

## The Clinical Significance of the Valve Mechanism in Communicating Popliteal Cysts

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**Summary.** In a previous investigation of 41 patients presenting with distended popliteal cysts, a valvular mechanism was demonstrated in 25 cases by means of a specific arthrographic procedure. In the present study the clinical symptoms and signs from the popliteal space and from the joint were assessed and related to the presence or absence of a valvular mechanism. By arthroscopy or arthrotomy seventeen associated knee disorders were diagnosed, e.g., synovitis, osteoarthritis, and tears of a semilunar cartilage. Intra-articular symptoms and intrinsic joint diseases were significantly correlated to the absence of a valve mechanism. The presence of a valve mechanism was indicative of the absence of pathological findings in the joint.

**Zusammenfassung.** In einer vorhergegangenen arthrographischen Studie war bei 25 von 41 Patienten mit klinisch nachgewiesenen Kniekehlenzysten ein Ventilmechanismus zwischen der Zyste unter der Gelenkhöhle nachgewiesen worden. In der vorliegenden Studie werden die Symptome und Befunde vom Gelenk untersucht und zu dem Vorhandensein eines Ventilmechanismus in Beziehung gesetzt. Mittels Arthroskopie und/oder Arthrotomie wurden 17 zugeordnete Gelenkerkrankungen diagnostiziert, u. a. Synovitis, Arthrose und Meniskusschäden. Beim Fehlen eines Ventilmehanismus wurden in der Regel pathologische intraartikuläre Befunde erhoben, während nur ausnahmsweise Gelenkbeschwerden und -erkrankungen nachgewiesen wurden, wenn ein Ventilmehanismus den Rückfluß des Zysteninhaltes in das Gelenk verlegte.

Popliteal cysts arise from fluid distension of the constant, large bursa at the postero-medial aspect of the knee. In elderly subjects this bursa usually communicates with the joint cavity. In younger persons such communication is less frequent, and in children it is rare (Wolfe and Coloff, 1972; Lindgren and Willén, 1977). The bursa is located beneath the tendon of the medial head of the gastrocnemius muscle and between this tendon and the semimembranosus muscle. The communication with the joint is invariably situated high up under the gastrocnemius tendon at the site where it merges with the capsule. The opening takes the shape of a transverse slit 1–2 cm wide. On extension of the knee the slit is always firmly closed due to the compression sustained between the condyle and the overlying tendons. On knee flexion the communication of normal bursae opens, allowing the fluid to pass over into the joint (Lindgren, 1978; Rauschnig, 1979a).

As demonstrated in a previous study (Lindgren and Rauschnig, 1979) a valve mechanism is operative at the site of communication in some clinically significant popliteal cysts. When the flow of fluid from the cyst to the joint was impeded or obstructed no effusion was found in the joint and the fluid in the cysts was usually more viscous than the articular synovial fluid. These cysts also were significantly larger than those with an unimpeded flow of fluid into the joint.

Popliteal cysts only occasionally give rise to severe symptoms. Usually they cause slight or moderate discomfort and they may interfere with extension of the knee (Rauschnig and Lindgren, 1979). They sometimes develop into giant cysts tracking down into the calf, particularly in patients with long-stand-

ing arthritis and considerable joint effusion. Sometimes there has been confusion with deep venous thrombosis, especially in rheumatoid arthritis. Occasionally dissection of the cyst wall with leakage of synovial fluid into the interstitial tissue occurs. Not infrequently the cyst wall ruptures completely, allowing large amounts of synovial fluid to escape into the intermuscular planes of the leg. Particularly in rheumatoid arthritis the inflammatory contents from the joint are known to have tissue-irritating properties. The inflammation caused by this fluid leads to calf symptoms indistinguishable from those seen in deep venous thrombosis (Dixon and Grant, 1964; Hench, 1966; Hughes and Pridie, 1970; Vahvanen, 1973). A variety of underlying intrinsic disorders of the knee have been found such as rupture of the menisci and the ligaments, osteoarthritis and osteochondritis dissecans (Burlison et al., 1956; Childress, 1970; Wolfe and Coloff, 1972; Bacon and Gerber, 1974; Smillie, 1974). In other cases, however, no symptoms or signs indicative of an intraarticular disorder have been found, particularly in children (Morscher, 1957; Gristina and Wilson, 1964; Malloch, 1970; Dinham, 1975).

A valvular mechanism between the joint cavity and the cyst itself might constitute an aetiopathological factor in the formation of popliteal cysts. The present study was undertaken to assess the articular symptoms and signs and the findings at arthroscopy and arthrotomy in relation to the presence or absence of a valve mechanism.

## Patients

A series of 41 consecutive patients with distended popliteal cysts were investigated. There were 18 women and 23 men with a mean age of 43.5 years. As was demonstrated by a special arthrographic procedure a total valve mechanism was present in 18 of the knees, in 7 the valvular mechanism was subtotal and in 16 the fluid moved freely from the cyst to the joint. The age distribution and the number of patients with a valve mechanism in the different age groups are shown in Fig. 1.

Twenty-three cysts were in the right and 18 in the left leg. They had caused popliteal symptoms for an average of 1.2 years (range 1 month to 10 years). Ten patients reported a definite history of trauma. Seropositive rheumatoid arthritis was known in 4 patients and one had psoriatic arthritis. In 10 patients plain radiographs had revealed marked osteoarthritic changes, particularly in the medial femoro-tibial and the patello-femoral articulations. Four patients with symptoms indicative of deep venous thrombosis proved to have ruptures of a popliteal cyst. Most patients were referred to the orthopaedic surgeon on account of the popliteal swelling. In a few cases the cyst was found at examination of the knee performed because of symptoms from the joint.

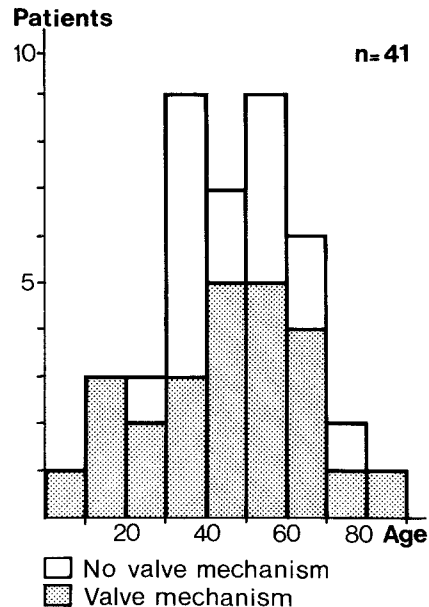


Fig. 1. Age distribution of the patients and the presence or absence of a valve mechanism in the different age groups

Table 1. Grading of symptoms from the knee joint. A patient was assigned to the grading category for which he or she fulfilled three or more parameters

0	No swelling No pain No instability or weakness No limitation of movement No limitation of work or participation in sports
I	Slight swelling Slight discomfort Some giving-way or weakness, muscular atrophy < 1 cm Negligible limitation of movement < 10° No hard labour, no elite sport
II	Moderate swelling Pain following moderate exertion Slight or moderate instability, locking, muscular atrophy 1—2 cm Limitation of movement 10—20° No physical work, finished with some sport
III	Considerable and tense swelling Severe pain interfering with activities of daily life, pain at rest Disabling instability, contractures, muscular atrophy > 2 cm Limitation of movement > 20° Stopped working because of knee derangement, no sport

## Methods

The symptoms from the knee joint were graded as shown in Table 1 and the popliteal symptoms were assessed according to criteria given in Table 2. On examination of the joint any effusion, instability, wasting of the quadriceps muscle, or

**Table 2.** Grading of popliteal symptoms

0	No swelling or pain
I	Some swelling, slight discomfort following strenuous use of the joint
II	Considerable swelling without pain, or swelling following normal activities with some tenderness on full extension and flexion, no limitation of movement
III	Constant tense swelling of cyst, does not disappear at rest, considerable tenderness, limited range of motion

**Table 3.** Associated articular symptoms in relation to the presence or absence of a valve mechanism at the communication between the joint and the popliteal cyst\*

Joint symptoms	Arthrography		Total
	Valve mechanism	No valve mechanism	
None	8	—	8
Slight	12	—	12
Moderate	5	9	14
Severe	—	7	7
Total	25	16	41

\*  $\chi^2 = 28.732$  (\*\*\*) =  $P < 0.001$  calculated from the figures condensed into a four-fold table)

restriction of the range of motion was recorded, as well as crepitus and pain at varus-valgus or rotational stress and on patello-femoral compression. In addition to palpation of the cyst, the sensitivity and circulatory status of the leg were assessed.

In 34 cases the joint had been examined arthrographically. Additional information concerning the joint was obtained by arthroscopy in 11 cases. In 7 cases both arthroscopy and arthrotomy were performed and in 8 cases the articular diagnosis was based on arthrotomy alone. Thus a direct visual diagnosis was made in 26 joints. In the remaining 15 there was no doubt concerning the knee disorder or there were no signs of an articular disease. Seventeen of the popliteal cysts were operated upon and the morphological findings at the site of communication were recorded photographically. In 12 cases the pathological condition of the joint was surgically corrected, whereas the cysts were left untouched.

**Results of the Clinical Examination**

The symptoms from the joint in relation to the presence or absence of a valvular mechanism are presented in Table 3. Four of 5 patients with a valve mechanism had no or only slight joint symptoms, whereas articular symptoms were present in all 16 cases with a free communication.

In 14 cases quadriceps wasting was noted, but only in 3 did this amount to more than 2 cm. In one knee

**Table 4.** Associated articular disorders in relation to the presence or absence of a valve mechanism between the joint and the popliteal cyst (see also Methods)

Associated articular disorder (arthroscopy/arthrotomy-diagnoses)	Arthrography		Total
	No valve mechanism	Valve mechanism	
Osteoarthritis	4	1	5
Synovitis			
1. rheumatoid	3		
2. villonodular		1	
3. psoriatic	1		
4. non specific	1	1	7
Torn meniscus	4		4
Chondromalacia patellae	1		1
Total	14	3	17

**Table 5.** Associated articular disorders in relation to the presence or absence of a valve mechanism between the joint and the popliteal cyst\*

Articular diagnosis	Arthrography		Total
	Valve mechanism	No valve mechanism	
No associated knee disorder	18	2	20
Associated knee disorder	3	14	17
Total	21	16	37

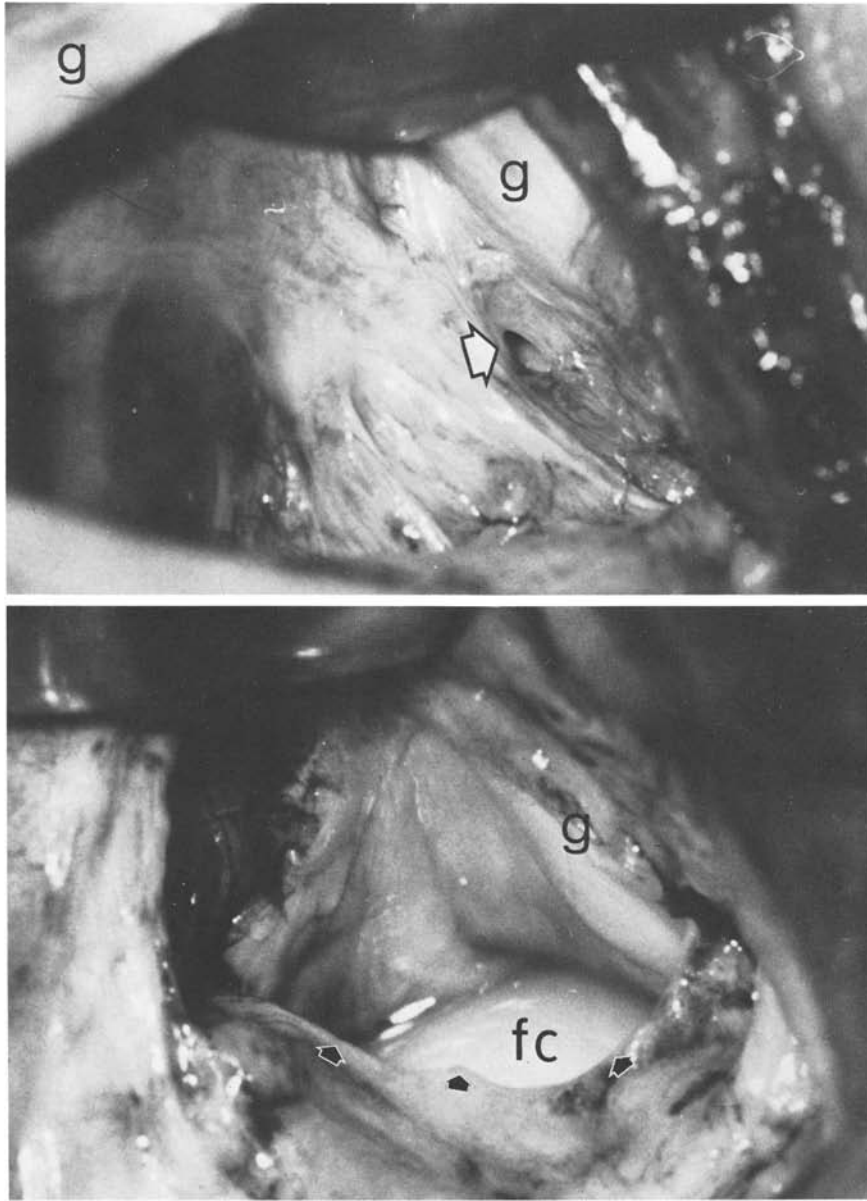
\*  $\chi^2 = 18.022$  (\*\*\*) =  $P < 0.001$ )

medial instability was found. In 13 knees the total range of motion was restricted by less than 30°, in 4 knees by more than 30°. This restriction was due to the articular disorder rather than to the mechanical hindrance caused by the cyst.

Twenty-two cysts were maximally distended, 10 were tense and the remainder were palpable and soft. The incidence and the severity of popliteal symptoms showed no correlation to the presence or absence of a valve mechanism, nor were the popliteal symptoms related to the symptoms from the joint, the effusion or the presence of an intraarticular disorder or its duration.

**Associated Disorders of the Joint**

Of 37 patients 17 were found to have associated articular disorders. The articular diagnoses in these 17 pa-



**Fig. 2.** Intraoperative view of the communication in a patient with a radiographically demonstrated valve mechanism. The gastrocnemius tendon (g) is retracted. Synovial membranes with small openings (arrow) conceal the opening (upper). After removal of the membranes the capsular opening and the femoral condyle (fc) are seen (lower)

tients as based on clinical and radiographic examination, arthroscopy and/or arthrotomy are presented in Tables 4 and 5. To correct the articular disorder a total of 7 anterior synovectomies, 5 excisions or resections of a semilunar cartilage, 2 advancement-osteotomies of the tibial tuberosity and one tibial osteotomy were performed. At the synovectomies in the rheumatoid cases the contents of the popliteal cysts could be emptied into the joint by manual compression, although all contained fibrin lumps. The majority of cysts had completely disappeared or had become clinically inapparent within a few months postoperatively and the rest had become less tense and tender. One cyst recurred more than one year after a synovec-

tomy in connection with flaring up of the rheumatoid synovitis. In this patient a further synovectomy is planned.

#### The Communication at Operation

Among the 14 patients in whom the popliteal cyst was operated upon a valve mechanism had been demonstrated in 11 preoperatively. In the 3 patients without such valvular mechanism one had osteoarthritis with symptoms from the popliteal space but none from the joint, another had osteocartilaginous loose bodies in the cyst causing mechanical irritation and the third

had symptoms due to scarring after excision of a popliteal cyst 3 years previously. In practically all cases with a valve mechanism a meshwork of *synovial membranes* covered the opening from outside the joint (Fig. 2). In some cases several layers of membranes with round holes or slit-formed apertures concealed the opening. When these were removed the normal slit-formed communication into the joint was disclosed.

The cysts were resected if their walls were fibrotic, whereas soft cysts were left in situ. The capsular opening was closed by means of one row of sutures which was reinforced by a proximally based flap from the overlying gastrocnemius tendon (Rauschnig, 1979b).

## Discussion

Associated joint disorders were demonstrated in 17 of the 41 patients with popliteal cysts. Burleson et al. (1956) reported articular disorders in 34 out of 82 cases, Gristina and Wilson (1964) diagnosed joint diseases in 47 out of 67 adult patients and Vahvanen (1973) established pathological joint diagnoses in 35 out of 42 patients, most of them with rheumatoid arthritis. Most reported series are not sufficiently well identified as to age, articular symptoms and signs to permit a comparison with this material and in none of the reports has attention been paid to the presence or absence of a valve mechanism between the joint and the cyst.

No previous investigation has been performed with the aim of clarifying the morphological basis of the valvular mechanism at the site of the communication. Jayson and Dixon (1970) suggested that the valve might be of the Bunsen type (compression of the canal) or of the Ball type (obstruction of the opening by a fibrin plug), but provided no evidence to support either theory. In this study membranes, synovial bands and folds were found in all valvular cases. The origin of these membranes is unknown. Scarring and mechanical irritation might be one explanation. They may, however, constitute remnants of the connective tissue which in most younger subjects is interposed between the joint and the bursal cavity, forming a broad barrier (Lindgren and Willén, 1977). In favour of the latter view is the frequency with which membranes are observed within the cyst cavity. At arthroscopy both the communication and membranes in the canal could be inspected. The membranes concealing the opening would also lend an explanation to the fact that many surgeons have been unable to detect the capsular opening even though at preoperative arthrography the

cyst had filled with contrast medium from the joint (Burleson et al., 1956; Morscher, 1957; Gristina and Wilson, 1964; Malloch, 1970).

## Clinical Conclusions

The results of this study suggest that popliteal cysts may form by two essentially different mechanisms. The cyst development is also based upon completely disparate aetiopathogenetic backgrounds that would permit to distinguish two types of cysts implying the need for different diagnostic and therapeutic approaches:

*The primary or idiopathic cyst* has a valvular connection with the joint cavity impeding or totally obstructing fluid influx into the joint. The cyst content is usually viscous or highly viscous. Symptoms from the joint or articular disorders rarely occur. This type seems to be the rule in young patients. In children popliteal cysts should not be operated upon as they are liable to disappear spontaneously (Dinham, 1975). If a primary cyst in an adult causes considerable symptoms, operative intervention may be considered. This should be aimed at tight closure of the communication, whereas it is less important to excise all cyst tissue radically (Rauschnig, 1979b).

*The secondary or symptomatic cyst* communicates freely with the joint cavity, allowing ready fluid exchange between the two cavities. It contains synovial fluid of normal viscosity. In the vast majority of non-valvular popliteal cysts articular symptoms are present. The secondary cysts indicate a careful examination of the joint as they are often the presenting symptoms of a knee disease. Accordingly arthroscopy is useful in the search for the underlying articular disorder, as it allows a direct inspection of the cartilage and the synovial membrane. Any intraarticular pathological condition should be treated if possible. A cure of the underlying condition usually causes the secondary cyst to disappear or become less tense, as the effusion in the joint decreases. Only in rare cases is it necessary to resort to surgical treatment of this type of popliteal cyst.

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