

## Sonography of Baker's Cyst (Popliteal Cyst): the Typical and Atypical Features

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### ABSTRACT

*Baker's cyst (Popliteal cyst) is an abnormal distension of the gastrocnemius-semimembranosus bursa, which is a commonly encountered condition in sonographic knee examinations. A cystic lesion extending between the tendons of semimembranosus and the medial head of gastrocnemius remains the key to diagnosis. However, a variety of normal appearances and pathologies may constitute uncommon or even relatively rare manifestations of Baker's cysts on sonography, and leads to diagnostic confusion. The variety of sonographic appearances and differential diagnosis of Baker's cyst are described in this review, so as to allow a better appreciation of the sonographic appearances of Baker's cysts and facilitate a more definitive diagnosis.*

*Key Words: Anterior cruciate ligament; Bursa, synovial; Knee; Popliteal cyst; Ultrasonography*

### 中文摘要

#### 膕窩囊腫在超聲影像中的典型及非典型特徵

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本膕窩囊腫又名Baker囊腫，是膕窩深部滑囊腫大的現象，在膝超聲檢查中很普遍。診斷憑據為半膜肌肌腱與腓腸肌內側頭觀察到囊性病變。此病的症狀表現及病理很多樣化，部分在超聲上為罕見或甚為少見的膕窩囊腫表現，引致診斷困難。本文回顧膕窩囊腫在超聲影像中的特徵及其鑒別診斷，讓醫生對此病有更多理解，從而達成更明確的診斷。

### INTRODUCTION

In 1840, Adams originally described the popliteal cyst.<sup>1</sup> In 1877, Baker<sup>2</sup> described eight cases of popliteal fossa swelling and concluded that this finding was secondary to fluid escaping from the knee joint. Since then, his name has been eponymously used for popliteal cysts.

Baker's cyst is an abnormal distension of the

gastrocnemius-semimembranosus bursa. It is usually extends posteriorly between the tendons of the medial head of gastrocnemius and the semimembranosus muscle, and is the most common cyst located in the posteromedial aspect of the knee.

Among adult patients who undergo magnetic resonance imaging (MRI) of the knee, its prevalence ranges from 5 to 38%.<sup>3-6</sup> It is increasingly more common with

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increasing age, and is significantly more frequent in persons aged 50 years or more.<sup>7</sup>

In a prospective ultrasound study on asymptomatic children, the prevalence of Baker's cysts was estimated to be 2.4%.<sup>8</sup> In a retrospective MRI study on 393 children (mostly referred for knee pain), a Baker's cyst was found in 25 (6.3%) patients.<sup>9</sup>

## AETIOLOGY AND ANATOMY

The pathogenesis of adult-onset Baker's cyst is explained as a communication channel between the knee joint and the bursa, as well as corresponding fluid mechanics. Such a connection was found in 30 to 50% of cadaveric dissections,<sup>10,11</sup> in 55% of surgically proven cysts,<sup>12</sup> in 37% of arthroscopically examined knees,<sup>13</sup> and in 50% of arthrograms of normal knees.<sup>14</sup> The communication channel is a 15 to 20 mm transverse slit-like capsular opening adjacent to the proximal posterolateral margin of the medial femoral condyle and just distal to the origin of the gastrocnemius tendon, which opens into the gastrocnemius bursa.<sup>11,15</sup> The relative weakness of the posteromedial joint with reinforcement from the medial meniscal posterior horn attachment is also contributory to its formation.<sup>7</sup>

During knee movements, fluid moves to and fro between the knee joint and the bursa until the communication is closed by the tense gastrocnemius-semimembranosus muscles, trapping bursal fluid.

Baker's cysts are commonly associated with intra-articular lesions. Baker's cysts were found to be associated with one or more disorders detected by MRI in 94% of cases.<sup>16</sup> They are meniscal (83%), frequently involving the posterior horn of the medial meniscus, chondral (43%) and anterior cruciate ligament tears. It has been suggested that in many cases, the presence of knee joint effusion increases the pressure within the joint space. The presence of an effusion-producing derangement, rather than the abnormality itself, is proposed to be the important factor for Baker's cyst formation.<sup>3,17</sup>

Baker's cysts are also frequently associated with arthritis. In a study by Liao et al<sup>18</sup> of patients referred from rheumatology clinic who underwent ultrasound examination of knee, 50.6% (81/180) of Baker's cyst associated with osteoarthritis, 20.6% (37/180) with rheumatoid arthritis, 13.9% (25/180) with gout, 7.8%

(14/180) with seronegative spondyloarthropathy and 7.2% (13/180) with pyrophosphate arthropathy.

In contrast, the communication between the joint and Baker's cyst is not shown in paediatric patients. In a retrospective MRI study on 393 children mostly referred for knee pain, a Baker's cyst was found in 25 (6.3%) patients, but only four (16%) of them had joint effusions, whilst none had co-existing meniscal or anterior cruciate ligament tears.<sup>8</sup> In children, Baker's cysts are due to primary bursal irritation rather than extensions from abnormal joints.<sup>12</sup> However, Baker's cysts are frequently encountered in patients with juvenile rheumatoid arthritis.<sup>9</sup>

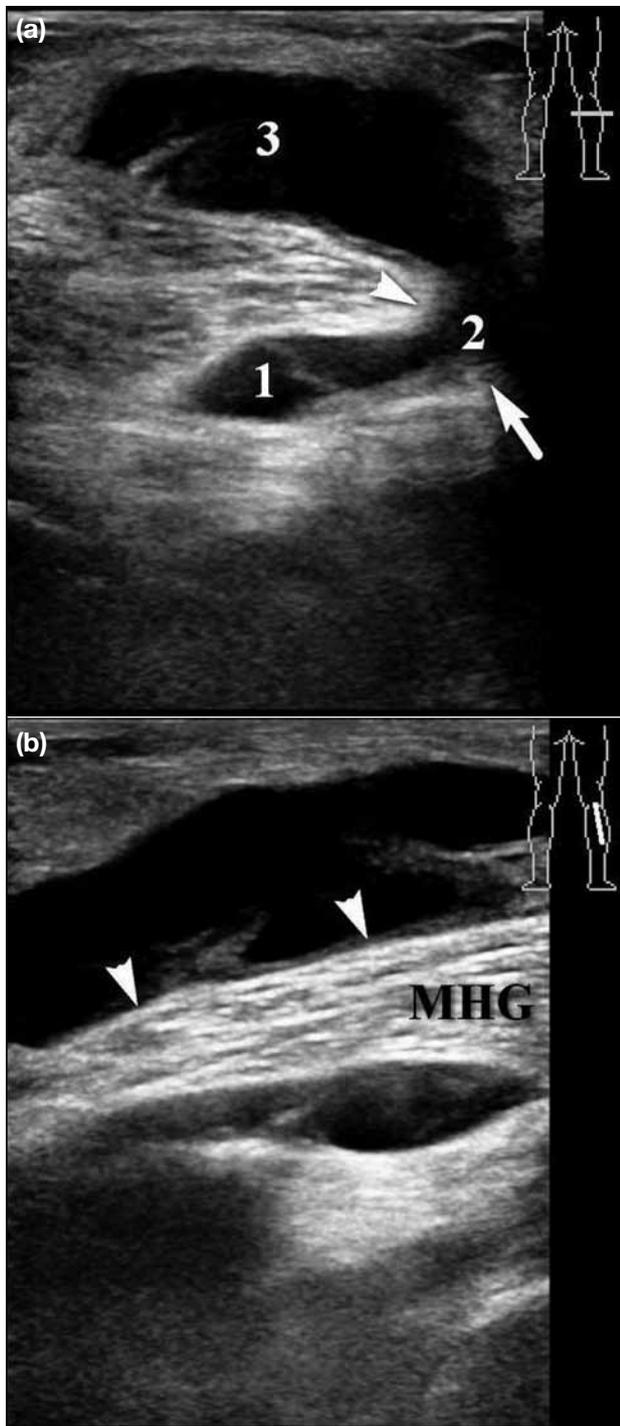
The gastrocnemius-semimembranosus bursa is composed of two bursae: the gastrocnemius and the semimembranosus, being relatively more laterally and medially situated, respectively. Each of these bursae is divided by a septum into an anterior and a posterior horn. Depending on the location of the septum, the horns may be of different sizes. The gastrocnemius-semimembranosus bursa is located between the medial head of the gastrocnemius and semimembranosus tendons and the medial femoral condyle. The popliteal vessels are located more laterally.

## TYPICAL SONOGRAPHIC FEATURES

The crescent- and beak-shaped forms have been described as the classical forms of Baker's cysts. As the communication channel opens to the bursa of the medial gastrocnemius muscle, and the bursae of the medial gastrocnemius muscle and the semimembranosus muscle usually do not communicate owing to a central septum, only the gastrocnemius bursa fills. Thus, the cyst develops around the medial head of the gastrocnemius muscle and appears horseshoe or crescent-shaped on transverse sonograms.<sup>19</sup>

In most cases, three components of the cyst can be demonstrated. The base is located in the semimembranosus tendon, the tendon of the medial head of the gastrocnemius and the posterior capsule. The base of the cyst is usually smaller than its superficial part. The neck is located between the tendon of the semimembranosus and the tendon of the medial head of the gastrocnemius. The superficial portion of the cyst (the body) is subcutaneous and ends with a rounded pole (Figure 1). As Baker's cysts enlarge, they usually extend superficially and caudally between the crural fascia and medial head of gastrocnemius (Figure 2).

Most Baker's cysts are anechoic. In patients with trauma, osteoarthritis, neuropathic joint disease, or



**Figure 1.** Baker's cyst: sonographic appearance. (a) A transverse sonogram shows the different components of a typical Baker's cyst: the base (1), the neck (2) located between the tendon of the semimembranosus (arrow) and the tendon of the medial head of the gastrocnemius (arrowhead), and the large body (3). (b) A longitudinal sonogram depicts the base and the body of the cyst separated by the straight tendon (arrowheads) of the medial head of the gastrocnemius (MHG).

synovial abnormalities such as chondromatosis or osteochondromatosis, intra-articular loose bodies can be appreciated within the cyst as a result of migration of fragments from the joint (Figure 3).

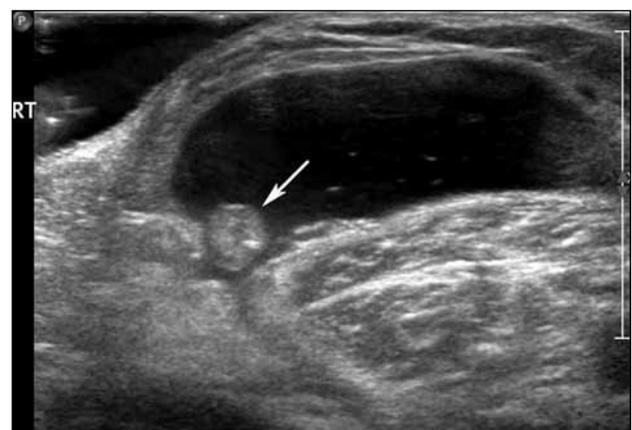
### ATYPICAL SONOGRAPHIC FEATURES

Although Baker's cyst is classically anechoic, echogenic material such as septations (Figure 4), fibrin and clotted blood are sometimes encountered, especially in patients with knee pain or symptoms simulating deep vein thrombosis (DVT). These echogenic materials were reported in 65% of Baker's cysts who presented with the aforementioned symptoms, whereas they were anechoic in asymptomatic subjects.<sup>7</sup>

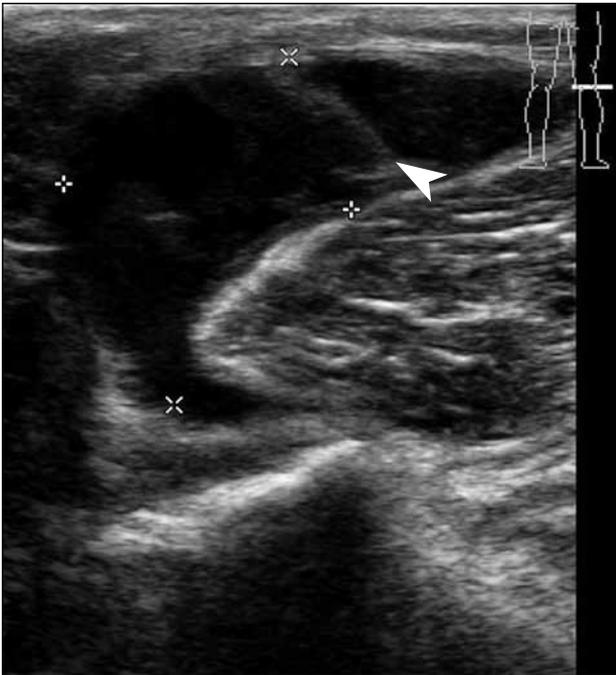
In rheumatoid arthritis or other conditions associated with synovial hypertrophy, such as seronegative arthritides or pigmented villonodular synovitis (PVNS), the cystic lumen can be partially or completely filled



**Figure 2.** Baker's cyst with caudal extension: a longitudinal sonogram shows a Baker's cyst which extends caudally between the crural fascia and the medial head of the gastrocnemius (MHG). Calipers outline the cyst.



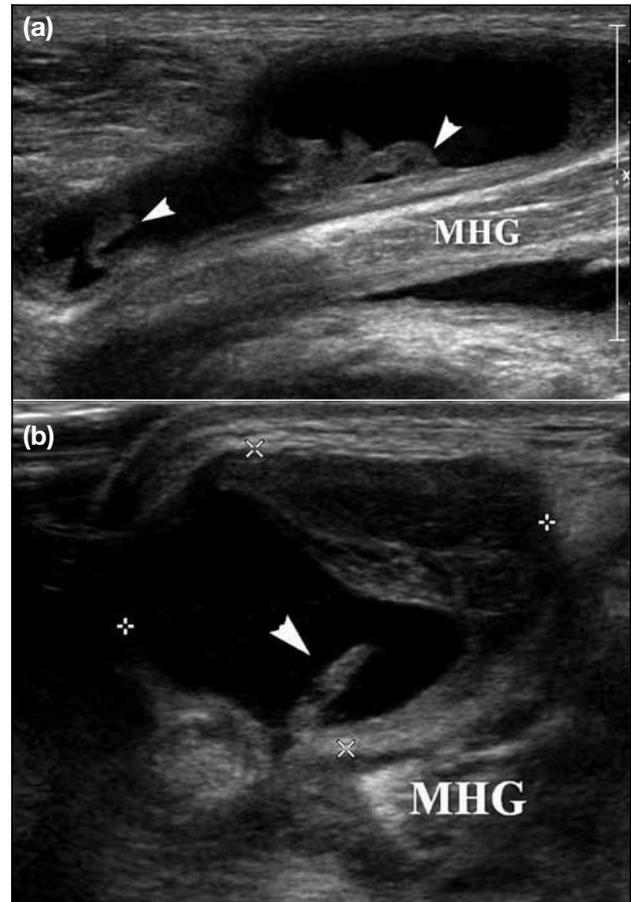
**Figure 3.** A longitudinal sonogram shows a thick-walled Baker's cyst with intra-bursal loose body (arrow).



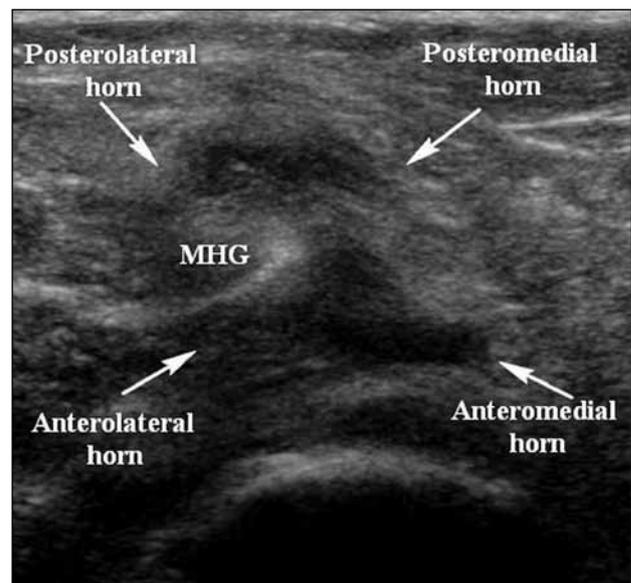
**Figure 4.** A transverse sonogram shows a Baker's cyst with synovial proliferation and internal septum (arrowhead). Calipers outline the cyst.

with synovium (Figure 5). Rheumatoid Baker's cysts characteristically have markedly irregular synovial lining, with numerous internal echoes identified within the fluid, and tend to be much larger than those associated with other types of joint pathology.<sup>20</sup>

Apart from being crescent-shaped, even x-shaped and grape-like forms have been described on transverse sonograms.<sup>19</sup> The x-shaped Baker's cyst is explained by a communication between the medial gastrocnemius and the semimembranosus bursae. Both bursae end with anterior and posterior horns; fluid accumulation results in the filling of all four horns, producing an x-shaped appearance (Figure 6). The grape-like form of Baker's cysts can be attributed to long-standing derangement associated with rheumatoid or other inflammatory arthritides of the knee. Septations or daughter cysts may lead to a grape-like appearance. In this form of cyst, debris and synechiae result in a wide variety of appearances, with wall thickening and / or blood clots. A rare variant in this group is the popliteal cysts with a sonographic appearance similar to that of solid tumours. By demonstrating the presence of flow signals within the mass, colour Doppler can eliminate the possibility of a popliteal cyst mimicking a solid tumour. However, because blood flow may be sluggish in some tumours, a negative-colour Doppler cannot rule out a tumour, and



**Figure 5.** Baker's cyst: synovial proliferation is shown. (a) Longitudinal and (b) transverse sonograms demonstrate the Baker's cyst with peripheral synovial projections (arrowheads) pointing towards the centre of the lumen. MHG denotes the medial head of the gastrocnemius muscle. Calipers outline the cyst.



**Figure 6.** An X-shaped Baker's cyst is shown. Both bursae end with anterior and posterior horns, fluid accumulation results in the filling of all four horns, producing an x-shaped appearance. MHG denotes the medial head of the gastrocnemius muscle.

MRI is indicated to clarify the situation.<sup>19</sup> In a study by Liao et al,<sup>18</sup> among 180 Baker's cysts, crescent shape, which looks like horse shoe, on the transverse scan is the most dominant (98%); just two (2%) of cases yielded x shapes.

When a Baker's cyst enlarges, the less common pathways include cranial extension. Baker's cyst may also sometimes extend deep between the gastrocnemius and soleus muscle. Rarely, the cysts may dissect through intramuscular planes. Fang et al<sup>21</sup> reported three cases of Baker's cyst extending into vastus medialis muscle or medial head of gastrocnemius.

## COMPLICATIONS

Leakage is the most common complication associated with Baker's cysts. Clinically, it presents with diffuse painful swelling and tenderness over the calf, often mimicking acute-onset thrombophlebitis. Such a combination of symptoms, in the absence of thrombophlebitis, is known as the pseudothrombophlebitis syndrome, of which leakage from a Baker's cyst is probably the commonest cause. In one study of 3072 patients having ultrasound examinations for suspected DVT, 789 (26%) had DVT, 95 (3%) had a Baker's cyst, 10 (0.3%) had demonstrable leakage, and 7 (0.2%) had coexisting DVT.<sup>22</sup> Uncomplicated Baker's cysts have smooth and convex contours. Leakage is more common from the distal pole, and associated with a change in appearance from round to a pointed appearance (Figure 7). Extravasation of fluid into the distal subcutaneous tissue may also be appreciated.

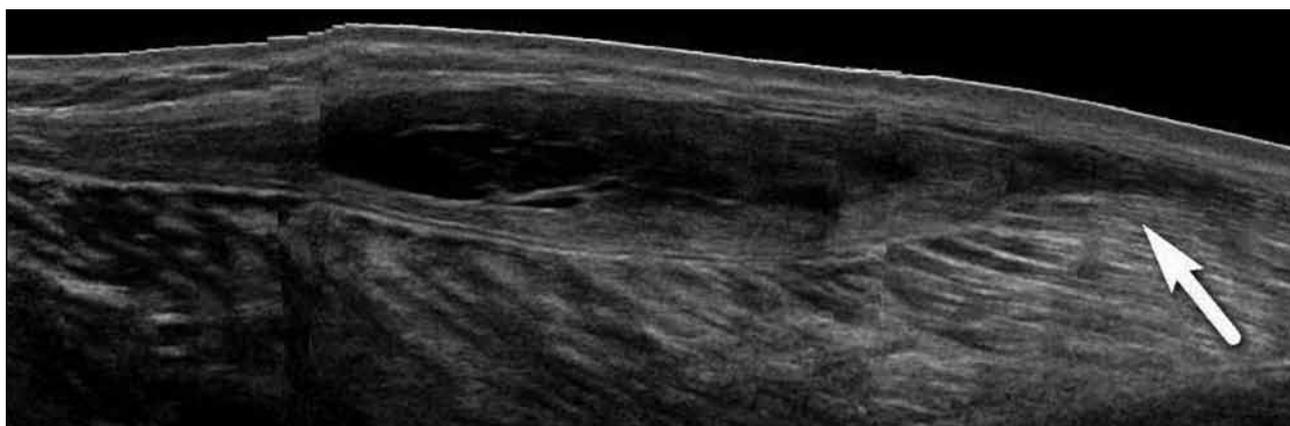
Intracystic haemorrhage may be encountered particularly in patients taking anticoagulants. In them,

ultrasound depicts an irregular cystic content containing mixed hypo-anechoic areas reflecting a combination of serum and clots filling the lumen.

Infection is a rare complication of Baker's cysts and mostly affects immunocompromised patients. Clinical findings include fever, warmth, and local pain. The sonographic appearance of an infected cyst is non-specific; in general, purulent material appears more echogenic and the cystic walls are markedly thickened and irregular.<sup>23</sup>

Large Baker's cysts may compress (though infrequently) the adjacent vein, nerve and artery. Popliteal vein thrombosis due to compression by a large Baker's cyst is uncommon but can contribute to popliteal vein thrombosis in patients at risk (e.g. with thrombophilia).<sup>24</sup> Thus, patients with large Baker's cysts and calf swelling should have ultrasound evaluation to exclude associated venous thrombosis that could be mistaken as pseudothrombophlebitis only. Nerve entrapment is a rare complication of Baker's cyst. Posterior leakage of a Baker's cyst into the calf muscles rarely leads to posterior tibial neuropathy due to posterior compartment syndrome.<sup>25</sup> Calf claudication is also a rare symptom that occurs when the popliteal cyst is large and causes extrinsic compression of the popliteal artery.<sup>26</sup>

As Baker's cysts are lined with synovium, they are subject to synovial processes, such as osteochondromatosis and PVNS, and may arise primarily from the bursa or from the knee joint.<sup>3,27,28</sup> In synovial osteochondromatosis involving Baker's cysts, there may be synovial hyperplasia and multiple osteochondral loose bodies of similar size. Osteochondral loose bodies are characterised by a hyperechoic bone component



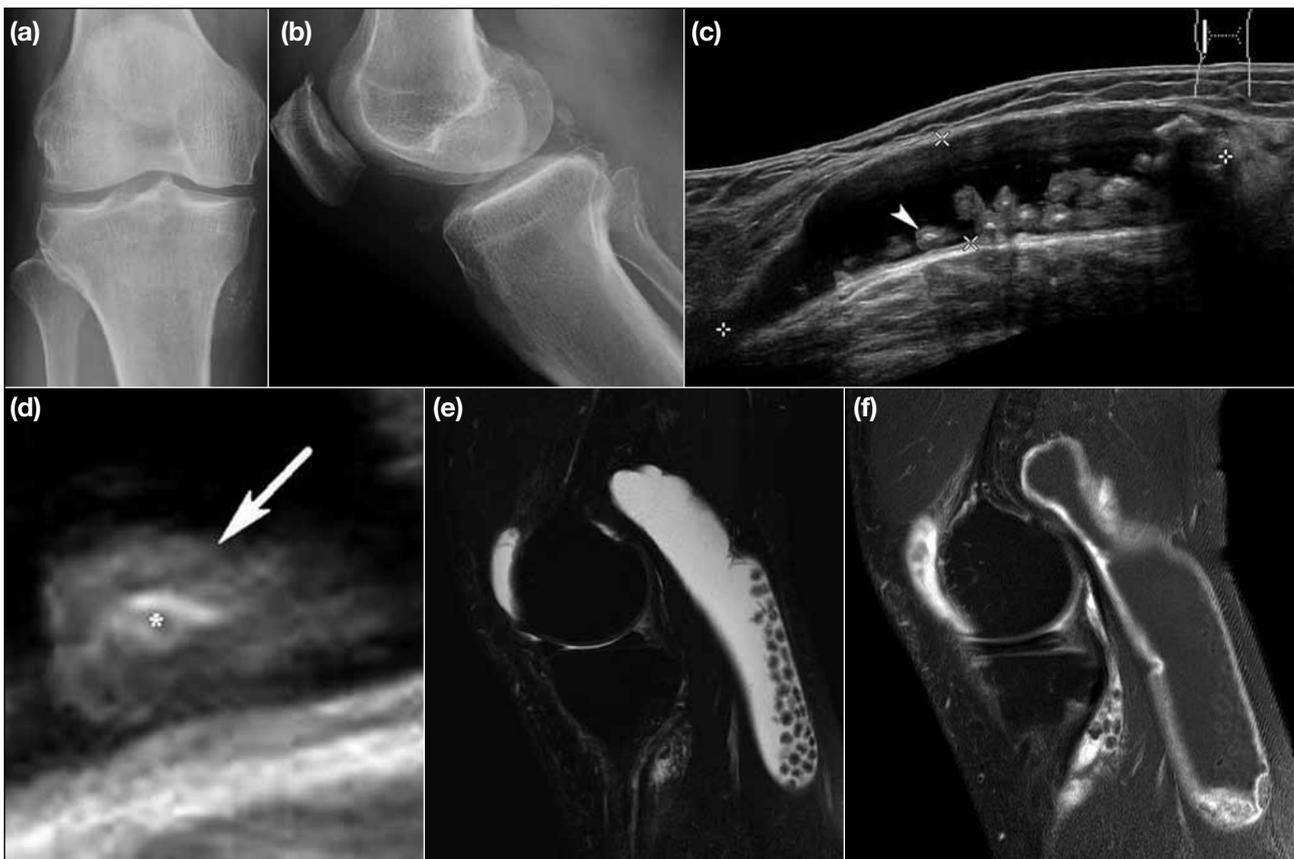
**Figure 7.** Complicated Baker's cyst: leakage is shown. A longitudinal sonogram shows a Baker's cyst with pointed appearance of distal end (arrow), indicative of recent leakage.

that shows posterior shadowing and a definite hypoechoic chondral component (Figure 8). PVNS is a benign proliferative disorder of the synovium of uncertain aetiology that typically causes monoarticular arthritis. Since Baker's cysts are lined by synovium, occasionally a tumour may evolve or extend into the cyst's cavity.<sup>28</sup> PVNS in a Baker's cyst may present as a mass composed of cystic and solid areas on ultrasound, mimicking a complicated Baker's cyst.<sup>29</sup> MRI is the method of choice to resolve the problem, as it is very sensitive for detecting haemosiderin, which is a hallmark of these tumours.

Cases of synovial sarcoma arising in association with Baker's cysts have been reported.<sup>30,31</sup> They also present as cystic lesions with a solid component inside the cyst. As Baker's cysts are contiguous with the knee joint, the aforementioned synovial pathologies may co-exist within the joint. Thus, scrutinising the knee joint is essential whenever a Baker's cyst is noted.

## DIFFERENTIAL DIAGNOSES

Many cystic lesions at the popliteal fossa can be potential mimickers. Ganglia are common behind the knee and can become large, so as to appear as cruciate ligament or meniscal cysts. Pes anserine bursitis or inflammation of the tibial collateral ligament bursa can also produce cystic masses that mimic Baker's cysts. A popliteal artery aneurysm can also sometimes present as a cystic lesion in the popliteal fossa. Duplex Doppler analysis is helpful in demonstrating turbulent whirling flow within its cavity, and there may be bidirectional velocities at the neck of pseudoaneurysm (due to forward flow in systole and reverse flow in diastole). Though less common, cystic degeneration of a sarcoma and neurogenic tumours in the popliteal fossa can mimic a Baker's cyst.<sup>32</sup> Apart from sarcoma, none of these lesions extend between the tendons of medial head of gastrocnemius and semimembranosus, and can therefore be differentiated from a Baker's cyst.<sup>28</sup>



**Figure 8.** Synovial osteochondromatosis in a Baker's cyst is shown. (a, b) Frontal and lateral radiographs of the knee show multiple calcific foci at joint space and inferior popliteal fossa. (c) A longitudinal sonogram demonstrates a Baker's cyst with multiple intrabursal loose bodies of similar size (arrowhead, which are enlarged in d). (d) Enlarged intrabursal loose body shows a hyperechoic bone centre (\*) and hypoechoic chondral periphery (arrow). (e, f) Sagittal fat-suppressed T2-weighted and post-contrast T1-weighted magnetic resonance images show numerous small hypointense foci at dependent region of Baker's cyst, representing multiple osteochondral loose bodies. Peripheral enhancement of the Baker's cyst is depicted, suggestive of synovial proliferation.

## TREATMENT

The uncomplicated Baker's cyst is usually treated conservatively, which entails rest, elevation of the leg, cold packs, non-steroidal anti-inflammatory drugs, and aspiration of the fluid with corticosteroid injection into the knee joint.<sup>33</sup> Correction of intra-articular lesions may bring about cyst resolution. Surgical excision is indicated for substantial local symptoms.<sup>28</sup>

## CONCLUSION

Baker's cyst is a common clinical condition, which is frequently encountered during ultrasound examination of knee. Cystic lesions extending between the tendons of semimembranosus and the medial head of gastrocnemius remain the key to the diagnosis. However, variance from the normal appearance, complications and associated pathologies give rise to less usual or even rare feature, leading to confusion as to the diagnosis. Better understanding of the variations, complications, and differential diagnosis allows more accurate assessment. As a Baker's cyst is an abnormal distension of the gastrocnemius-semimembranosus bursa secondary to development of a communication channel, any underlying joint pathology must be identified from plain radiograph, sonography, and even MRI whenever necessary.

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