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Efficacy of Ultrasound-Guided Unidirectional Valve Enlargement in Treatment of Popliteal Cysts

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Abstract

Purpose: To investigate the effect of ultrasound-guided unidirectional valve cleft enlargement in the treatment of popliteal cysts. **Methods:** Forty-eight patients with popliteal cysts who met the inclusion criteria and were admitted to our hospital from December 2018 to June 2020 were randomly divided into group A (24 cases) and group B (24 cases). Group A was treated with a central venous catheter dilator, and group B was treated with traditional open surgery to remove the popliteal cyst. Visual analogue scale (VAS) was used to evaluate discomfort. The VAS, Lysholm score of knee joint and Rauschning-Lindgren grade 0~I improvement rate were compared at 6 months after operation. **Results:** The postoperative VAS in group A was significantly better than that in group B ($P < 0.05$), and the postoperative Lysholm score and Rauschning-Lindgren grade 0~I in group A were higher than those in group B ($P < 0.05$). There was no recurrence or other complications in either group. **Conclusions:** Ultrasound-guided central venous catheter dilator is more effective than traditional surgical resection of popliteal cysts.

Keywords

Popliteal Cyst, Ultrasound, Open Surgery

1. Introduction

William Baker [1] first described popliteal cysts as a fluid-filled mass in 1877 and elaborated the link between cysts and intra-articular lesions. Studies have shown that there is a channel with a transverse opening of unidirectional valve function in the posteromedial aspect of the knee capsule, and when joint effusion is

caused by various reasons, the pressure in the joint cavity increases, and the synovial fluid flows from the joint cavity into the synovial sac to form a cyst [2]. Handy [3] reported that communicating connections between popliteal cysts and joint cavities were observed in 30% to 50% of autopsies, 55% of open surgical resections, 37% of knee diagnostic arthroscopies, and 50% of normal knee arthroscopies. When various causes lead to joint effusion, increased pressure in the joint cavity, effusion through the unidirectional valve structure into the gastrocnemius semimembranosus sac, but cannot reflux back into the joint cavity, it leads to the occurrence of popliteal cysts. The majority of popliteal cysts are asymptomatic, and when symptomatic, they often present with posterior knee pain with tightness, stiffness, and discomfort, as well as limited joint extension and flexion. Secondary popliteal cysts in adults are often associated with gouty arthritis, rheumatoid arthritis, etc., synovial inflammatory proliferation, easy to produce a number of effusion, resulting in enlargement of the gastrocnemius muscle semi-membranous bursa communicating with the joint cavity. Conservative treatment is mostly performed with ultrasound-guided aspiration of cyst fluid and intracystic steroid injection, but the cyst recurrence rate is high [4] [5]. Surgical treatment is often required when conservative treatment is ineffective, and traditional open surgery is based on resection of the cyst, which is invasive and prone to scar formation. Many scholars use arthroscopy to treat popliteal cysts, and the unified view is that arthroscopic management of intra-articular pathological lesions is performed, and it is controversial whether to enlarge the communicating site or suture the valve communicating orifice and remove the cyst wall [6] [7]. No matter which surgical method is used, the current study data indicate that good clinical efficacy and low cyst recurrence rate have been achieved [8].

According to the advantages of ultrasound interventional therapy, in this study we used ultrasound-guided central venous catheter dilator to dilate the valve communication between popliteal cyst and joint cavity, and to observe the clinical efficacy and safety of this method.

2. Materials and Methods

2.1. Patients

Forty-eight patients with popliteal cysts who met the inclusion criteria and were admitted to our hospital from December 2018 to June 2020 were selected, aged 40 - 69 years; 14 males and 34 females; the cysts were unilateral. All patients were diagnosed with popliteal cysts located between the medial gastrocnemius muscle and semimembranosus tendon by ultrasound and communicated with the joint cavity, excluding knee deformity, instability, trauma, infection, history of surgery and skin infection and giant cysts in the puncture area, cysts that did not communicate with the joint cavity or multilocular cysts that communicated with multiple joint cavities. They were randomly divided into group A (n = 24) and group B (n = 24): group A was treated with ultrasound-guided central ven-

ous catheter dilator to dilate the valve communication port between popliteal cyst and joint cavity, and group B was treated with traditional open surgery to remove popliteal cyst. The study was approved by the Ethics Committee of the hospital and informed consent was signed by the patients.

2.2. Operation Method

In Group A, the patient was placed in the prone position with a thin pillow of moderate thickness at the ankle to fully expose the popliteal fossa area, using an ultrasonic diagnostic apparatus (Wisonic Navigator, Huasheng Medical Technology Co., Ltd.), a high-frequency probe was selected to scan the cyst in the popliteal fossa area to observe whether there were separated and hyperechoic images in the sac. Open the disposable epidural anesthesia puncture set and central venous catheter set, routinely disinfect the operation area 3 times, spread a sterile towel, apply an appropriate amount of coupling agent on the surface of the probe, wrap the probe with sterile gloves, and pay attention that the surface of the probe should be evenly fitted with gloves, so as not to produce bubbles affecting the imaging effect. Ultrasound scans were used to dynamically observe the cyst, so that the developed image was placed in the middle of the screen to present the best image, to distinguish the medial gastrocnemius muscle and penumbral tendon, and to determine the neck of the cyst. Local skin infiltration anesthesia was performed at the puncture site. The sterile injection needle broke the skin. The in-plane puncture technique was used. The epidural puncture needle was replaced to penetrate into the cyst. The needle tip and needle body were visualized in the middle of the screen as far as possible to facilitate the operation. When the needle tip is close to the cyst neck, let the assistant fix the needle body, place the guide wire by the operator, enter the entrance of cyst neck under ultrasound visualization, slowly enter the joint cavity through the valve communication orifice, and pay attention to the gentle action. Withdraw the puncture needle, place the central venous catheter dilator along the catheter and pass through the perforating site, pull back and forth, and change the direction of the dilator to dilate the aperture of the perforating site. Withdraw the dilator, place the lumbar puncture needle along the guidewire, then withdraw the guidewire, withdraw the cyst fluid from multiple directions with a 20ml syringe, use normal saline for lavage and suction for 3 - 4 times, use a 5 ml syringe to extract 1ml of anti-inflammatory and analgesic mixture (2% Lidocaine 2 ml + Triamcinolone Acetonide 10 mg + 0.9% Sodium Chloride Injection 2 ml) and inject it into the cyst cavity, pull out the puncture needle, and use sterile gauze to bandage after disinfection.

In Group B, under epidural anesthesia or arachnoid anesthesia, S or Z-shaped incision was often made according to the cyst site, and then the tissue structure around the cyst was separated in turn from shallow and deep, and resection was performed after the cyst wall was fully visualized, the internal orifice suture was ligated, adequate hemostasis was performed, the incision was sutured and

dressed with elastic bandage after iodophor and normal saline irrigation.

The clinical results were compared between the two groups before treatment and 6 months after treatment, and the VAS score, Lysholm score of knee joint and Rauschning-Lindgren (RL) grade 0~I improvement rate were recorded before treatment and 6 months after treatment.

2.3. Data Analysis

Measurement data were expressed as ($\bar{x}$ ± s) and t-test was used for comparison. Chi-square test was used to assess categorical variables. The level of significance was set at $p < 0.05$. Statistical analysis was performed using IBM SPSS Software, v.17.0. (IBM Corp., NY, USA).

3. Results

The general data of the two groups were similar ($P > 0.05$) and comparable (Table 1). The Lysholm score of both groups after operation was significantly higher than that before operation ($P < 0.05$). The VAS score was significantly lower than that before operation ($P < 0.05$). Six months after operation, Lysholm score and VAS score in group A were significantly better than those in group B ($P < 0.05$) (Table 2), Rauschning and Lindgren grade 0~I was improved in 87.5% (21/24) of group A and 58.3% (14/24) of group B, which was higher in group A than in group B ($P < 0.05$) (Table 3).

Table 1. Comparison of general data of patients.

	Group A	Group B	t/χ^2	*P* value
Case	24	24		
Age (years)	55.46 ± 6.15	56.63 ± 6.58	0.64*	0.53
Sex (male/female, n)	6/18	9/15	0.87	0.35
Position (male/female, n)	10/14	8/16	0.356	0.55
BMI (kg/m^2)	22.54 ± 2.12	23.78 ± 2.77	1.735*	0.09
R-L Grading (II/III, n)	16/8	15/9	0.9	0.76

R-L = Rauschning-Lindgren, **t* value.

Table 2. Comparison of knee joint function and pain score between the two groups ($\bar{x}$ ± s, points).

Clinical Score	n	Before treatment	Last follow-up	*P value*
Lysholm				
Group A	24	48.29 ± 9.69	85.17 ± 6.39	P < 0.05
Group B	24	47.96 ± 8.46	78.83 ± 4.63	P < 0.05
t		0.127	3.928	
P value		0.900	0.000	
VAS				
Group A	24	6.13 ± 0.99	1.71 ± 1.04	P < 0.05
Group B	24	6.21 ± 1.18	2.70 ± 1.04	P < 0.05
t		−0.265	−3.325	
P value		0.792	0.002	

Table 3. Comparison of postoperative improvement rate between the two groups.

	R-L grade/case				
Group	Grade 0	Grade I	Grade II	Grade III	Percentage of grade 0~I
A	8	13	3	0	21 (87.5%)
B	4	10	10	0	14 (58.3%)
χ^2	-	-	-	-	5.169
P value	-	-	-	-	0.023

4. Discussion

Children develop primary popliteal cysts without knee-related disease, do not communicate with the joint space, cysts often exist alone, generally do not require treatment, and most will disappear automatically [9] [10]. Adult secondary popliteal cysts, cysts often communicate with the joint cavity, and there are joint pathological lesions, such as rheumatoid arthritis, arthritis and so on. At present, domestic and foreign scholars generally agree that the causes of popliteal cysts are knee joint effusion caused by various pathological reasons, increased joint cavity pressure, effusion flowing into the gastrocnemius semi-membranous muscle sac through the unidirectional valve communication structure between GSB and joint cavity, but cannot reflux back to the joint cavity, which leads to the occurrence of popliteal cysts [11]. With the development of arthroscopic techniques, Sansone and DePonti [12] first used arthroscopy to dilate the unidirectional valve channel between the popliteal cyst and the joint space, but did not resect the capsule wall, and 95% of patients were found to improve their clinical symptoms at 2 years of follow-up. Thus, the key to treatment is not whether to remove the capsule wall, and the treatment of unidirectional valve structure and intra-articular lesions can achieve effective treatment of popliteal cysts. In this study, patients in the ultrasound-treated group had significantly higher Lysholm scores 6 months after surgery than before surgery, and knee function was also well improved. It shows that ultrasound-guided central venous catheter dilator destroys the unidirectional valve structure and dilates the communication caliber between the cyst and the joint cavity so that the fluid on both sides can circulate freely in both directions and facilitate the absorption of effusion.

Popliteal cysts in children are mostly primary, without knee joint-related diseases, and do not communicate with the joint cavity. Cysts often exist alone, generally do not need treatment, and most of them will disappear automatically [9] [10]. Adults are mostly secondary popliteal cysts, cysts often communicate with the joint cavity, and there are joint pathological lesions, such as rheumatoid arthritis, osteoarthritis, and so on. At present, scholars generally agree that the occurrence of popliteal cyst is due to a variety of pathological causes of knee joint effusion, the increase of joint cavity pressure, and the effusion flows into the gastrocnemius semimembranous muscle capsule through the one-way valvular communication structure between GSB and joint cavity, but cannot flow

back to the joint cavity, which leads to the occurrence of popliteal cyst [11]. With the development of arthroscopy, Sansone and DePonti [12] used arthroscopy to dilate the unidirectional valvular passage between popliteal cyst and articular cavity for the first time, but the cyst wall was not removed. Follow-up for 2 years found that 95% of the patients' clinical symptoms improved. Thus it can be seen that the key to the treatment is not whether to remove the cyst wall or not. The treatment of unidirectional valvular structure and intra-articular lesions can effectively treat popliteal cysts. In this study, the Lysholm score of patients in ultrasound treatment group was significantly higher than that before operation 6 months after operation, and the function of knee joint was also improved. It shows that the dilator of the central venous catheter under the guidance of ultrasound destroys the unidirectional valve structure and expands the communication caliber between the cyst and the joint cavityso that the fluid on both sides can flow freely in both directions and facilitate the absorption of effusion.

With the development of musculoskeletal ultrasound technology, ultrasound can identify the superficial tissue around the knee joint, determine the size of popliteal cyst and the location of neck. Under the guidance of ultrasound, the method of in-plane puncture is adopted to realize the visualization of the whole process of needle and improve the accuracy of puncture and operation. The author summarizes that in the process of operation, the unidirectional valve structure should be dealt first, and the unidirectional valve structure should be destroyed completely. In the beginning, the cyst fluid cannot be sucked. If the cyst fluid is sucked out, the unidirectional valve structure is not easy to be identified under ultrasound. During the treatment, it should be noted that there are multiple unidirectional valve-like structures in some popliteal cysts, and each valve-like structure needs to be treated. When the expander expands the traffic port, it is recommended to expand back and forth in multiple directions repeatedly, to make the diameter of the channel fully expanded as far as possible, to avoid adhesion and recurrence caused by smaller caliber.

5. Conclusion

Ultrasound-guided central venous catheter dilator is safe and effective in the treatment of popliteal cyst. It makes use of the advantages of ultrasound visualization to expand the one-way valve orifice in the case of minimally invasive, avoiding surgical treatment of patients, and also achieves a good clinical treatment effect. The deficiency is that the number of samples is small and the follow-up time is short, which needs to be further confirmed by large samples and long-term follow-up studies.

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Conflicts of Interest

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

References

[1] Baker, W.M. (1994) On the Formation of Synovial Cysts in the Leg in Connection with Disease of the Knee-Joint. *Clinical Orthopaedics and Related Research*, **299**, 2-10. https://doi.org/10.1097/00003086-199402000-00001

[2] Rauschning, W. (1980) Anatomy and Function of the Communication between Knee Joint and Popliteal Bursae. *Annals of the Rheumatic Diseases*, **39**, 354-358. https://doi.org/10.1136/ard.39.4.354

[3] Handy, J.R. (2001) Popliteal Cysts in Adults: A Review. *Seminars in Arthritis and Rheumatism*, **31**, 108-118. https://doi.org/10.1053/sarh.2001.27659

[4] Smith, M.K., Lesniak, B., Baraga, M.G., *et al*. (2015) Treatment of Popliteal (Baker) Cysts with Ultrasound-Guided Aspiration, Fenestration, and Injection: Long-Term Follow-Up. *Sports Health*, **7**, 409-414. https://doi.org/10.1177/1941738115585520

[5] Caglayan, G., Ozcakar, L., Kaymak, S.U., *et al*. (2016,) Effects of Sono-Feedback during Aspiration of Baker's Cysts: A Controlled Clinical Trial. *Journal of Rehabilitation Medicine*, **48**, 386-389. https://doi.org/10.2340/16501977-2049

[6] Ohishi, T., Takahashi, M., Suzuki, D., *et al*. (2015) Treatment of Popliteal Cysts via Arthroscopic Enlargement of Unidirectional Valvular Slits. *Modern Rheumatology*, **25**, 772-778. https://doi.org/10.3109/14397595.2015.1008779

[7] Han, J.H., Bae, J.H., Nha, K.W., *et al*. (2019) Arthroscopic Treatment of Popliteal Cysts with and without Cystectomy: A Systematic Review and Meta-Analysis. *Knee Surgery and Related Research*, **31**, 103-112.

[8] Yang, B., Wang, F., Lou, Y., *et al*. (2017) A Comparison of Clinical Efficacy between Different Surgical Approaches for Popliteal Cyst. *Journal of Orthopaedic Surgery and Research*, **12**, 158. https://doi.org/10.1186/s13018-017-0659-z

[9] Akagi, R., Saisu, T., Segawa, Y., *et al*. (2013) Natural History of Popliteal Cysts in the Pediatric Population. *Journal of Pediatric Orthopaedics*, **33**, 262-268. https://doi.org/10.1097/BPO.0b013e318281e9bf

[10] Takahashi, M. and Nagano, A. (2005) Arthroscopic Treatment of Popliteal Cyst and Visualization of Its Cavity through the Posterior Portal of the Knee. *Arthroscopy*, **21**, 638.e631-638.e634. https://doi.org/10.1016/j.arthro.2005.02.007

[11] Rauschning, W. (1979) Popliteal Cysts and Their Relation to the Gastrocnemio-Semimembranosus Bursa. Studies on the Surgical and Functional Anatomy. *Acta Orthopaedica Scandinavica*, **179**, 1-43. https://doi.org/10.3109/ort.1979.50.suppl-179.01

[12] Sansone, V. and Ponti, A.D. (1999) Arthroscopic Treatment of Popliteal Cyst and Associated Intra-Articular Knee Disorders in Adults. *Arthroscopy the Journal of Arthroscopic & Related Surgery*, **15**, 368-372. https://doi.org/10.1016/S0749-8063(99)70053-8