were removed using a motorized shaver and leaving a 4 to 5-mm opening. Prior to treatment, the mean RLC grade was 2.2. At 1 year postoperatively, the mean RLC grade was 0.4 with 1 case of recurrence.

Two studies by Ko and Ahn²⁵ and Yinghui et al.²⁶ both described the results of arthroscopic debridement of the cyst followed by enlargement of the cyst opening. In both studies, an arthroscope was placed directly into the cyst cavity to debride the cyst wall and enlarge the joint communication, followed by arthroscopic treatment of the intra-articular pathology. Among 14 patients in the study by Ko and Ahn, there were no recurrences at 1 year and all patients experienced complete resolution of the cysts²⁵. Among the 41 patients in the study by Yinghui et al., there was 1 recurrence and the rest of the patients experienced complete resolution²⁶.

TABLE III Arthroscopic Management Study Characteristics*

Study	Brief Operative Description	Coleman Score	No. of Knees	Age† (yr)	Follow-up‡ (mo)	Recurrences‡	Outcome Measures
Chen ³⁰ (2019)	Arthroscopic enlargement and cyst wall debridement	56	21	61	29.4§	1 (4.8)	RLC, ultrasound
Gu ³¹ (2018)	Arthroscopic enlargement and cyst wall debridement	68	34	55.4	14.8	0	RLC, MRI
Xinxian ³⁶ § (2018)	Arthroscopic enlargement only	61	31	54.8	33.3	6 (18)	RLC, Lysholm score, MRI
Jiang ²⁹ (2017)	Arthroscopic enlargement and cyst wall debridement	65	58	63.5	24	0	VAS, Lysholm score
Yang ³⁵ # (2017)	Arthroscopic enlargement only	82	32	55.3	13.7	1 (3.1)	Incision healing, VAS, RLC, Lysholm score, MRI
Pankaj ³⁴ (2016)	Arthroscopic enlargement only	61	12	50.3	28	1 (8.3)	RLC
Ohishi ³³ (2015)	Arthroscopic enlargement only	61	29	62.6	22.9	1 (3.4)	RLC, MRI
Cho ³² (2012)	Arthroscopic enlargement and cyst wall debridement	78	111	57	24	0	RLC, MRI or ultrasound
Lie ²⁸ (2011)	Arthroscopic enlargement and cyst wall debridement	51	10	60	13	0	RLC
Ahn ²⁷ (2010)	Arthroscopic enlargement and cyst wall debridement	64	31	47.7	36.1	0	RLC, MRI
Yinghui ²⁶ (2008)	Arthroscopic enlargement and cyst wall debridement	65	41	50.3	18	1 (2.4)	RLC
Calvisi ²⁴ (2007)	Arthroscopic closure only	56	22	56	24	2 (9.1)	RLC, MRI
Ko ²⁵ (2004)	Arthroscopic enlargement and cyst wall debridement	51	14	48	29.7	0	RLC, ultrasound
Rupp ²³ (2002)	Intra-articular pathology corrected	61	16	NA	25.2	11 (68.8)	VAS, ultrasound
Sansone ² (1999)	Arthroscopic enlargement only	56	30	56	32	1 (3.3)	RLC, ultrasound

*NA = not available. †The values are given as the mean. ‡The values are given as the number of patients, with the percentage in parentheses. §This is the median. #This is a comparative study comparing open and arthroscopic excisions.

Since 2010, a total of 5 studies have been performed utilizing arthroscopic enlargement of the cyst opening via a posteromedial portal followed by cyst wall debridement via an additional, extra-articular, intracystic portal²⁷⁻³¹. Generally, in these studies, a posteromedial portal was used to enlarge the opening to the cyst. Subsequently, a

posteromedial, extra-articular, cystic portal was also established. A cystectomy was performed by removing the inner wall of the cyst via this additional posteromedial portal. Intra-articular pathology was treated afterwards. All 31 patients in the study by Ahn et al. did not require a future surgical procedure; 55% of patients had no evidence of a cyst on

magnetic resonance imaging (MRI), and 45% of patients exhibited a reduction in size at a mean follow-up of 36 months²⁷. In the study by Lie and Ng, there were no cases of recurrence in 10 patients at a mean follow-up of 13 months²⁸. In the study by Jiang and Ni, there were no reported cases of recurrence among all 58 patients at a mean follow-up of 24

TABLE IV Combined Open-Arthroscopic Management Study Characteristics

Study	Brief Operative Description	Coleman Score	No. of Knees	Age* (yr)	Follow-up* (mo)	Recurrence†	Outcome Measures
Xinxian ³⁶ ‡ (2018)	Arthroscopic enlargement and open excision	61	34	54.8	33.3	1 (3.1)	RLC, Lysholm score, MRI
Yang ³⁵ ‡ (2017)	Arthroscopy and open excision	82	19	55.4	13.7	1 (5.2)	Incision healing, VAS, RLC, Lysholm score, MRI
Saylik ³⁷ (2016)	Arthroscopy and open excision	76	103	49	39	2 (1.9)	RLC, Lysholm score, MRI

*The values are given as the mean. †The values are given as the number of patients, with the percentage in parentheses. ‡This is a comparative study comparing open and arthroscopic excisions.

months²⁹. Among the 21 patients in the study by Chen et al., 20 patients had complete resolution of the cysts, and 1 patient had a recurrence with ultimate reduction in size at a mean follow-up of 29.4 months³⁰. In the study by Gu et al., there were no recurrences in a total of 34 patients undergoing the operation at a mean follow-up of 14.8 months³¹.

Cho utilized a slightly different technique to enlarge the cyst opening and debride the cyst wall³². In this study, only 1 posteromedial portal was used instead of 2 portals, as previously described. An intracystic portal was created using a spinal needle and transillumination to avoid vascular damage. To allow for adequate visualization of the cyst wall through the anterolateral portal, a 70° arthroscope was used. There was no evidence of recurrence in 111 patients, with all showing excellent or good results according to the RLC grade.

The results for arthroscopic enlargement of the cyst opening via a posteromedial portal without additional debridement of the cyst wall were outlined in studies by Ohishi et al.³³, Pankaj et al.³⁴, Yang et al. (1 arm)³⁵, and Xinxian et al. (1 arm)³⁶. Among 29 patients evaluated in the study by Ohishi et al., 12 cysts disappeared completely, 16 cysts were reduced in size, and 1 cyst recurred with an increase in size³³. In the study by Pankaj et al., there was 1 failure with recurrence among 12 patients³⁴. In

the 1 arm of the study by Yang et al., there was 1 case of recurrence in 32 patients³⁵. In the 1 arm of the study by Xinxian et al., among a total of 31 patients, 5 patients experienced recurrent cysts³⁶. Of note, patients with septal membranes within the cyst were excluded in this study.

Combined Open-Arthroscopic Management

A total of 3 of the 21 operative studies utilized a combined open-arthroscopic approach (Table IV). Although Rauschnig²² concluded that open excision of popliteal cysts led to unacceptable recurrence rates, the efficacy of open excision with additional arthroscopic intervention has been reexamined in a recent group of studies. These studies include those by Yang et al.³⁵, Xinxian et al.³⁶, and Saylik and Gökkuş³⁷. In the study by Saylik and Gökkuş, an incision was made along the flexor crease, and the cyst was dissected and excised followed by closure of the capsule with sutures. Arthroscopy was then performed to treat intra-articular pathology. Of 103 cysts treated with this method, 2 patients had a recurrence³⁷. In the combined open-arthroscopic arm of the study by Xinxian et al., an incision was made directly over the cyst. The cyst was excised following blunt dissection. Closure was performed in

layers without repairing the posteromedial capsule. Via arthroscopy, the capsular fold was removed, and intra-articular pathologies were managed. In this part of the study, 34 patients were treated and there was 1 case of recurrence. Two patients experienced superficial wound infections³⁶. In 1 arm of the study by Yang et al., arthroscopy was performed followed by an S-incision in the medial popliteal area. After blunt dissection, the cyst was excised from the root and the opening to the joint space was sutured. In 19 patients who underwent this combined arthroscopic-open procedure, there was 1 recurrence³⁵.

Discussion

This systematic review included a total of 30 studies; 9 studies outlined non-operative treatments, whereas 21 studies outlined operative treatments. Eight of 9 nonoperative studies utilized corticosteroid injections, with the remaining study utilizing radiation therapy. Of the 8 studies, 6 performed intracystic injections, 1 performed intra-articular injections, and 1 performed both. Fenestration of the cyst prior to injection was used in 2 of the studies examining intracystic injections. Of the 21 operative treatment studies, 6 used an open technique, 15 used arthroscopy, and 3 used a combined open-arthroscopic technique. Thirteen studies enlarged the

opening to the cyst cavity, 7 studies closed the opening, and 3 studies did not specify. Fifteen of the studies opted to excise and debride the cyst wall, whereas 6 studies left the cyst wall undisturbed.

Although there is a large variety of treatment methods described, the literature remains clear that the mainstay of initial treatment for popliteal cysts is conservative management with corticosteroid injection if persistently symptomatic. Even so, several different treatment methods with corticosteroids have been outlined in the literature^{10-12,15,16}. These methods consist primarily of intra-articular injection with or without aspiration and of aspiration and intracystic injection with or without cyst fenestration. As demonstrated by Köroğlu et al., ultrasonographic evaluation is useful in the initial management of popliteal cysts to help to predict the response to treatment. That study classified cysts as simple or complex and subsequently demonstrated the increased risk of non-response to corticosteroids for patients with complex cysts. Cysts with thick septations are less likely to respond to corticosteroids and are more likely to have residual cyst volume from retained pockets of fluid formed by septations¹⁵. This understanding of the structure of cysts informed the study by Smith et al., which showed that fenestration prior to the injection of complex popliteal cysts can improve outcomes by ensuring complete evacuation of the fluid and penetration of the corticosteroid into all aspects of the cyst wall¹⁶.

Although there have been advancements in the conservative treatment of popliteal cysts, corticosteroid injections may not always provide adequate relief of symptoms. Throughout the past several decades, many techniques for surgical treatment have been described in the literature to treat patients with persistent symptoms resistant to conservative management. The only consensus in the literature is that associated intra-articular pathologies must be addressed. This was demonstrated clearly in the randomized trial by Yang et al., the only Level-I study examining operative treatment options

identified in this review. This study showed more than a 7.5-fold increase in recurrence rates in patients treated with open excision alone compared with those treated with open excision and arthroscopic treatment of underlying joint pathology³⁵. Rupp et al. also demonstrated that cysts can resolve with isolated treatment of intra-articular pathology. According to that study, patients with meniscal tears complicated by popliteal cysts can be treated effectively with meniscectomy; however, patients with high-grade osteoarthritis may need additional operative treatment to resolve the popliteal cysts because of persistent joint effusion²³.

Beyond this level of consensus, there remain advocates for several different operative treatments. The field had seemingly concluded that open excision of popliteal cysts was inferior, but there exist advocates for combined open-arthroscopic treatments³⁵⁻³⁷. Although these studies are valuable in further elucidating the effect of treating intra-articular pathologies as outlined by Yang et al., it is hard to recommend an open operative procedure, because of the increased invasiveness, without a clear demonstration of superior outcomes³⁵. Enlargement compared with closure of the cyst opening is another technical issue that persists. A meta-analysis by Zhou et al. investigating this variable concluded that enlargement of the cyst opening is superior³⁸. Additionally, the lack of recent studies examining closure of the cyst opening could suggest that enlargement is a preferable strategy. One surgical variable that remains to be quantitatively examined is debridement of the cyst wall. Among 8 studies in this review that examined arthroscopic enlargement of the cyst opening and debridement of the cyst wall, there were a total of 320 patients and 2 documented recurrences²⁵⁻³². In 5 studies examining arthroscopic enlargement without cyst cavity debridement, there were 134 patients and 9 documented recurrences^{2,33-36}.

Our preferred protocol for popliteal cyst management involves initial nonoperative management. At the initial presentation, we perform aspiration of any knee effusion, if present, followed by intra-articular injection, cyst aspiration under ultrasound guidance, and intracystic injection. If there is no knee effusion, an ultrasound-guided aspiration of cysts with a corticosteroid injection is performed. Any loculations visualized under ultrasound are penetrated to ensure drainage. However, this protocol has oscillated between intracystic injection and intra-articular injection in recent years. Repeat procedures are performed up to 3 times for symptomatic patients. Patients with recurrences are referred for surgical consultation if the cyst is large and symptomatic or if they have 2 recurrences within 6 months or 3 recurrences within 12 months. For surgical intervention, management involves arthroscopy with the treatment of intra-articular pathology, including the treatment of meniscal tears or gentle chondroplasty for loose articular cartilage flaps. Then, while using an anterior viewing portal through the intercondylar notch, a posteromedial portal is established under direct visualization. This portal is used to enlarge the cyst valve with a basket and shaver to decompress the cyst.

A limitation of this systematic review of the literature was the lack of prospective, randomized controlled trials on the topic. Of the studies meeting inclusion criteria for this review, there were only 2 randomized trials, 1 examining nonoperative treatment and 1 comparing open treatment with arthroscopic treatment. However, because there is no currently adopted standard of care for the operative management of popliteal cysts, it is not surprising that there is a lack of randomized controlled trials. Additionally, among the studies outlining operative treatment methods, only 4 of the 21 studies were prospective in nature, with the remaining 17 studies being retrospective, observational

studies. Because of the lack of randomized or prospective studies, as well as the heterogeneity in the outcome variables reported among studies, it was difficult to perform a quantitative comparison of clinical outcomes between treatment methods.

In conclusion, the literature on the treatment of popliteal cysts suggests that the ideal treatment for symptomatic popliteal cysts is conservative treatment, with progression to corticosteroid injections if symptoms continue. The most current literature recommends ultrasound evaluation to identify simple cysts compared with complex cysts, with intracystic aspiration and corticosteroid injection and possible cyst fenestration for complex cysts. Operative management should be reserved for persistently symptomatic cysts and treatment must include addressing the primary intra-articular pathology in addition to the cyst itself. The current literature suggests that arthroscopic enlargement of the cyst opening with debridement of the cyst wall is an effective technique with the least recurrences. However, the studies analyzed in this review are largely retrospective, observational studies, and future prospective studies need to be performed to further elucidate appropriate operative treatment.

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