ELSEVIER SAUNDERS

RADIOLOGIC CLINICS OF NORTH AMERICA

Radiol Clin N Am 45 (2007) 969–982

MR Imaging of Cysts, Ganglia, and Bursae About the Knee

Francesca D. Beaman, MD[a], Jeffrey J. Peterson, MD[b,*]

Cystic lesions around the knee comprise a diverse group of entities, ranging from benign cysts to complications of underlying diseases such as infection, arthritis, and malignancy. Although the presentation of cystic masses may be similar, their management may differ, thus highlighting the importance of appropriate categorization. For the purpose of this article, the authors limit the scope of their discussion to benign cysts, ganglia, and bursae about the knee.

Benign cystic lesions about the knee are common entities encountered in patients of all age groups. Although often discovered as incidental findings, they may present with pain, mechanical dysfunction of the knee, limitation in range of motion, or a palpable mass. Clinical manifestations reflect the size, location, mass effect, and relationship to surrounding structures of a lesion.

MR imaging is recognized as the gold standard in characterizing cystic lesions about the knee because of its ability to image the soft tissues exquisitely. MR can confirm the cystic nature of the lesion, evaluate anatomic relationships, and identify associated intra-articular pathology. In this article, the authors present their experience with benign cystic masses observed about the knee. It is not intended as a comprehensive review, but as an overview, emphasizing those lesions that are more common and highlighting their presentation, histology, pathogenesis, and characteristic MR imaging features.

Synovial cyst

The definition of a synovial cyst is a juxta-articular fluid collection that is lined by synovial cells. It is this synovial lining that histologically distinguishes them from other juxta-articular fluid collections. A synovial cyst represents a focal extension of joint fluid that may, or may not, communicate with the joint, and may extend in any direction [1,2]. The prototypical example of a synovial cyst is the popliteal cyst.

This article was originally published in *Magnetic Resonance Imaging Clinics of North America* 15:1, February 2007.

[a] Center Radiology, PC, Washington Hospital Center, 110 Irving Street NW, Washington, DC 20010, USA
[b] Department of Radiology, Mayo Clinic Jacksonville, 4500 San Pablo Boulevard, Jacksonville, FL 32207, USA
* Corresponding author.
E-mail address: peterson.jeffrey@mayo.edu (J.J. Peterson).

0033-8389/07/$ – see front matter
doi:10.1016/j.rcl.2007.08.005
radiologic.theclinics.com

Popliteal (Baker) cyst

A popliteal, or Baker, cyst is the most commonly encountered cyst located about the knee. It is located in the posteromedial aspect of the knee, and represents joint fluid extending through a slit-like communication between the knee joint and the normally occurring gastrocnemius-semimembranosus bursa (Fig. 1) [3,4]. Adult cadaveric studies have shown this communication to be present in more than 50% of the study population [4,5]. In 1877, Baker [6] described eight cases of popliteal fossa swelling and concluded that this finding was secondary to fluid escaping from the knee joint; thus, the term Baker cyst is reserved specifically for a fluid collection in this anatomic location.

In 1972, Wolfe and Colloff [7] outlined two requirements for popliteal cyst formation: an anatomic communication between the knee joint and the gastrocnemius-semimembranosus bursa, and a knee joint effusion. Theories regarding the formation of a popliteal cyst center on the weakness of the posterior joint capsule. The posterolateral joint obtains reinforcement from the ligament of Wisberg, the popliteus tendon, and the posterior cruciate ligament (PCL). Conversely, the posteromedial joint has supplemental reinforcement only from the posterior horn of the medial meniscus attached to the capsule [8]. This relative weakness, in combination with mechanical internal derangement or arthropathy, causes an increase in intra-articular pressure and a joint effusion, thus allowing joint fluid to escape through the path of lesser resistance into the gastrocnemius-semimembranosus bursa.

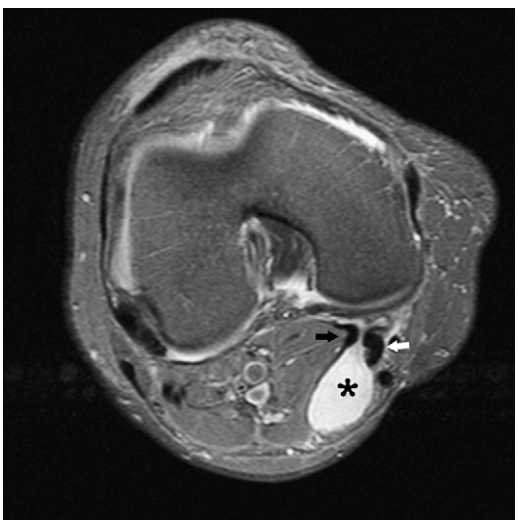

Fig. 1. Popliteal cyst. Axial proton density (4030/26) fast spin echo fat-saturated MR image shows a hyperintense fluid collection (*) in the posteromedial knee, located between the medial gastrocnemius tendon (*black arrow*) and the semimembranosus tendon (*white arrow*).

The gastrocnemius-semimembranosus bursa is composed of two parts: the gastrocnemius bursa and the semimembranosus bursa. These parts may be separated partially or completely by a central septum. Depending on their intercommunication and the quantity of fluid, one or both of these structures may distend. The semimembranosus bursa is the larger of the two and is located medial to the gastrocnemius component [9]. Classically, a popliteal cyst extends in the inferomedial direction, respecting the intermuscular planes [10]. Although this is the most common appearance, cysts may extend laterally or proximally [2,11], and rarely dissect intramuscularly into the vastus medialis or medial gastrocnemius muscles [10]. A fluid collection deep to the medial gastrocnemius muscle may coincide, representing fluid in the subgastrocnemius bursa [12].

In the literature, the incidence of popliteal cysts in patients who obtain an MR of the knee ranges from 5% to 38% [12–15]. The prevalence increases with age, and is significantly higher in those over 50 years [8]. Statistical association with popliteal cysts has been shown with internal derangement (81%), joint effusion (77%), and degenerative arthropathy (69%) [12]. Tears of the posterior horn of the medial meniscal consistently represent the highest associated derangement, at over 60% [5,7,13]. Fielding and colleagues [13] also showed popliteal cysts coexisting with lateral meniscal tears in 38%, bilateral meniscal tears in 27%, and complete anterior cruciate ligament (ACL) tears in 13% of cases. The posterior horn of the medial meniscus tear is thought to weaken the posterior joint capsule further and provoke an opening into the bursa [13]. Additional associations include prior meniscectomy, collateral or cruciate injury, articular cartilage damage, intra-articular osteochondral loose bodies, osteochondritis dissecans, infection, juvenile rheumatoid arthritis, rheumatoid arthritis, and other arthridities [7,13,16,17]. The presence of an effusion-producing derangement, rather than the abnormality itself, is proposed as the important factor in popliteal cyst formation [7,12]. Similar associations with popliteal cysts have not been shown in the pediatric population. In a review of 393 knee MR examinations in children aged 1 to 17 years, a popliteal cyst was present in 25 (6%), with only 4 of the 25 (16%) having joint effusions, and none with coexisting meniscal or ACL tears [16].

Popliteal cysts can be seen in asymptomatic patients and those presenting with internal or mechanical derangement, pain, a palpable mass,

swelling, or signs and symptoms of thrombophlebitis [7,8,10]. Cysts may rupture and dissect along or into adjacent structures, thus simulating symptoms of thrombophlebitis [8]. Conversely, proximal dissection has been reported to cause compression of the sciatic nerve [18]. Rarely, a deep vein thrombosis may coexist with a dissecting popliteal cyst [8,19]. Calf claudication is also a rare presenting symptom when the popliteal cyst is large and causes extrinsic compression of the popliteal artery [20]. Clinically, popliteal cysts may mimic adipose tissue proliferation, popliteal artery tortuosity or aneurysm, vessel thrombosis, or tumor.

Other synovial cysts

The popliteal cyst is the most common synovial cyst, but it simply represents one specific type of synovial cyst. Synovial cysts about the knee may extend in the anterior, medial, or lateral planes as well [21–23]. The tibiofibular joint communicates with the knee joint in approximately 10% of adults [17]. Although synovial cysts in this location are uncommon, with a reported prevalence of between 0.09% and 0.76% [22,24], they may be associated with pain and foot drop secondary to impingement on the common peroneal nerve [22]. Dysesthesia in the territory of the tibial nerve can also be seen secondary to extension of the synovial cyst into the popliteal fossa [25]. Synovial cysts have also been described deep to the iliotibial band, thus mimicking iliotibial band friction syndrome [21], and deep to the medial patellar retinaculum, causing recurrent medial knee pain postoperatively, following medial meniscus repair [23].

Giant synovial cysts are large, well-defined cavities filled with synovial fluid and lined by a synovium-like membrane, which typically involve large joints such as the knee, shoulder and elbow [26]. Most commonly, these cysts are reported in association with rheumatoid arthritis, but also with trauma, osteoarthritis (OA), gout, systemic lupus erythematosus, and juvenile rheumatoid arthritis [26,27]. Clinical presentation is one of pain and swelling [27].

Imaging features of synovial cysts

A popliteal (Baker) cyst is located in a specific anatomic location, between the tendons of the medial gastrocnemius and semimembranosus muscles, and may extend medial, lateral, superficial, or deep to these muscles [1]. Cysts may be simple, multiloculated, or septated, and contain debris, hemorrhage, or osseous loose bodies (Fig. 2) [1,10,12,17,28]. MR imaging of a simple cyst shows a cystic mass with low signal on T1-weighted and high signal on T2-weighted spin echo or STIR (short-TI inversion-recovery) sequences [1,10,29,30]. Rupture of a cyst typically results in edema in the surrounding fascial planes and subcutaneous fat, with fluid tracking inferiorly along the medial side of the medial gastrocnemius muscle plane (Fig. 3) [17,28]. Blood products from intracystic hemorrhage [28], or protein-rich synovial fluid, may result in increased signal on T1-weighted images. Enhancement may be seen in the cyst wall and internal septations following intravenous gadolinium administration (Fig. 4) [17,28]. Because the cysts are lined by synovium, synovial processes such as synovial osteochondromatosis or pigmented villonodular synovitis may be seen also [12,17], but this is not common. Complex cysts may appear heterogeneous and demonstrate foci

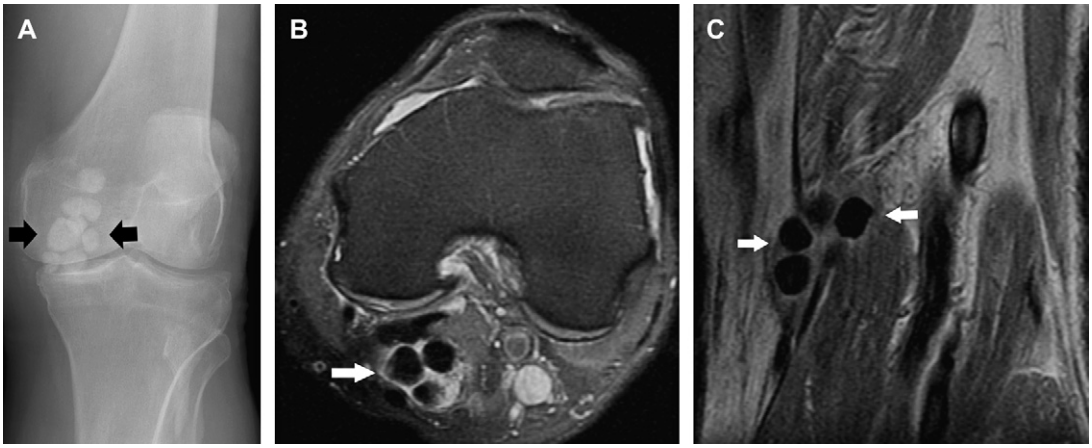

Fig. 2. Loose bodies within a popliteal cyst. (*A*) Anteroposterior radiograph of the knee shows several mineralized loose bodies (*between arrows*) in the medial knee joint. (*B*) Axial T2-weighted (4000/18) fast spin echo fat-saturated and (*C*) coronal T2-weighted fast spin echo MR images show several hypointense loose bodies (*arrows*) within a popliteal cyst.

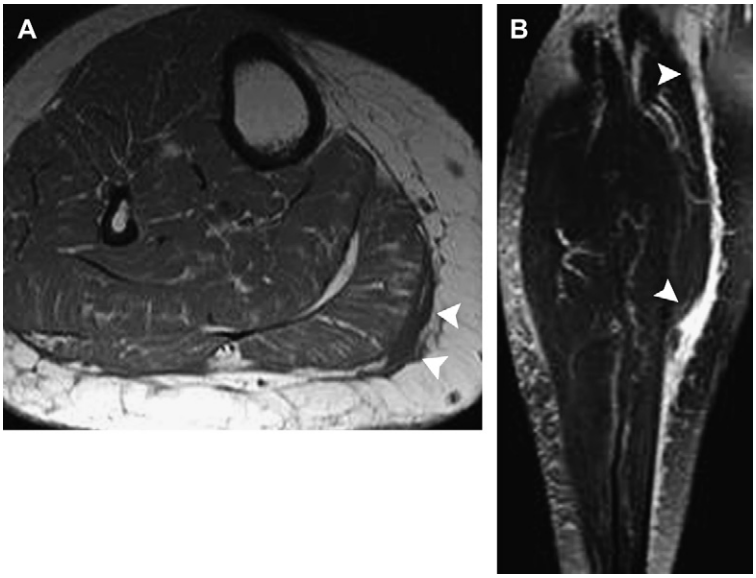

Fig. 3. Popliteal cyst dissection. (*A*) Axial T1-weighted (819/10) spin echo MR image shows hypointense fluid (*arrowheads*) along the medial margin of the medial gastrocnemius muscle. (*B*) Coronal T2-weighted (4000/68) fast spin echo fat-saturated MR image nicely shows the extent of the dissected fluid (*arrowheads*) originating from the gastrocnemius-semimembranosus bursa and extending caudally almost the entire length of the calf.

of enhancement following gadolinium administration, thus mimicking neoplasm. Thus, strict adherence to the gastrocnemius – semimembranosus bursal location with communication with the knee joint is essential for accurate diagnosis of a popliteal cyst. An enhancing, solid component suggests a superimposed synovial process.

Ganglion

A ganglion is a cystic, tumor-like lesion of unknown origin, which is surrounded by dense connective tissue filled with gelatinous fluid rich in hyaluronic acid and other mucopolysaccharides [31]. These cysts are classified as myxoid lesions, with suggested causes including synovial herniation and tissue degeneration or repeated trauma [32–34]. The World Health Organization does not address ganglia because they are not tumors, and, therefore, no rigid classification scheme exists. The authors find it useful to place ganglia into one of the following general categories: juxta-articular, intra-articular, and periosteal.

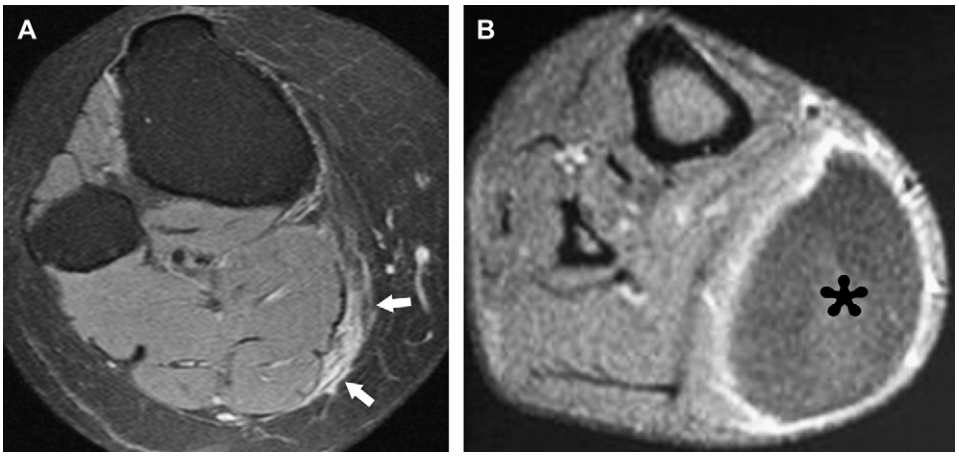

Fig. 4. Popliteal cyst wall enhancement and dissection. (*A*) Axial proton density (3280/18) fast spin echo fat-saturated MR image shows hyperintense fluid (*arrows*) along the medial gastrocnemius muscle plane, which has dissected caudally from a popliteal cyst. Note the septations within the fluid. (*B*) Axial T1-weighted (450/11) spin echo fat-saturated, postgadolinium MR image shows a large hypointense cyst (*) juxtaposed between the medial gastrocnemius muscle and subcutaneous tissues. The cyst shows thin rim enhancement following contrast administration.

Juxta-articular ganglion

As a whole, juxta-articular ganglia are quite common, with greater than one half located around the wrist [28]. Around the knee, ganglia may be located in any of the extra-articular soft tissues, and are associated commonly with the origins of the medial and lateral gastrocnemius muscles and the tibiofibular articulation (Fig. 5) [35,36]. Knee lesions are often asymptomatic, discovered incidentally on MR imaging. However, patients may present with pain or symptoms of nerve entrapment, specifically with a lesion arising from the tibiofibular articulation. As with synovial cysts, lesions in this location may compress the common peroneal nerve, resulting in foot drop and paresthesia over the dorsum of the foot [33,37]. If nerve compression is longstanding, MR images may also reveal findings of compressive neuropathy, such as muscle atrophy, fat infiltration, and increased signal on fluid-sensitive sequences.

Intra-articular ganglion

Intra-articular ganglia are relatively uncommon lesions typically associated with the cruciate ligaments, but have also been described in Hoffa's fat pad and arising from the posterior joint capsule [38,39]. The incidence rate on MR imaging is approximately 1% [38,40], which correlates well with the incidence rate reported at arthroscopy of 0.8% to 1.1% [41,42]. Ganglia may be located within or adjacent to the cruciate ligaments [40]. The ACL is affected more commonly than the PCL, with most originating from the tibial insertion of the ACL [38,41]. Although the exact cause of intra-articular ganglia is unknown, they are presumed to be caused by mucinous degeneration of connective tissue. Mucoid degeneration of the cruciate ligament and ganglia likely represent different manifestations along the same pathologic continuum [40]. Another possible theory suggests an origin from herniation of synovial tissue through a defect in the joint capsule or tendon sheath, a mechanism similar to that suggested for wrist ganglia [43].

Intraosseous ganglia are solitary, uni- or multilocular cystic lesions located in the epiphyses of long bones [44]. The pathogenesis is unclear and debate persists as to whether they are distinct from degenerative or posttraumatic cysts. Intraosseous abnormalities frequently coexist with cruciate ganglia and mucoid degeneration of the cruciate ligaments [40]. On MR they are well-defined cystic lesions that may or may not communicate with the joint or be associated with a soft-tissue component [44].

Clinical symptoms are varied but nonspecific, and include knee pain, locking, clicking or popping sensations, and decreased range of motion [38,40,42]. Many patients are asymptomatic, with lesions discovered incidentally on MR or at arthroscopy [41]. Ganglia anterior to the ACL tend to limit knee extension, whereas those posterior to the PCL often limit knee flexion [41].

Periosteal ganglion

Periosteal ganglia are rare lesions, with few described in the literature. More than 50% of periosteal ganglia occur in men, with most patients in

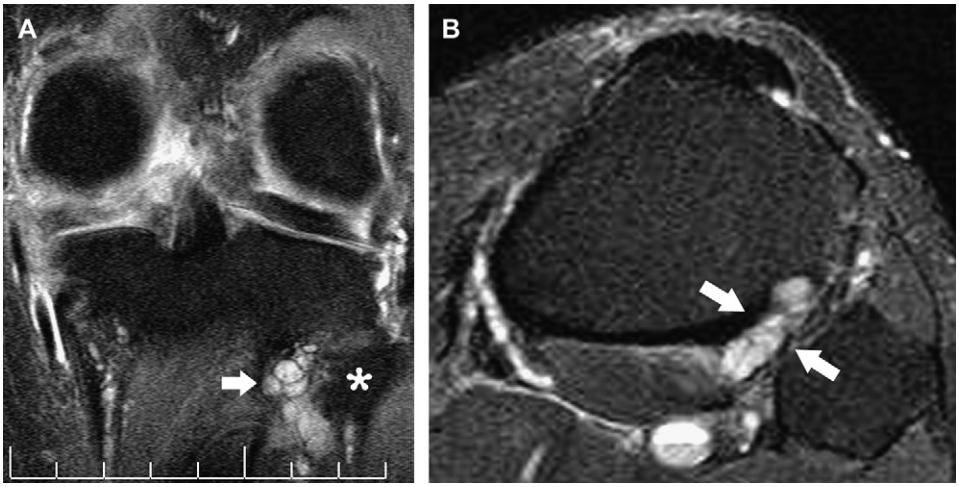

Fig. 5. Ganglion extending from the tibiofibular articulation. (*A*) Coronal proton density (3527/25) fast spin echo fat-saturated MR image shows a hyperintense, multilobulated fluid collection (*arrow*) extending from the tibiofibular articulation in the soft tissues, just medial to the fibula (*). (*B*) Axial T2-weighted (2100/68) fast spin echo fat-saturated MR image shows the ganglion to be hyperintense, similar to fluid, and confirms the location in the tibiofibular articulation (*between arrows*).

the fourth or fifth decade. They are found commonly in the region of the pes anserinus, with the remainder located mainly at the ends of long tubular bones [45,46]. As with pes anserine bursitis, patients often present with symptoms mimicking internal derangement of the knee, such as swelling and pain [46].

Imaging features of ganglia

Ganglia may be unilocular or multilocular, are round to lobular in configuration, and often contain sharply defined internal septa. They appear as cystic masses on MR, with low signal intensity on T1-weighted images and high signal intensity on fluid-sensitive and T2-weighted images (Fig. 6) [1,17,29,35,36,38,40]. Long-standing lesions often have a more complex appearance, especially if complicated by previous hemorrhage or infection. Rarely, lesions may be isointense to slightly hyperintense relative to skeletal muscle on T1-weighted images secondary to high proteinaceous content or internal hemorrhage. Following gadolinium administration, rim enhancement may be seen, in addition to diffuse enhancement [40].

Juxta-articular ganglia have features similar to synovial cysts, and thus may be indistinguishable on MR. Making this distinction is of little consequence, with the important features of both entities being location and relationship with adjacent structures. If adjacent to bone, the bone occasionally demonstrates resorption caused by pressure remodeling or periosteal new bone formation (Fig. 7) [34]. Fluid-filled pseudopodia may be seen connecting the ganglia to the adjacent joint.

Anterior cruciate ganglia and mucoid degeneration of the ACL may occur as independent entities or coexist [40], although typically, neither entity is associated with ligamentous instability. Bergin and colleagues [40] proposed criteria for the MR differentiation of ACL ganglia and mucoid degeneration. Criteria for ACL ganglia include fluid signal in the substance of the ligament disproportionate to the quantity of joint fluid, which has a mass effect on intact ligament fibers (Fig. 8). Mucoid degeneration is defined as an intact ligament that is seen poorly on T1-weighted or proton density MR sequences, but seen clearly on T2-weighted sequences [40]. Although ACL ganglia typically have a fusiform appearance and may be interspersed within the fibers of the ligament, posterior cruciate ganglia are typically well-defined cystic structures located along the surface of the ligament (Fig. 9).

Periosteal ganglia typically have a characteristic imaging appearance. The hallmark of these lesions is their associated cortical erosions, caused by extrinsic pressure remodeling [45,46]. Various degrees of cortical scalloping and periosteal new bone formation may also be present, often seen best on radiographs. Spicules of periosteal new bone extend from the scalloped region, oriented perpendicular to the underlying cortex, and appear thick and well-defined [47]. MR shows a juxtacortical mass that is homogeneous and well-defined, with low signal intensity on T1-weighted images and high signal intensity on T2-weighted images [45,46].

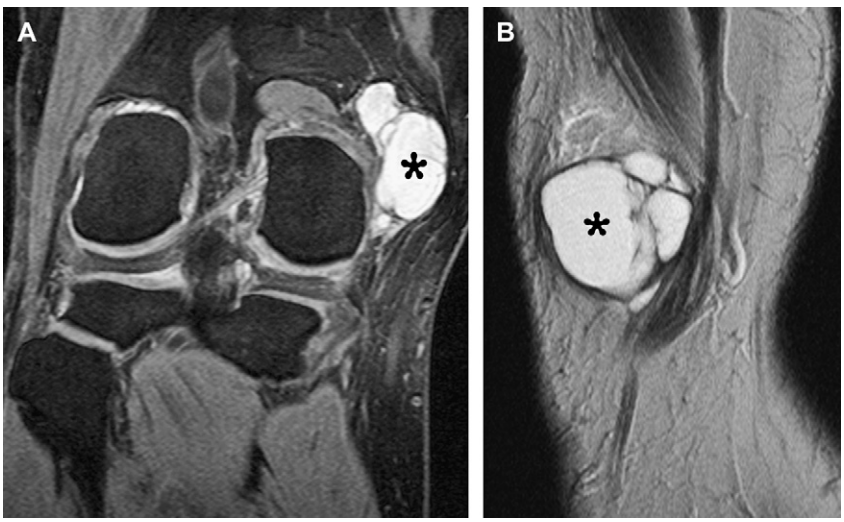

Fig. 6. Ganglion. (*A*) Coronal 3-D double echo steady state (DESS) (22.8/6.22) and (*B*) sagittal T2-weighted (5160/95) fast spin echo MR images show a hyperintense cystic mass (*) in the superomedial knee, compatible with a ganglion. Note the multiple internal septations, which are seen easily on the coronal and sagittal images.

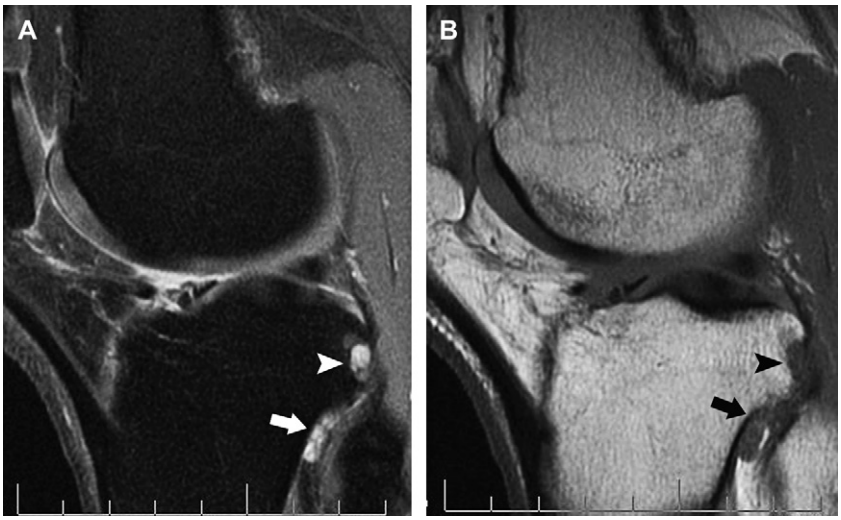

Fig. 7. Juxta-articular ganglion with intraosseous component. (*A*) Sagittal proton density (2650/22) fast spin echo fat-saturated MR image shows a lobulated fluid collection (*arrow*) arising from the tibiofibular articulation and extending along the tibial periosteal margin. Note also the intraosseous component (*arrowhead*) within the posterolateral tibial plateau. (*B*) Sagittal T1-weighted (566.7/11) spin echo MR image shows the periosteal (*arrow*) and intraosseous (*arrowhead*) components of the ganglion to be isointense to skeletal muscle, suggesting proteinaceous or mucinous contents.

Peripheral enhancement may be seen following gadolinium administration [47].

Treatment options for ganglia include excision, puncture, aspiration, and corticosteroid injection. If joint communication exists with juxta-articular or periosteal ganglia, this connection must be excised as well to prevent recurrence.

Subchondral cyst (geode)

Subchondral lucencies are referred to by many names in the literature, including subchondral cysts, synovial cysts, subarticular pseudocysts, necrotic pseudocysts, and geodes [48]. The term subchondral cyst is not accurate technically because the cyst does not have an epithelial lining and is not fluid filled uniformly [48]. However, this term is ubiquitous in the literature, and will therefore be used in the following discussion.

OA is a process of articular degeneration characterized by asymmetric joint space narrowing because of chondromalacia, subchondral bone proliferation, marginal osteophytes, and subchondral lucencies. The pathogenesis of subchondral cyst formation in OA has two prevailing theories. One suggests that elevated intra-articular pressure forces synovial fluid through compromised articular cartilage, with subsequent subchondral cyst formation [49]. The other postulates that the impaction of apposing bony surfaces causes fracture and vascular insufficiency in the subchondral bone, with subsequent cystic necrosis [50]. Degenerative cysts are often multiple, and segmental in distribution, with surrounding sclerosis and an adjacent abnormal joint. Posttraumatic cysts typically develop over a period of months, have a sclerotic margin,

Fig. 8. ACL ganglion. Sagittal proton density (2500/26) fast spin echo MR image shows a fusiform ganglion (*arrows*) with hyperintense signal relative to the PCL, within the intercondylar notch. No intact ACL fibers were present on adjacent images, consistent with a complete ACL tear.

Fig. 9. PCL ganglion. (*A*) Sagittal T1-weighted (616.7/22) SE and (*B*) sagittal proton density (3250/22) fast spin echo MR images show a fusiform fluid collection (*arrow*) posterior to the PCL, which is consistent with a PCL ganglion. T1 signal intensity is isointense to skeletal muscle, suggesting a proteinaceous or mucinous component. Note that there is no associated mucoid degeneration of the PCL.

and communicate with the joint. MR imaging shows focal, nonenhancing fluid collections abutting an articular surface, with a variable degree of associated intra-articular pathology (Figs. 10, 11).

Meniscal cyst

A meniscal cyst is a focal collection of synovial fluid located within, or adjacent to, the meniscus. Various theories have been proposed regarding the etiology of these cysts, with the most widely accepted reason stating that joint fluid accumulates within a torn or degenerated meniscus, creating an intrameniscal cyst, and fluid extravasation through a meniscal tear into the surrounding soft tissues results in parameniscal cyst formation [30,51,52]. A horizontal component to the tear is present in most cases [17,51]. Although numerous studies have reported lateral meniscal cysts to be two to four times more common than medial meniscal cysts [1,52], additional literature has shown nearly equal cyst frequency between the medial and lateral

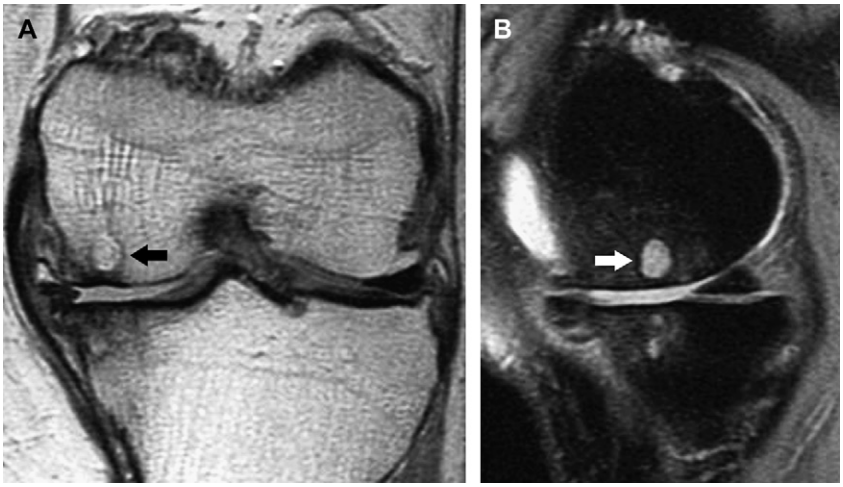

Fig. 10. Subchondral cyst (geode) with OA. (*A*) Coronal proton density (3000/12) fast spin echo and (*B*) sagittal proton density (2366.7/25) fast spin echo fat-saturated MR images show a circumscribed cystic focus (*arrow*) in the distal femur, abutting the articular surface. The 'cyst' is isointense to subcutaneous fat in (*A*), suggesting proteinaceous or mucinous contents. Note the associated osteoarthritic changes of the medial and lateral compartments, with joint space narrowing and osteophytes.

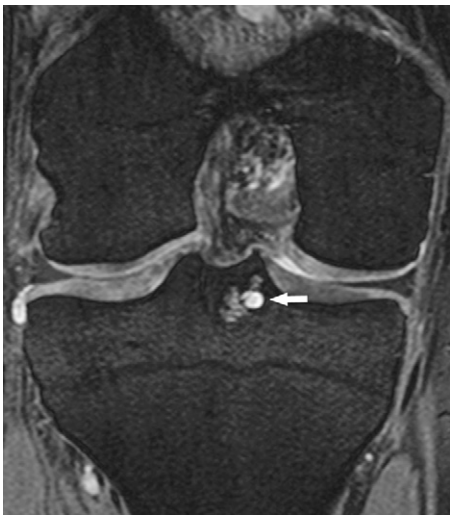

Fig. 11. Subchondral cyst (geode). Coronal 3-D DESS (23.87/6.73) MR image shows a multilobulated hyperintense cyst (*arrow*) in the tibial plateau, abutting the articular surface.

compartments [53], and, also, medial compartment predominance [30,51]. Campbell and colleagues [51] reviewed 2572 imaging reports of knee MR examinations for the prevalence and location of meniscal tears and cysts. They found that medial meniscal tears were twice as common as lateral meniscal tears (66% versus 34%), with a 4% overall prevalence of meniscal cysts (109 cysts in 2572 knees). Two thirds of the cysts were located in the medial compartment, with one third present in the lateral compartment. Although the overall number of medial cysts was greater, the incidence of cysts with respect to the incidence of meniscal tears was equal between the compartments (7.7% medially and 7.8% laterally). Tschirch and colleagues [30] conducted a review of MR images in 102 asymptomatic knees and also observed medial meniscal cyst predominance, with 4 cases having medial cysts and no cases with lateral cysts.

Most meniscal cysts are associated with tears of the associated meniscus, with up to 98% of cases demonstrating a direct communication identifiable on MR imaging (Fig. 12) [51]. In those cases where no distinct connection can be identified, one may see a meniscal tear with no communication to the cyst, or a degenerative intrasubstance signal within the meniscus, which does not meet strict MR imaging criteria for a tear [30,51]. The location of meniscal cysts is determined by the location of the meniscal tear and the capsuloligamentous planes of the knee [17,54]. Most medial cysts are located posteromedially [54], adjacent to the posterior horn [51], but may also be primarily located anteriorly, adjacent to the anterior horn, next to the meniscal body, or may extend superficial to the medial collateral ligament (MCL) [51,54]. Lateral cysts are more varied, with one study showing 54% adjacent to the anterior horn, 16% adjacent to the body, and 30% adjacent to the posterior horn [51]. Anteriorly, the cysts may track deep to

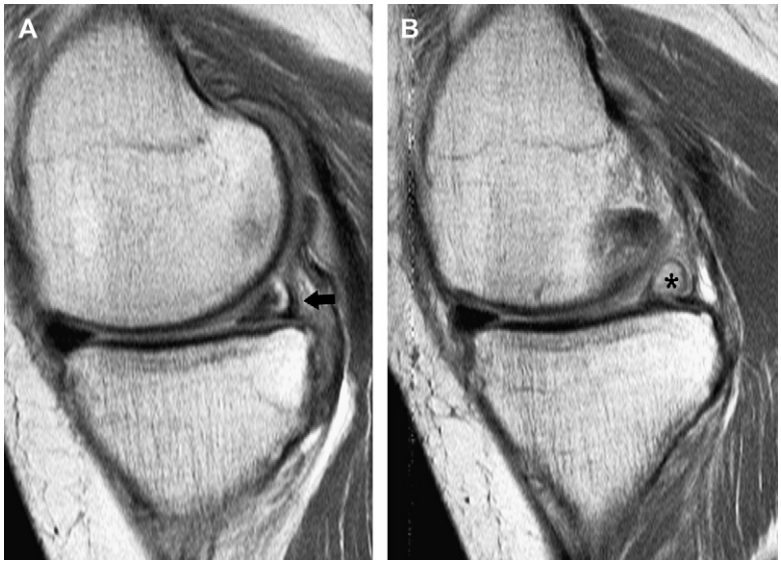

Fig. 12. Meniscal cyst. Consecutive sagittal proton density (3000/25) fast spin echo MR images show a tear in the posterior horn of the medial meniscus (*arrow in A*) and a cyst (* *in B*) extending into the intercondylar notch through this defect. Note the cyst is hyperintense to skeletal muscle, suggesting proteinaceous or mucinous contents.

the iliotibial band, and posteriorly, they may track deep to the lateral collateral ligament [54]. Pericruciate meniscal cysts, which arise from the posterior horn of the medial meniscus tears, simulate PCL ganglia because of their location posterior to, or surrounding, this structure. Differentiation may be important clinically, owing to differences in treatment options. Four MR findings of pericruciate meniscal cysts that may aid in the differentiation include (1) identification of a meniscal tear, (2) connection between the torn meniscus and the cyst, (3) location mainly posterior to the PCL and centered on the ligament, or (4) location surrounding the PCL. PCL ganglia tend to be located at the femoral or tibial insertion of the PCL, rarely surround the ligament, and do not communicate with a meniscal tear, should one be present [55].

Patients typically present with symptoms including swelling, a palpable mass, pain and tenderness, or limited mobility [1,29,55], although asymptomatic cysts may be detected as well [30]. Lateral meniscal cysts present as palpable masses more commonly than medial meniscal cysts [17,51], likely because of the relatively scant amount of fatty soft tissue present in the lateral aspect of the knee [51]. On MR imaging, a well-circumscribed cystic mass is seen, which may be unilocular or show septations and multiple loculations with low signal intensity on T1-weighted images, and increased signal intensity on T2-weighted images [1,17,29,51,55,56]. Cyst contents may also be isointense to skeletal muscle on T1-weighted images secondary to hemorrhage or high proteinaceous content, or low signal on T2-weighted images because of hemosiderin deposition or content desiccation [17,52,56]. Meniscal cysts may also result in osseous erosions [57,58]. Therapy typically requires both cyst drainage and repair of the associated meniscal tear.

Bursa

Bursae are normally occurring, synovial-lined structures that function to reduce friction between moving structures, such as tendons, ligaments, and bone. Typically, they are not visible on imaging because they normally contain only limited fluid. Inflammation from local and systemic processes such as overuse, trauma, internal joint derangement, inflammatory arthropathy, and collagen vascular diseases, in addition to infection and hemorrhage, may cause thickening of the synovial lining and fluid accumulation [1,17]. In this scenario, the bursae become visible on MR imaging as fluid collections with low signal on T1-weighted images and high signal on T2-weighted images. In chronic cases, signal may be more heterogeneous, and complicated by hemorrhage and calcification, thus mimicking a soft-tissue tumor [2,59]. Acute inflammatory bursitis usually responds to rest, ice, and nonsteroidal anti-inflammatory medications, whereas chronic bursitis may require aspiration, local anesthetic, or corticosteroid injections. Infectious bursitis necessitates aspiration and antibiotic therapy [1,17].

Bursae about the knee are numerous and normally occurring. Discussing them based on anatomic location (anterior, posterior, medial, or lateral) provides a useful means of classification. Anterior and posterior bursae are demonstrated best on sagittal or axial images, whereas medial or lateral bursae are seen best on coronal or axial images.

Anterior

The suprapatellar bursa is a midline structure that is located between the quadriceps tendon and the femur. It normally communicates with joint, unless the suprapatellar plica, a normal embryonic septum, fails to involute, thus isolating this compartment (Fig. 13) [1]. Clinically, patients may

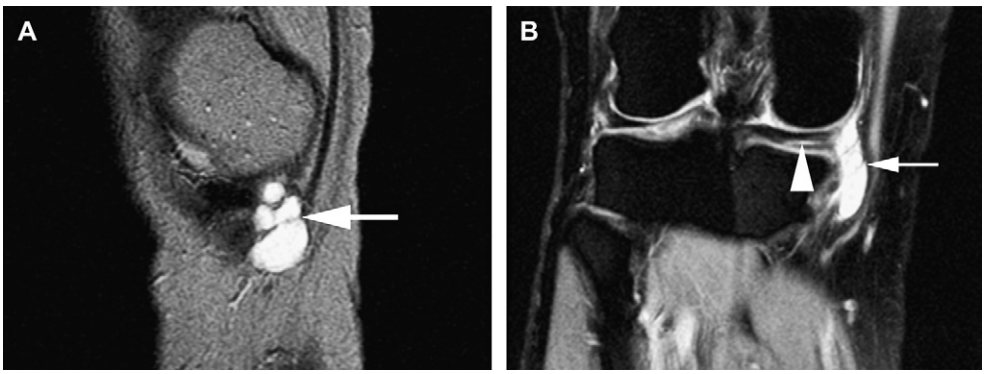

Fig. 13. Meniscal cyst. (*A*) Sagittal T2 (4050/79) fast spin echo and (*B*) coronal fat-suppressed proton density (3000/25) MR images depict a horizontal tear (*arrowhead*) of the medial meniscus with an associated complex medial meniscal cyst (*arrows*).

present with an anterior soft-tissue mass caused by bursal enlargement because of fluid accumulation from synovitis, hemorrhage, or trauma [1]. Loose bodies arising from the joint may be isolated within this compartment, especially if the septum is discontinuous.

The prepatellar bursa is located anteriorly between the patella and subcutaneous tissues. Bursitis is caused commonly by overuse injury or chronic trauma, such as occupational or recreational kneeling or crawling (housemaid's knee, carpet-layer's knee), and results in focal pain and swelling. On MR, a focal fluid collection is seen anterior to the patella. It may be heterogeneous or poorly defined on T2-weighted images, from associated inflammation, hemorrhage, or even infection [1].

The superficial infrapatellar, or pretibial, bursa is juxtaposed between the tibial tubercle and the overlying skin. Although this is an uncommon site of bursitis, direct trauma or occupational overuse (clergyman's knee) may result in focal inflammation or hemorrhage, causing pain anterior to the tibial tubercle [1,17].

The deep infrapatellar bursa is located directly posterior to the distal third of the patellar tendon, juxtaposed between the tendon and the anterior tibia. Cadaveric study has shown no connection with the knee joint, and an average width slightly greater than the width of the distal patellar tendon [60]. Normally, a small amount of fluid may be seen in this bursa on MR imaging [30,61]. Conversely, deep infrapatellar bursitis results from extensor mechanism overuse, particularly in runners and jumpers, and manifests as anterior knee pain, mimicking patellar tendonitis [60].

Posterior

The gastrocnemius-semimembranosus bursa, or popliteal cyst, is discussed in the synovial cyst section.

Medial

The pes anserine bursa is located along the medial aspect of the tibia and separates the pes anserinus, which is formed by the distal tendons of the sartorius, gracilis, and semitendinosus muscles, and the distal tibial collateral ligament at the tibial insertion [1,9,17]. The prevalence of pes anserine bursitis on MR has been shown at 2.5% in symptomatic cases, whereas the prevalence of fluid in the bursa, without clinical symptoms of bursitis, has been shown to be as high as 5%, thus allowing investigators to conclude that not all fluid-containing bursae represent bursitis [30,62]. Pes anserine bursitis frequently results from overuse injury, often in runners, causing medial knee pain and swelling. Pes anserine bursitis commonly mimics a medial meniscus tear clinically [62]. On MR, a fluid collection is identified along the medial joint, adjacent to the pes anserinus, which does not communicate with the joint. Meniscal and synovial cysts may also occur in a similar location, but they do communicate with the joint, although this communication is not always visible [1].

The MCL, or tibial collateral ligament, bursa is a vertically elongated compartment located between the superficial and deep layers of the MCL, at the level of the middle knee joint line (Fig. 14). Cadaveric study has shown separate femoral and tibial components in most specimens [63]. Fluid confined to the MCL bursa as an isolated finding is extremely rare, with most cases associated with arthridities (OA, gout, rheumatoid) and medial intra-articular pathology [17,63]. Additionally, edema surrounding the MCL has been associated with OA and medial intra-articular pathology [64].

The semimembranosus-tibial collateral ligament bursa, also located along the medial joint line, lies between the semimembranosus tendon and the MCL, at the level of the medial tibial condyle. Inflammation may result in focal pain along the posteromedial knee at the level of the knee joint line. The MR appearance is that of a fluid collection oriented along the plane of the semimembranosus tendon, which may drape over or surround the tendon [29]. This bursa does not communicate with

Fig. 14. Suprapatellar bursa. Sagittal proton density (3000/26) fast spin echo fat-saturated MR image shows a suprapatellar bursa (*), which normally communicates with joint unless the suprapatellar plica (*arrow*) fails to involute, thus isolating this compartment.

Fig. 15. MCL bursa. Coronal proton density (2610/44) fast spin echo fat-saturated MR image shows hyperintense signal (*arrowheads*) between the superficial and deep layers of the MCL, consistent with MCL bursal fluid. Note this patient had experienced recent medial knee trauma, with resultant medial meniscus tear and medial femoral condyle bone contusion.

the knee joint or other medial knee bursa, although multifocal bursitis may coexist. The proximal extent of the bursa abuts the posterior horn of the medial meniscus; thus, a meniscal cyst is in the differential for a fluid collection in this location [65].

Lateral

The iliotibial band bursa is located between the distal portion of the iliotibial band, just proximal to its insertion on Gerdy's tubercle, and the adjacent tibia. Overuse injury, commonly in runners, is the leading cause of bursal inflammation, with resultant anterolateral knee pain. MR shows a well-defined fluid collection near the insertion of the iliotibial band on the tibia. Clinically, bursitis may mimic iliotibial tendonitis, with the latter condition showing abnormal MR signal within the tendon itself [1].

The fibular collateral ligament (FCL)-biceps femoris bursa is located lateral to the distal FCL, and extends around the anterior and anteromedial portions of this ligament. Cadaveric study has shown a consistent anatomic location, with the superior extent at the level of the crossing of the biceps femoris superficial to the FCL, and the distal extent at the insertion of the FCL on the fibular head [66].

Summary

Cystic lesions about the knee are common findings, representing diverse causes and, therefore, varied prognosis and therapeutic options. MR aids in the characterization of lesions by first localizing them, and then defining their relationship with adjacent structures and identifying any additional abnormalities. Cystic lesions and their relationships are best depicted on long TE/TR (fluid-sensitive) MR sequences. Careful attention to these details will allow one to provide a reasonable MR diagnosis and thus ensure the most appropriate patient care.

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