



## **Anatomy of the Posteromedial Capsule of the Knee Joint and the Technique of Arthroscopic Approach to the Baker's Cyst**

S.A. Xontini <sup>1</sup>, T.O. Skipenko <sup>2</sup>, N.V. Zagorodny <sup>3</sup>

1. Federal State Autonomous Educational Institution of Higher Education "Peoples' Friendship University of Russia", Moscow, Russia

2,3. FGBU of the Ministry of Health of the Russian Federation. National Medical Research Center for Traumatology and Orthopedics named after N.N. Priorov, Moscow, Russia

**Corresponding Author: S.A. Xontini**, Federal State Autonomous Educational Institution of Higher Education "Peoples' Friendship University of Russia", Moscow, Russia.

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### **Abstract**

*The article provides an overview analysis of English and Russian sources on the anatomical structure of the posteromedial capsule of the knee joint, the etiopathogenesis of the Baker's cyst, and the technique of arthroscopic access to the Baker's cyst using the posteromedial port. The posterior medial port is more commonly used in orthopedic surgery, traumatology, and musculoskeletal radiology. The use of knowledge about the anatomical features of the posteromedial zone, possible ways of accessing the capsule of the knee joint will make it possible to personalize the approach to each patient.*

**Key words:** *Baker's cyst, popliteal cyst, treatment and formation of a popliteal cyst, anatomy of the posteromedial capsule of the knee joint.*

### **Introduction**

Cystic formation in the tendon of the medial head of the semimembranosus muscle is a variant of the norm. In the presence of a chronic inflammatory process in the cavity of the knee joint, which causes hypersecretion of the joint fluid, the destruction of the morphological integrity of the tendon, ligament and other structural elements of the knee joint capsule is triggered, which is a predictor of the occurrence of secondary pathological morphofunctional structures that significantly reduce the quality of life of a person of working age.

The existing interest in the search for new arthroscopic methods of treating Baker's cysts is due to the interest in reducing the social and material costs for recovery, subsequent rehabilitation of the individual.

Much research has been devoted to the study of the structural and functional parameters of the anatomy of the posteromedial capsule of the knee joint in normal and pathological conditions, including using the latest research methods. Interest in the anatomy of the posteromedial region of the knee joint capsule is justified due to the increase in interventional procedures associated with access to the Baker's cyst and in the cavity of the knee joint.

The literature describes the anatomical complex of the posteromedial capsule of the knee joint, which includes the distal semimembranosus tendon, the oblique popliteal ligament, and the posterior arcuate

ligament. The boundaries of the complex in front are the posterior edge of the tibial collateral ligament, behind - the medial edge of the posterior cruciate ligament [1] .

**Goal of the work :**

To study the anatomy of the posterior medial capsule of the knee joint and describe the techniques for arthroscopic access to the Baker's cyst.

**Materials and Methods**

A PubMed search was conducted for keywords related to the pathogenesis, diagnosis, and treatment of Baker's cyst, namely: Baker's cyst, popliteal cyst, treatment, the formation of a popliteal cyst, anatomy of the posteromedial capsule of the knee joint. Based on the results of the sample, 11 foreign literary sources and 6 domestic ones were analyzed. The first part of the review discusses the anatomical structure of the posteromedial capsule of the knee joint, the etiopathogenetic mechanism of the formation of the Baker's cyst. The second part describes the technique of arthroscopic approach using the posteromedial port to the Baker's cyst.

**Anatomy of the posteromedial capsule of the knee joint:**

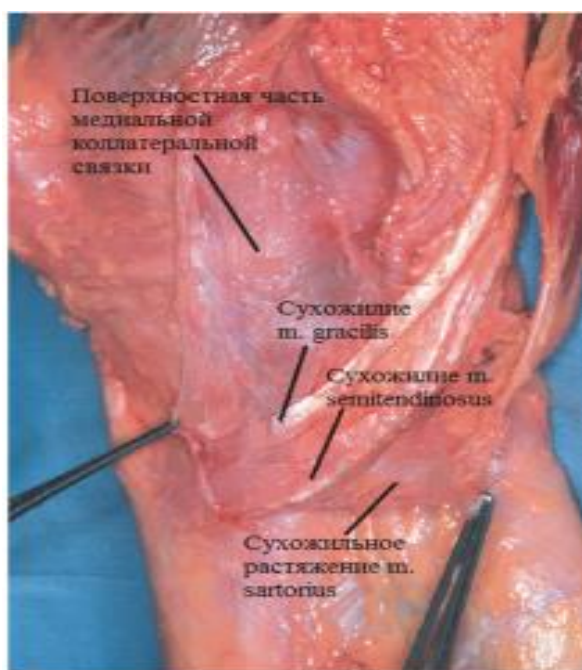
The medial surface of the knee joint area can be divided into three levels: superficial, medium and deep. The posterior medial region of the knee joint capsule is mainly formed from the tendon bundles of the semimembranosus muscle, which diverging in a fan-like manner, are woven in layers into the posterior part of the knee joint capsule [2]. The semimembranosus tendon has about eight attachment points, distal to the main common tendon [3].

The articular bag of the knee joint itself has a heterogeneous density in all departments and is strengthened by the ligamentous apparatus, which is formed from the tendons of the thigh muscles [4]. On the posterior surface of the articular capsule is the oblique popliteal ligament and the arcuate popliteal ligament.

The oblique popliteal ligament is a continuation of part of the bundles of the semimembranosus muscle, going from the medial condyle of the tibia obliquely upwards, in the form of arcs, arches to the external condyle of the thigh. The oblique popliteal ligament, the largest posterior structure of the knee, forms a broad fascial sheath over the posterior surface of the knee and is 48.0 mm long and 9.5

mm wide at its medial origin and 16.4 mm wide at its lateral insertion. The oblique popliteal ligament has two lateral attachments, one to the meniscomfemoral part of the posterolateral joint capsule and one to the tibia, along the lateral edge of the posterior cruciate ligament facet [2,3].

The topography of the tendon of the fine and semitendinosus muscles, lying between the first and second layers, is shown in Fig.1. The tendons of the gracilis and semitendinosus muscles lie between the first and second layers (in the splitting of the fascia covering the sartorius muscle and the superficial part of the MCL).



**Fig.1.** Anatomical preparation of the medial surface of the knee

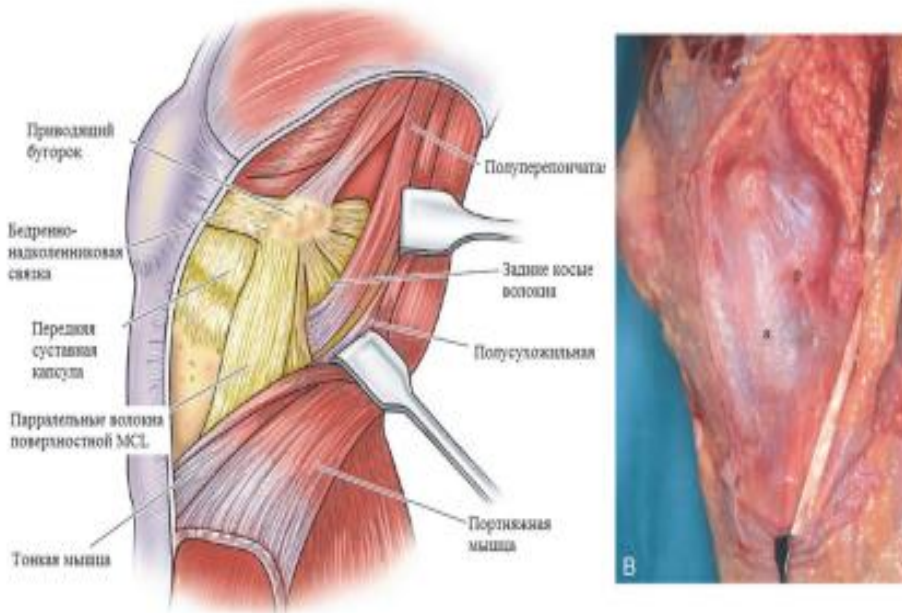
The tendons of the semimembranosus muscle are not only woven into the capsule of the knee joint, but also connected to the tendon fibers of the oblique popliteal fossa, the posterior arcuate ligament [5].

In classical anatomy, it is noted that under all places of attachment of the muscles of the knee joint there are synovial bags that communicate with the cavity of the knee joint, the sizes and number of bags are individual [6].

On the inner surface of the synovial membrane of the capsule of the knee joint there are round or oval thinnings, which are most often found in places of the greatest accumulation of synovial fluid. These

structures are called "hatchholes", which provide the processes of transsynovial exchange and serve to equalize intra-articular pressure [7].

Figure 2 shows the second layer. The sartorius muscle is dissected distally and abducted with a hook. Parallel (anterior) and oblique (posterior) fibers of the superficial portion of the medial collateral ligament are shown. According to Basmajian J.V.: Grant's method of anatomy, ed 10, Baltimore, 1980, Williams & Wilkins



**Fig.2.** Schematic representation of the medial surface of the knee.

The etiopathological cause of the formation of a Baker's cyst is weakness, extensibility of the tendon fibers of the semimembranosus muscle, which occurs secondarily, as a result of constant chronic inflammation, followed by stretching of the fibers and the formation of a synovial cyst. The cavity of the cyst communicates with the cavity of the knee joint due to an anastomosis, which has a one-way valve mechanism that moves the synovial effusion only in the direction from the joint cavity to the bursa, which favors the formation of such cysts [8].

There is also an opinion that this functional valve mechanism is created by the interaction of the tendons of the gastrocnemius, semimembranosus and semitendinosus muscles, which pull and compress the narrow isthmus of the anastomosis, which ensures the outflow of fluid. When the knee is flexed, the "valve" opens, and when the knee is extended, the "valve" closes due to the tension of these muscles. In addition, the existing intra-articular pressure of the knee prevents the formation and

filling of popliteal cysts. Intra-articular pressure during partial flexion of the knee has a negative value (-6 mm Hg), when the knee is extended, the pressure becomes positive (16 mm Hg) [9,10].

### **Arthroscopic access technique for Baker's cyst:**

Arthroscopically, the anatomy of the posteromedial capsule of the knee joint is divided into three types: type I - no capsular fold and no foramen; type II - there is a capsular fold without opening; type III - there is a capsular fold, along the ligament with a hole.

When reviewing the literature, a statistically significant relationship was found between the type of anatomy of the posteromedial capsule of the knee joint and the popliteal Baker's cyst ( $p=0.001$ ), popliteal cysts were found in the knee joints of type II and knee joints of type III [11].

Arthroscopic access to the Baker's cyst is preferable to open excision due to the minimization of invasive intervention, which leads to quick rehabilitation and restoration of working capacity. Recent advances in arthroscopic techniques make it possible to effectively revise intra-articular pathology, obliterate existing anastomoses and complex cysts with a valvular mechanism.

In the literature, it is noted that the fibrous membrane of a cystic formation favors the formation of additional cysts, partitions inside the cyst, which entails the possibility of a cyst recurrence after an arthroscopic cystectomy, which leads to a proposal to revise the techniques of arthroscopic treatment of cystic formations.

Surgical excision of the popliteal cyst in the presence of symptoms can be performed by several approaches: limited posteromedial, extended posteromedial, and direct posterior.

The direct posterior approach was described by Haggart as a curved or S-shaped incision above the popliteal fossa in mid-flexion, with the patient in the prone position. With this surgical intervention, a dissection of the superficial fascia is performed, followed by identification of the semimembranosus and medial head of the gastrocnemius muscle. The medial head of the muscle is retracted to expose the cyst and find the anastomosis with the joint [12].

The posterior medial limited and expanded approaches have been described and recommended for excision of the popliteal cyst by Rauschnig, Medvecky and Noyes. During surgery, the patient is placed on his back with the table leg lowered to provide access to the posteromedial part of the knee. For small cysts, a posteromedial limited approach is used. For large cysts or cysts that are multilocular, an extended posterior medial approach is used [13,14].

This literature review describes the inside-out arthroscopic approach for direct limited posteromedial access. The advantage of this technique is the prevention of damage to the saphenous nerve, as well as the popliteal vessel, when using transillumination [15].

When the patient is in the supine position, a standard leg holder is used on the surgical field, when it is possible to subsequently bend the knee at an angle of 90°. A tourniquet is applied to the operated thigh, under the gluteal fold. The other, non-operative leg is placed in a well-sealed leg holder in a lithotomy position that gives the surgeon and assistants enough room to perform the operation.

The leg to be operated on is placed in an arthroscopic leg holder at the level of the femoral tourniquet and the leg position is adjusted so that the thigh is parallel to the floor. A stocking is put on the foot and the distal part of the lower leg and fixed with an elastic bandage. A sterile U-drape and a standard lower limb arthroscopic drape are applied around the thigh.

After general or spinal anesthesia, the fluid from the popliteal cyst is aspirated as much as possible using an 18G needle. With another syringe, through the same needle, we inject methylene blue dye into the cyst. Thus, there is an accessible place for opening the popliteal cyst, which can sometimes be obliterated by a pliable fibrous septum. The posteromedial patella crease is expanded, followed by resection, to form a wide anastomosis between the popliteal cyst and the joint. Arthroscopic intervention in the cavity of the knee joint is performed through a standard anterolateral port using a wide-format 4.5 mm 30° arthroscope.

During arthroscopic intervention, an audit of concomitant intra-articular pathology is carried out, for example, removal of free bodies in the joint cavity, partial meniscectomy or chondroplasty. After carrying out revision measures, the knee is bent at an angle of 90 ° to move the tailor's branch of the saphenous nerve posteriorly.

The subsequent introduction of the arthroscope through the anterolateral port into the posteromedial department through the intercondylar notch between the medial femoral condyle and the posterior cruciate ligament is carried out. The passage of the arthroscope is facilitated by light but steady pressure on the arthroscope as medially as possible. The soft spot is palpated between the medial collateral ligament, the medial head of the gastrocnemius muscle, and the tendon of the semimembranosus muscle.

The localization of the posteromedial portal is carried out in this soft spot, just above the joint line, using a spinal needle. A superficial longitudinal incision of the skin is made, and with the help of a hemostat, a blunt dissection of the subcutaneous tissue is performed, followed by penetration into the



joint capsule. Using a probe, the cyst opening is identified through the posteromedial portal by downward displacement of the overlying capsular fold located on the posteromedial side of the medial head of the gastrocnemius muscle.

After identifying the valvular structure of the cyst, a partial resection of the capsular fold is performed through the posteromedial port by inserting a set of basket forceps. The valve opening of the capsule is expanded with a motorized shaver. Insertion of the motorized razor is through a straight posterior port that facilitates intracystic debridement.

After excision of the capsular fold, the arthroscope at an angle of 30° is passed into the wall of the cyst through an opening located behind the medial head of the gastrocnemius muscle. With the presence of a fibrous membrane, nodes, additional valves and partitions in cystic formations, the presence of a direct posterior port greatly facilitates intracystic sanitation.

The patient's leg is straightened. When using the transillumination technique to indicate the position of the direct posterior approach, it avoids damage to the popliteal vessel. The arthroscope is removed from the sheath and then the insertion of the Wissinger rod is carried out, which is necessary to make sure that there are no foreign objects between the knife and the Wissinger rod. A palpation examination of the course of the Wissinger rod is carried out along the skin. A shaver is then inserted through a straight posterior port to remove the fibrous sheath, nodules, and septa.

A subsequent total arthroscopic cystectomy is performed by shaving off the intimate wall of the popliteal cyst. A suction drain is placed, followed by the application of a pressure bandage. Ordinary physical activity and active-passive movements are allowed in accordance with the protocol with concomitant intra-articular pathology [16,17].

In conclusion, it should be noted that the existing surgical techniques for resection of popliteal cysts differ from one author to another, therefore, attempts are being actively made to improve the methods of arthroscopic resection. The authors agree that the elimination of the anastomosis between the joint cavity and the cyst is the goal of any surgical intervention to completely remove the cyst.

The use of arthroscopic access to the popliteal cyst provides effective treatment not only of the cyst itself by arthroscopic decompression, but also of concomitant intra-articular pathology with simultaneous surgical treatment of combined intra-articular lesions that cause the development of a chronic inflammatory process.



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