

# Treatment of Popliteal Cyst through Radiofrequency Thermocoagulation under Ultrasound Guidance

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## Abstract

**Objective:** The purpose of this study was to explore the clinical efficacy and security of the treatment of popliteal cyst through radiofrequency thermocoagulation (RFT) under ultrasound guidance. **Methods:** The clinical data of 35 patients with popliteal cyst, who were treated by RFT under ultrasound guidance from June 2019 to June 2020, were retrospectively analyzed. The Visual Analogue Scores (VAS) and the size of cyst before and after treatment were recorded at the first month, the third month, the sixth month. After six months, the recovery rate of Rauschnig and Lindgren classification (R-L classification) level 0, 0 - I were counted. All the complications of the patients were observed. **Results:** 32 patients were followed up for six months. The scores and cyst sizes of each patient before and after the treatment were on a normal distribution curve. There was no significant difference in VAS scores before and after the treatment ( $P > 0.05$ ). However, there was a significant difference in cyst sizes before and after the treatment ( $P < 0.05$ ). Moreover, there was no significant difference in VAS scores and cyst sizes in each period after treatment ( $P > 0.05$ ). According to the R-L classification in 6 months after treatment: the recovery rate of class 0 was 62.5% and class 0 - I level was 87.5%. There were no serious complications in the process. **Conclusion:** Treatment of popliteal cyst through RFT under ultrasound guidance is a simple, easy, reliable method that is worthy of clinical promotion.

## Keywords

Ultrasound Guidance, Radiofrequency Thermocoagulation, Popliteal Cyst

## 1. Introduction

Popliteal cyst, also known as Baker's cyst, is the general term for popliteal syn-

ovial cyst. With common symptoms such as popliteal discomfort, swelling, and pain, the condition can be confirmed by ultrasound or magnetic resonance examination. Popliteal cysts can occur in both children and adults, and they tend to be more common in adults. In children, in which the vast majority of etiology is primary, cysts and joint cavity do not communicate and exist independently. Rarely do children have clinical symptoms and cysts were often found in the physical examination or parents to bathe the child [1]. The primary popliteal cyst in children usually does not require treatment [2]. In adults, in which the etiology is mostly secondary and related to knee lesions, cysts are often linking the joint cavity. Common knee joint lesions include osteoarthritis, rheumatoid arthritis, meniscus tear and so on [3]. There are many synovial sacs in the popliteal fossa [4], which often communicates with the joint cavity. Abnormal accumulation of synovial fluid is the pathological basis of cyst formation. When a one-way valve-like structure is formed between the cyst cavity and the joint cavity, the synovial fluid cannot return to the joint cavity and forms a synovial hernia behind the knee, eventually forming a popliteal cyst [5]. At present, there are many treatment methods for the popliteal cyst. Non-surgical therapies mainly include interventions with absolute alcohol, biological protein glue, and steroid drugs after sucking the sac fluid under ultrasound guidance [6] [7]. These methods can provide minimal trauma and certain effect, but there is still a possibility of recurrence [8]. Surgical treatment is mainly based on arthroscopic minimally invasive treatment [9] [10], which treats both a popliteal cyst and the lesions in the knee joint cavity. However, this method poses relatively high requirements for the skills of the operator, with a long learning curve. Moreover, the required equipment and postoperative recovery have restricted the extensive application of the technique [11]. Recently, researchers worldwide suggest that the key to the treatment of a popliteal cyst is to treat related injuries in the knee joint and reconstruct the communication between the bursa and the joint cavity. Instead, the cyst should not be the major target of surgical treatment. As for its treatment, arthroscopy is used to treat the primary disease of the knee joint and expand the passage, with desirable treatment results [12] [13]. Linear high frequency ultrasound can directly show the size and shape of a popliteal cyst, and the direction of the probe can be adjusted to clearly show where the cyst communicates with the knee joint. From June 2019 to June 2020, in this study, RFT was used under ultrasound guidance to destroy the one-way valve structure of popliteal cyst in 35 cases. Impressive results have been achieved clinically, and no obvious serious complications have been seen. The reports are as follows:

## 2. Clinical Data and Methods

### 2.1. General Data

All cases were enrolled from the inpatient department of the Pain Management Division of the First People's Hospital of Jingzhou, and the general information of the patients is shown in **Table 1**. The study was reviewed and approved by the

**Table 1.** General information of patients.

Item	
No. of patients	35
Age, y (mean $\pm$ SD)	50.7 $\pm$ 9.2
Sex (female/male)	16/19
Duration of symptoms, months (mean $\pm$ SD)	16.1 $\pm$ 7.5
BMI (kg/m <sup>2</sup> )	25.29 $\pm$ 3.21
Treatment time (min)	26.82 $\pm$ 5.38
Side affected, n (%)	
Right	15 (52.86%)
Left	20 (57.14%)
Bilateral	0 (0%)
The Size of cyst, cm <sup>3</sup> (mean $\pm$ SD)	17.95 $\pm$ 12.31
History of rheumatoid arthritis, number of cases (%)	15 (42.85%)
History of osteoarthritis, number of cases (%)	5 (14.28%)
History of meniscus injury, number of cases (%)	8 (22.86%)
Rauschnig and Lindgren classification	
II class, n (%)	22 (62.86%)
III class, n (%)	13 (37.14%)

hospital ethics committee. Diagnostic criteria: 1) swelling, discomfort, or pain is found in the popliteal region, and the swelling is more prominent when the knee is bent; 2) the diagnosis is confirmed by ultrasound or NMR. Inclusion criteria: a) the diagnostic criteria are met; b) ultrasound or MRI shows that the popliteal cyst is located between the gastrocnemius and semimembraneus. The popliteal cyst communicates with the knee joint cavity; c) the patient is conscious and cooperative to complete the questionnaire and sign the informed consent form; d) R-L grade  $\geq$  II; e) blood routine test, coagulation analysis, and liver and kidney functions are normal, with the tolerance of radiofrequency under local anesthesia in the prone position; f) patients received a complete follow-up. Exclusion criteria: i) Patients have pacemaker, arrhythmia and other conditions; ii) children's popliteal cyst was not included in the study; iii) the examination revealed that the popliteal cyst was ruptured; iv) cyst diameter  $\geq$  5 cm was not included in the study; v) patients with a cyst which is not connected to the knee cavity; vi) the patient had contraindications to the treatment; vii) patients were unable to understand and cooperate with the treatment.

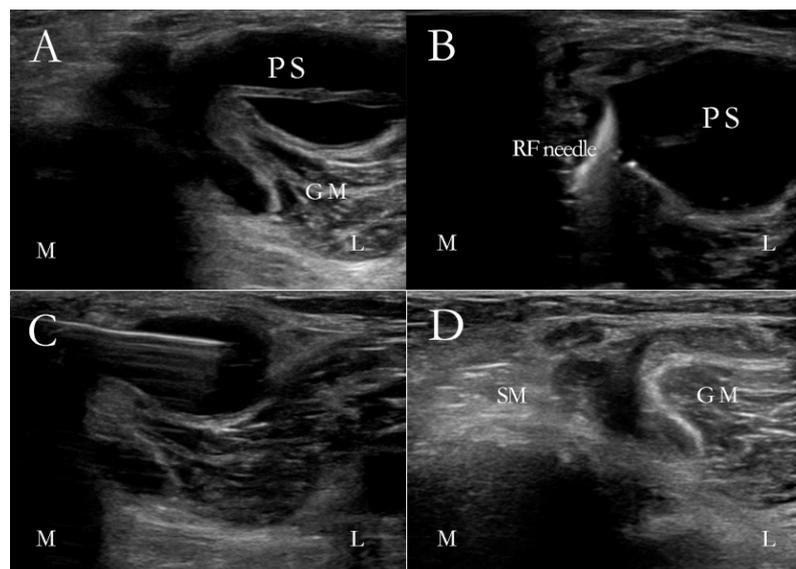
## 2.2. Treatment

The patient was placed in the prone position, and the popliteal region of the knee joint was fully exposed to establish venous access. Routine ECG monitoring was performed. The linear high-frequency probe (Wisonic, Shenzhen, China)

was placed horizontally in the popliteal region for scanning. The size, boundary, and surrounding tissues of the cyst were carefully observed, so as to identify the valve structure that communicates with the joint cavity. After the puncture point was determined according to the valve structure, the site was routinely disinfected and draped. The probe was wrapped with a sterile film. Under local anesthesia with 1% lidocaine, the needle was inserted into the plane. Under the guidance of ultrasound positioning, 22 G radiofrequency puncture need was inserted into the one-way valve, and the probe (Beiqi, Beijing, China) was connected for RFT at 80°C for 180 s. More targets should be treated similarly so that the needle tip treatment could cover the entire valve area as much as possible. After the RFT, an epidural puncture needle was used to draw out all the fluid in the sac under ultrasound guidance, and normal saline was infused and drawn out three to four times. Finally, the cyst cavity was injected with 2.5 ml of mixed anti-inflammatory and analgesic solution (0.5 ml of diprospan, 1 ml of 1% lidocaine, and 1 ml of normal saline). After the needle was withdrawn, the site was pressurized with a sterile dressing. The details of the operation under ultrasound guidance are shown in **Figure 1**.

### 3 The Observation of Clinical Effect

Each patient was followed up for half a year. The Visual Analogue Scale (VAS) was used to measure the changes in the patient's pain, with points ranging from 0 to 10. The change in the cyst size was ultrasonically observed and calculated by Tada's method. The major diameter, transverse diameter, and thickness of the



Abbreviations: PS, popliteal cyst; GM, gastrocnemius medialis; SM, semimembranosus; M, Medial ; L, lateral.

**Figure 1.** RFT treatment of popliteal cyst under ultrasound guidance. (A) The popliteal cyst is located between the gastrocnemius medialis and the semimembranosus. The fibrous septum is visible. (B) RFT destroyed the structure of one-way valved. (C) The popliteal cyst was punctured by epidural needle. (D) The situation of 6 months after treatment.

three largest cross-sections of the cyst that are perpendicular to each other were measured and substituted into the equation ( $V = \pi/6 \times \text{major diameter} \times \text{transverse diameter} \times \text{thickness}$ ) to obtain the volume. The R-L grading was used to measure the R-L grade of patients six months after surgery, as shown in **Table 2**. The recovery rates of grades 0 and 0 - I in the R-L grading six months after surgery were calculated. The related complications of patients during and half a year after treatment were observed.

#### 4. Statistical Method

SPSS18.0 software was used for statistical analysis, and the data was expressed as mean  $\pm$  standard deviation. The VAS scores and the cyst sizes before treatment and after treatment at one month, three months, and six months were tested by repeated data, and  $P < 0.05$  was considered statistically significant.

#### 5. Results

A total of 32 patients were followed up for half a year (three cases were lost to follow-up). The VAS scores and the cyst size were normally distributed both before and after treatment. Before and after treatment, there was no significant difference in the VAS scores ( $P > 0.05$ ), but there was a significant difference in the size of the cyst ( $P < 0.05$ ). There was no significant difference between the VAS scores and the cyst size at different time after treatment ( $P > 0.05$ ), as shown in **Table 3**. According to the R-L grading, there were 21 cases of grade II and 11 cases of III before treatment; 20 cases recovered to grade 0 and 28 cases recovered to grades 0 - I 6 months after surgery. The recovery rates were 62.5% and 87.5%, as shown in **Table 4**. All patients followed up had no infection at the puncture site. There was no arteriovenous injury during the operation and no scar adhesion, no knee joint dysfunction or other complications after the operation.

**Table 2.** Rauschnig and Lindgren classification

class	symptoms and signs
0 class	No swelling and pain, no limitation of movement
I class	There is tension in the popliteal fossa after mild swelling or strenuous activity, and the activity is slightly limited
II class	Swelling and pain after normal activity, limitation of activity $< 20^\circ$
III class	Swelling and pain can also occur during rest, limitation of activity $> 20^\circ$

**Table 3.** The VAS and the size of cyst before and after treatment.

Evaluation index	Before treatment	After treatment		
		1 month	3 months	6 months
VAS scores	2.47 $\pm$ 0.62	2.25 $\pm$ 0.51	2.24 $\pm$ 0.68	2.22 $\pm$ 0.49
the size of cyst (cm <sup>3</sup> )	18.03 $\pm$ 12.89	5.48 $\pm$ 2.44*	6.12 $\pm$ 2.63*	6.37 $\pm$ 2.71*

\* $P < 0.05$ , compared with before treatment.

**Table 4.** R-L classification before and half year after treatment.

Time	Number	R-L classification (N)			
		0	I	II	III
Before treatment	32	0	0	21	11
After treatment	32	20	8	4	0

The recovery rate of class 0: 62.5%; The recovery rate of class 0 - I: 87.5%.

## 6. Discussion

The popliteal cyst is the most common cyst behind the knee joint [14]. Baker described and named it after himself as early as 1877. The most common site is the bursa between the tendons of the medial head of the gastrocnemius and the semimembranosus [15]. The pathogenesis remains controversial, but studies on specimens have shown that [16] the bursa between these tendons communicates with the knee joint cavity or there is a weak area associated with the synovial cavity of the knee joint. Therefore, the anatomical basis for the formation of a popliteal cyst is the communication between the synovial layer around the knee joint and the bursa formed by surrounding tendons. When the effusion in the knee joint cavity increases, the synovial membrane that wraps the effusion herniates into the bursa through the fissure or weakened area. When there is a one-way valve-like structure in the hernia outlet, the synovial fluid cannot return to the joint cavity and constantly increases, accumulates, and concentrates in the popliteal fossa. As a result, it stimulates the proliferation and thickening of surrounding tissues to form the cyst wall and eventually form a popliteal cyst [17]. The popliteal cyst can be treated by freeing the Interaction of popliteal cyst and articular cavity. This study was intended to further simplify the treatment method by combining the advantages of ultrasound such as low cost, no radiation, and clear visualization with radiofrequency thermocoagulation, which is a minimally invasive method of destroying the one-way valve in the cyst. Treating a popliteal cyst in this way delivers minimal damage and low recurrence rate and is worthy of wide application. Theoretically, of course, any form of arthritis and joint effusion can be the predisposing factors of a secondary popliteal cyst [18]. For this reason, while radiofrequency thermocoagulation was employed under ultrasound guidance to destroy the one-way valve-like structure of a popliteal cyst, it is also necessary to actively treat knee-related diseases. After 6 months of follow-up, no serious complications such as nerve or vascular injury occurred in all patients. Because ultrasound can clearly distinguish the vascular and nerve structures as well as the muscle and tendon tissues around the cyst. All the puncture and operation can effectively avoid injury. Only one patient formed a scar about the size of a soybean grain at the puncture site.

Ultrasound diagnosis of a popliteal cyst has obvious advantages, as the one-way valve-like structure is most common at the three anchors at the distal end of the semimembranosus tendon and between the tendons of the medial head of the

gastrocnemius and the semimembranosus. In addition, it also occurs in the semitendinosus, popliteus, biceps femoris, and joint capsule, and even the sub-patellar fat pad has also been reported [19]. The shape of the cyst is generally irregular. It can be seen that a tubular structure of the pedicle extends to the deep part, and the cyst may be slightly deformed when the probe is pressurized. During the operation, radiofrequency thermocoagulation is first performed at the one-way valve, and as many targets as possible should be treated. Before the operation, the site should be repeatedly punctured with a radiofrequency needle to further destroy the one-way valve-like structure here. If the temperature cannot rise smoothly during the operation, it is mainly due to insufficient concentration of the fluid in the cyst and excessive resistance. In this case, the radiofrequency needle should be fixed first, and then an epidural puncture needle should be used to draw out some of the sac fluid before proceeding. During the treatment, it should be noted that some popliteal cysts have multiple one-way valve-like structures, and each valve-like structure needs radiofrequency treatment. The temperature for radiofrequency thermocoagulation is preferably above 75°C, which can fully destroy the one-way valve-like structure [20]. When the epidural puncture needle is used to draw the sac fluid, it should be used in multiple directions under ultrasound guidance, and the assistant should cooperate with the squeezing to draw out all the sac fluid of the popliteal cyst that forms multiple sacs. Finally, 2ml of mixed anti-inflammatory and analgesic solution was injected. It can reduce both the symptoms of knee joint pain and discomfort after treatment and the fluid accumulation produced by the synovium, so as to facilitate the adhesion, absorption, and reconstruction of the cyst cavity.

There was no significant difference between the VAS scores before and after treatment ( $P > 0.05$ ), but the mean still dropped. It might be that the knee joint pain was mainly caused by the primary disease of the knee joint and had little relationship with a popliteal cyst. There was a significant difference between the cyst sizes before treatment and at various time points after treatment ( $P < 0.05$ ). These results indicated that destroy the one-way valve-like structure while ensuring the two-way circulation of the synovial fluid in the joint capsule is the key to the treatment of a popliteal cyst. When the pathological basis of a popliteal cyst disappeared, and the synovial layer of the joint could fully absorb the effusion that flowed back into the joint cavity. Furthermore, it would not lead to huge refractory popliteal cysts, such as an enlarged popliteal cyst and twisted tubular structure of the pedicle. The recovery rate was 62.5% for grade 0 and 87.5% for grades 0 - I in the R-L grading, indicating that the use of RFT under ultrasound guidance to treat a popliteal cyst by destroying its one-way valve-like structure could deliver a valid therapeutic effect and lower recurrence rate. There were still some shortcomings in this study: the small number of clinical cases collected, the short follow-up time, the error in the calculation of the cyst size by Tada's method [21], and the different treatment methods for the primary disease of the knee joint. All of these could have a certain impact on the results.

In general, however, this method is clinically reliable, with less trauma, low equipment requirements, and a short learning curve. It is currently one of the effective methods for the treatment of a popliteal cyst and is suitable for wide application in primary hospitals.

## 7. Conclusion

This clinical study has an exact therapeutic effect, but there still are many imperfections, such as a small number of clinical numbers and inadequate duration of follow-up visits. The long-term therapeutic effect still requires further follow-up summary.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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