

— Pitorial Essay —

MR Imaging of Intra-articular / Juxta-articular Mass Lesions

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A wide variety of pathologies can arise in intra-articular/juxta-articular region. This can be a potential source of confusion in a clinical set-up. These entities are diverse in origin and can emanate from bone, synovium, soft tissue and other surrounding structures. The purpose of this essay is to present an overview of imaging features of these entities with emphasis on the usefulness and limitations of the magnetic resonance imaging (MRI) in the work-up. For the purpose of description the lesions are divided on the basis of their origin in separate groups.

Lesions With Synovial Origin or Involvement

Pigmented villonodular synovitis (PVS)

Pigmented villonodular synovitis is a benign proliferative disorder of unknown etiology and primarily affects the synovial membrane of various joints, bursae and tendon sheaths. It may appear either as a diffuse or a localized form. Microscopically it is characterized by hyperplastic synovium containing lipid-laden foam cells, histiocytes, giant cells, and hemosiderin.

The classically described radiographic findings of PVS are monoarticular involvement, soft tissue swelling without calcification, normal bony mineralization of the affected joint, preservation of cartilage space, and juxta-articular bony erosion and cysts on both sides of joint. Because of the presence of hemosiderin due to recurrent hemarthrosis, MRI allows a highly confident diagnosis of PVS in appropriate clinical set-

ting. The ferromagnetic properties of hemosiderin cause shortening of T1 and T2 relaxation time and synovium appears hypointense to muscles (dark) on all pulse sequences (Fig. 1,2). This is said to be the most consistent finding in PVS¹⁾. On gradient echo (T2*) weighted images PVS appears darker and larger in size. This "blooming effect" is attributed to the differences in the magnetic susceptibility between the hemosiderin-laden synovium and surrounding tissues. Extra-articular extension of PVS is well depicted on MRI and is valuable for surgical planning.

The MRI appearance of PVS is not pathognomonic as similar signal intensity pattern can be seen in rheumatoid arthritis, hemophilic arthropathy, amyloid arthropathy, chronic traumatic synovitis, synovial osteochondromatosis, sclerosing hemangioma and desmoid tumor²⁾. These entities can usually be distinguished on the basis of clinical history, laboratory data and plain radiographic findings. MRI features that can be helpful in the differentiation of these entities are listed in the Table.

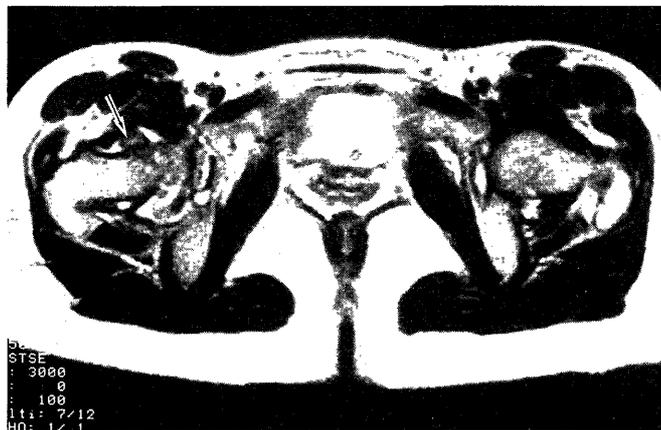


Fig. 1. Nodular PVS of right hip in 31 years old female with acute hip pain. Axial T1 (3000/100 [TR/TE]) weighted image shows a small nodular mass of low signal (arrow) in the right hip joint.

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Fig. 2. Diffuse PVS of the right hip in 55 years old female.

A-B. A multiloculated soft tissue mass (arrows) showing low to intermediate signal on coronal T1 (450/14 [TR/TE]) (A) and T2 (3000/105) (B) weighted images is seen in and around the hip. Note the presence of extensive bone erosion.

C. On gradient echo T2* weighted image (600/20) the mass (arrows) appears darker and larger "blooming effect." Presence of low signal on T2* weighted images is highly suggestive of PVS.

D. Post contrast fat saturated T1 (400/14) weighted image shows heterogeneous enhancement of the mass (arrows).

Synovial osteochondromatosis

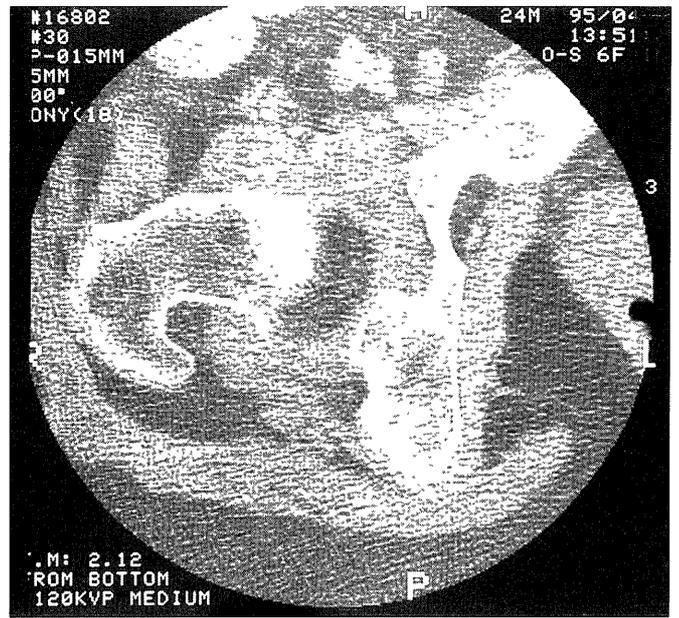
Synovial osteochondromatosis represents chondroid

metaplasia of the synovium resulting in cartilaginous masses within a joint, bursa or tendon sheath. It is nearly always monoarticular. Conventional radiographic findings include small calcified opacities of uniform size in and around the joint with synovial thickening and effusion. On computed tomography (CT) a soft tissue mass of water density with multiple calcifications is seen.

MRI appearance varies and depends upon the presence and extent of calcification and/or ossification²⁾.



A



B



C



D



E

Fig. 3. Synovial osteochondromatosis of the right hip in 24 years old male. A, B. AP radiograph and CT reveal multiple speckled calcification. C-E. Coronal T1 (500/13 [TR/TE]) (C), T2 (2000/18) (D) and post contrast enhanced fat saturated T1 (600/20) (E) weighted images show an intra-articular soft tissue mass with multiple low signal foci consistent with calcified bodies. However, the calcifications are best seen on the CT and plain radiograph.

Immature lesion (without calcification or ossification) appears low to intermediate signal intensity masses on T1 and intermediate to high signal intensity lesions on T2 weighted images. With calcification and ossification, it appears as hypointense on T1 and T2 weighted images (Fig. 3). Hypointense signal of these bodies becomes prominent on gradient echo image. However, MR is not as sensitive as radiograph or CT in the detection of small foci of calcification. Larger foci of calcification appear as a signal void on MRI. The differential diagnosis includes osteoarthritis, pigmented villonodular synovitis, synovial hemangioma, synovial sarcoma and chondrosarcoma.

Synovial hemangioma

Synovial hemangioma is an uncommon benign lesion composed of vascular channels that may be cavernous, capillary or venous in nature. It occurs most frequently in the knee; other reported sites of involvement are elbow, ankle, wrist and tendon sheaths³⁾. Arthropathy results from repeated episodes of hemarthrosis.

On T2 weighted images the lesion has a heterogeneous appearance with bright vascular channels due to stagnant blood and intervening linear or round areas of low signal intensity corresponding to fibrosing septa and thrombosed vascular channels³⁾. On T1 weighted images vascular channels typically exhibit low or intermediate signal and fatty septa appear hyperintense (Fig. 4). Erosion and osseous involve-

ment may be seen. Phleboliths are characteristic and appear as areas of signal void (Fig. 5).

Amyloid arthropathy

Amyloid arthropathy is characterized by extracellular deposition of protein fibrils in the bones, joints and tendons. Patients undergoing long term maintenance hemodialysis and suffering from multiple myeloma and rheumatoid arthritis etc. have propensity to develop amyloid arthropathy. The articular changes are usually bilateral and frequently involve shoulders, hips, wrists and knees. Conventional radiography reveals well-defined subarticular lesions in association with soft tissue masses. MRI signal characteristics of amyloid deposits are distinctive and show long T1 and short T2 relaxation times⁴⁾ (Fig. 6). Intraosseous and soft tissue lesions appear as low or isointense to muscles on T1 and T2 weighted images. On T2 weighted images a bright intra-articular joint effusion or hemarthrosis can also be seen. Differential diagnosis of MRI appearance of amyloid arthropathy includes pigmented villonodular synovitis, uncalcified synovial osteochondromatosis, tuberculosis and silicon synovitis.⁵⁾

Hemophilic arthropathy

Repeated episodes of intra-articular hemorrhage in a hemophilic patient lead to deposition of hemosiderin in the hypertrophied synovium. In advanced stages there is subchondral cystic changes, destruction of articular

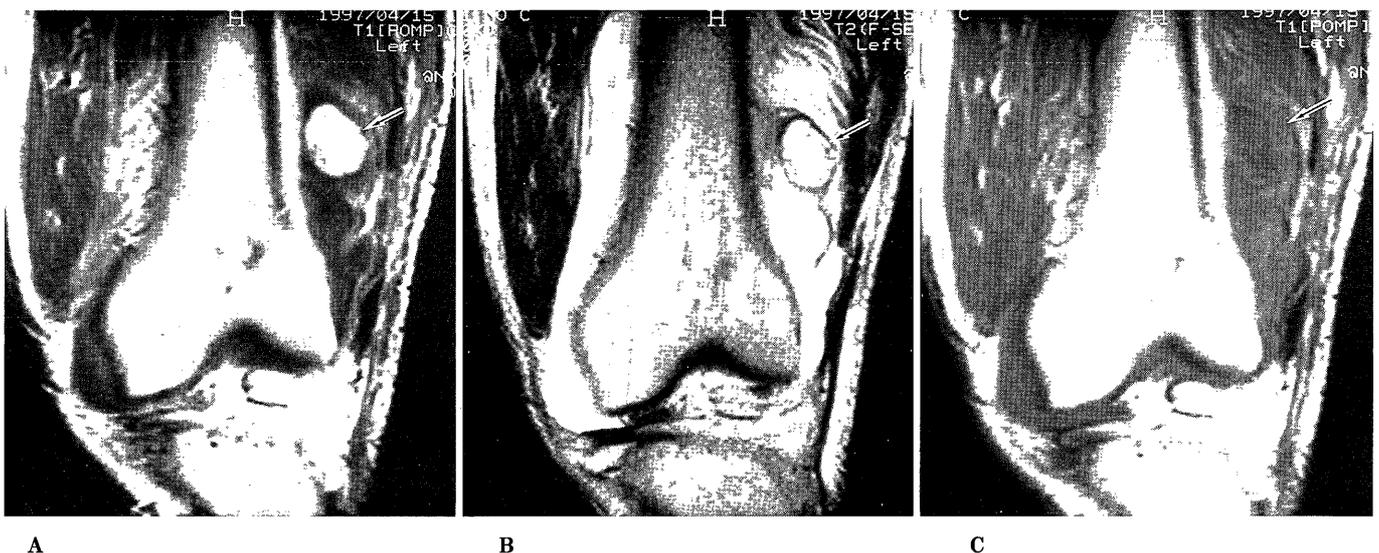


Fig. 4. Synovial hemangioma in 59 years old male with acute hemarthrosis of the left knee. A-C. Coronal T1 (340/15 [TR/TE]) (A), T2 (4000/100) (B) and post contrast enhanced T1 (340/15) (C) weighted images reveal a well-defined round mass (arrow) in the suprapatellar bursa of the knee. The lesion shows low signal on T1, markedly high signal on T2 and intense enhancement on the post contrast images.

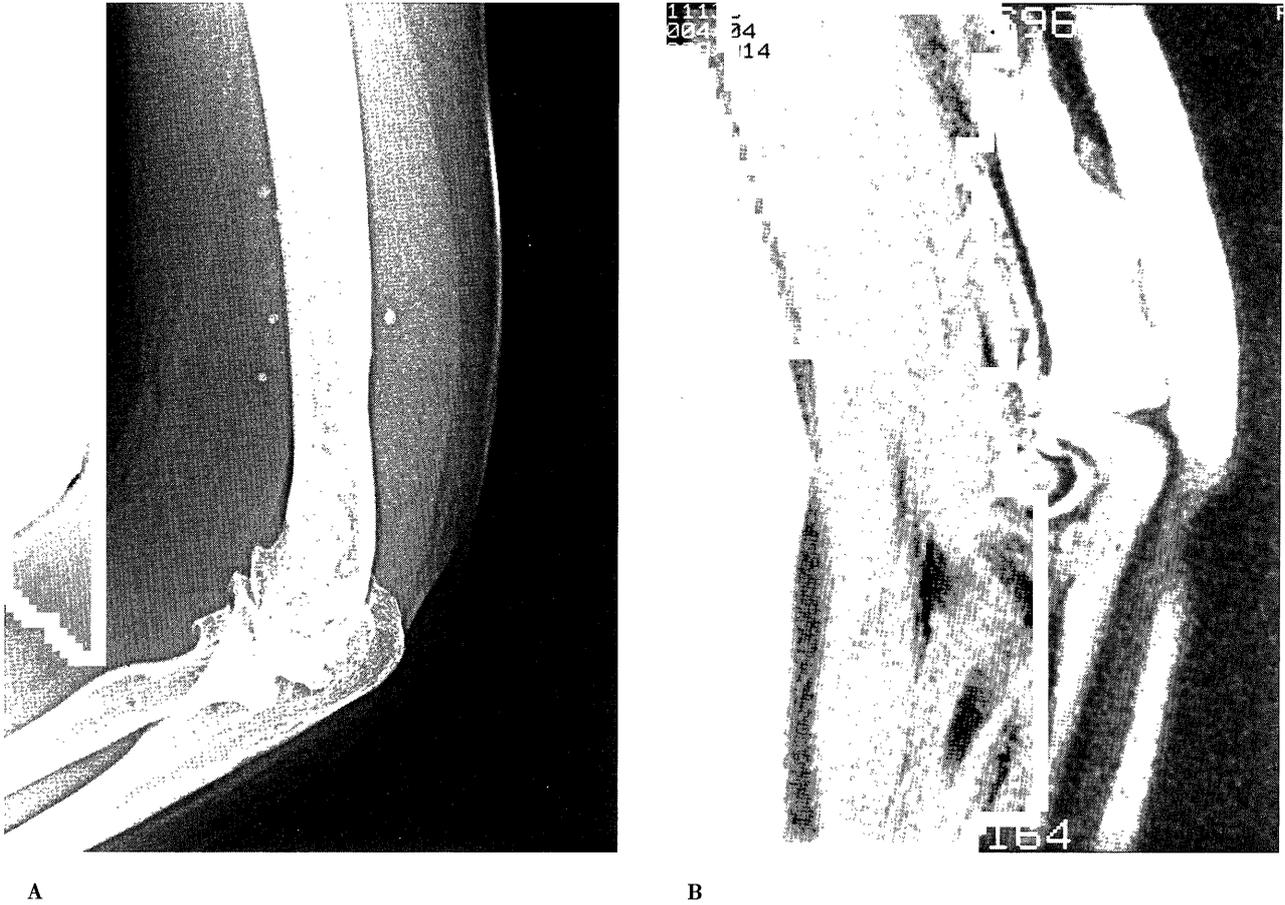


Fig. 5. Hemangioma of the elbow in 42 years old female with recurrent elbow swelling and pain. A. Multiple phleboliths in soft tissue and osteoarthritic changes are seen on the lateral radiograph. B. Sagittal T2 (2000/80 [TR/TE]) weighted image shows a high signal intensity soft tissue mass that is extending into the elbow joint.

cartilage, joint space narrowing and fusion. MRI signal characteristics vary according to the stage and duration of the disease⁶⁾ (Fig. 7). MRI is especially useful for the evaluation of articular cartilage and chondral defects.

Tuberculous arthropathy

Tuberculous arthropathy is mostly monoarticular and primarily involves large weight bearing joints e.g. hip and knee. Tuberculous foci with caseous necrosis and fibrin accumulation can appear as an intra-articular mass on MRI. Tuberculous lesions show heterogeneously intermediate signal intensity of T1 and both intermediate and high signal intensities on T2 weighted images (Fig. 8). Intermediate and high signal intensity on T2WI corresponds to the caseous necrosis and granulomas/effusion respectively⁷⁾. Tuberculous arthropathy should be considered in the differential diagnosis when intra-articular lesions with low to intermediate signal are seen on T2 weighted images.

Lipoma arborescens

Lipoma arborescens is benign hyperplastic condition in which mature adipose cells infiltrate the synovial tissue resulting in proliferative villous projections. On MRI a frond like synovial mass with signal intensity which parallels fat on all pulse sequences and associated joint effusion is seen⁸⁾ (Fig. 9). Differential diagnosis includes other synovial masses which contain fat e.g. synovial lipoma and synovial hemangioma. While synovial lipoma demonstrates identical signal characteristic it may be distinguished by the presence of solitary, round or oval inter-articular mass without synovial changes. Synovial hemangioma may contain considerable fat but signal intensity would not be homogeneously fatty due to presence of vascular channels and possible calcification.

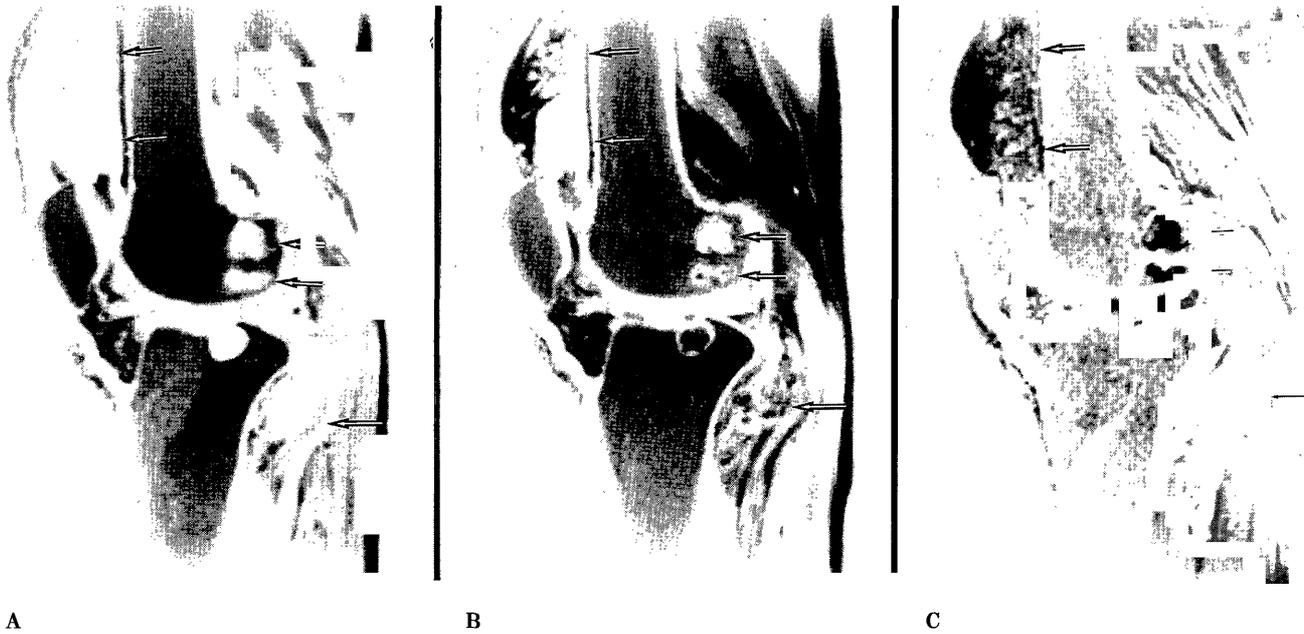


Fig. 6. Amyloid arthropathy of the knee in 66 years old female with history of hemodialysis. A, B. Hypertrophied synovium appears as low signal mass (arrows) on sagittal T1 (350/22 [TR/TE]) (A) and T2 (3000/100) (B) weighted images. Note the erosion of femur and tibia. C. On T2* weighted images (450/30) the mass appears as inhomogeneous intermediate signal intensity. Presence of intermediate to high signal on T2*WI is helpful to exclude PVS from the differential diagnosis.

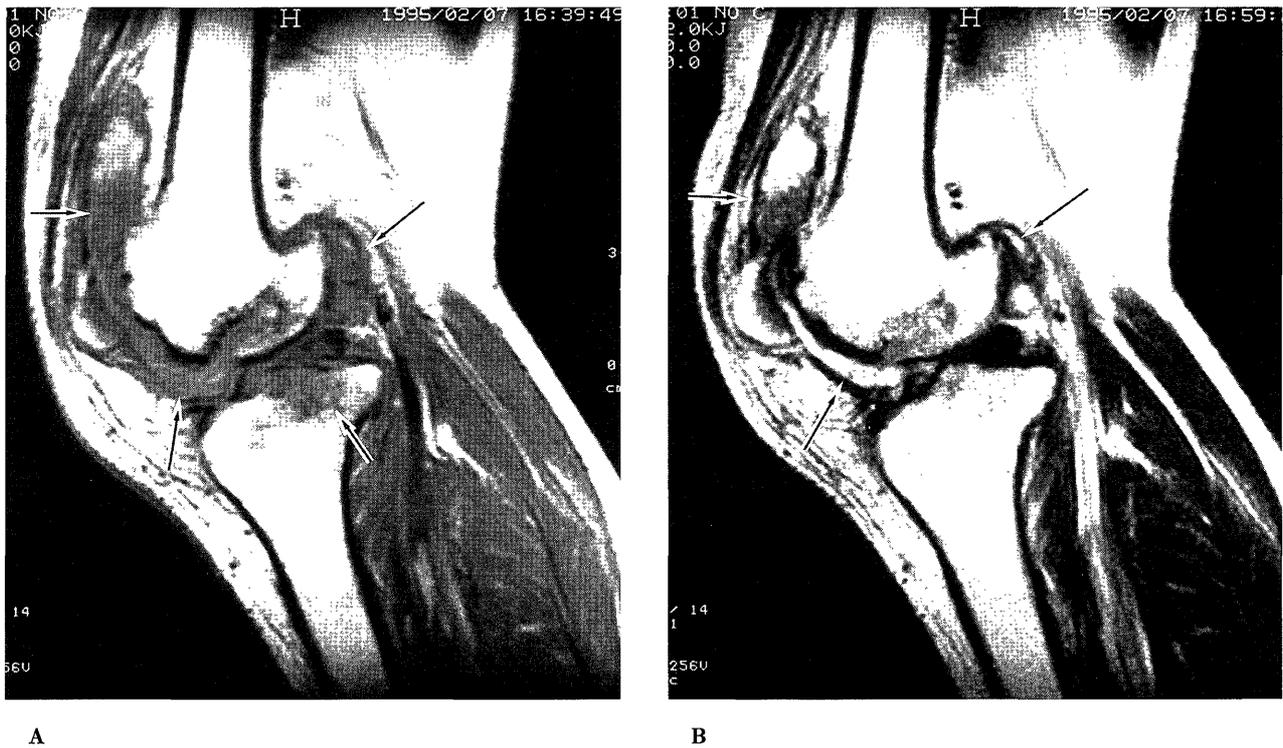


Fig. 7. Hemophilic arthropathy of the knee in 35 years old male. A, B. Hemosiderin-laden hypertrophied synovium appears as a low signal intensity mass (arrows) on both sagittal T1 (320/15 [TR/TE]) (A) and T2 (4000/90) (B) weighted images. Differential diagnosis includes PVS and other causes of recurrent hemarthrosis.

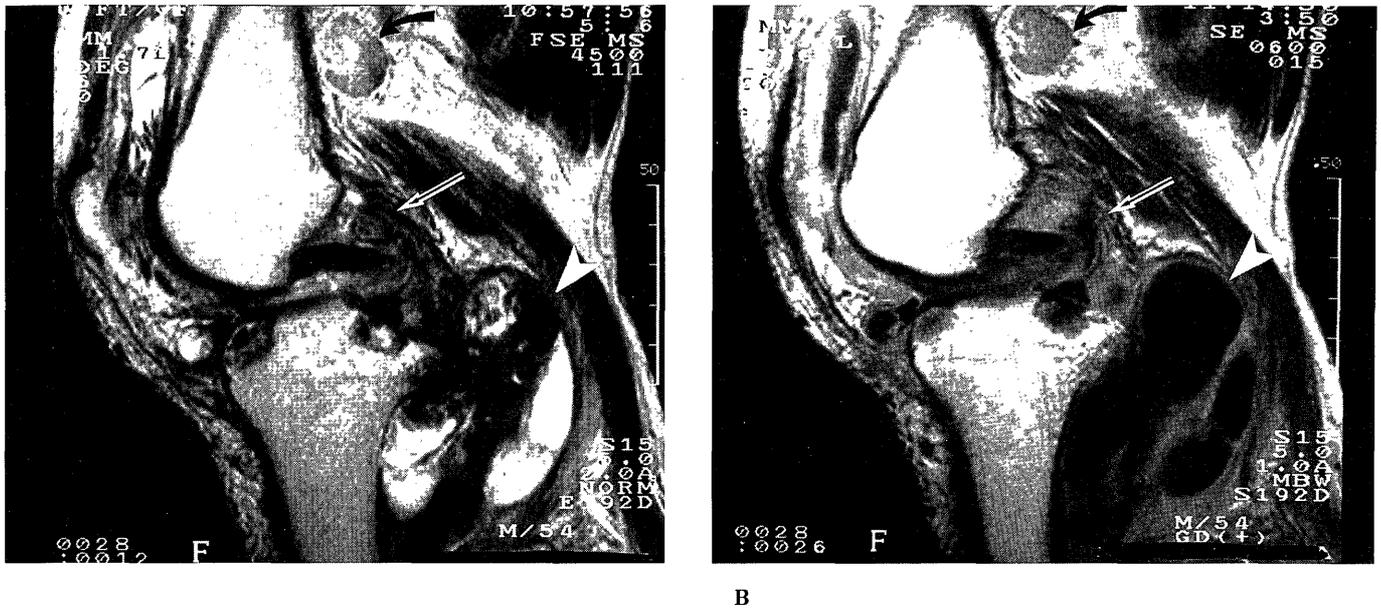


Fig. 8. Tuberculous arthropathy in 54 years old male. A, B. Sagittal T2 (4500/111 [TR/TE]) (A) and post contrast enhanced T1 (600/15) (B) weighted images of the knee show synovial thickening (arrow). A low signal intensity mass is seen posterior to the tibia (arrowhead) which shows no enhancement. This area corresponded with fibrin accumulation on histopathology. Tuberculous granuloma was found in the thickened synovium. Note an enlarged lymph node (curved arrow) posterior to the femur.

Lesions Arising From Bones

Chondroblastoma

Chondroblastoma is a benign cartilaginous tumor mostly arising in the epiphysis and apophysis of the long bones in young patients. It is important to differentiate it from malignant bone tumors and infection as it can be adequately managed by simple curettage with or without bone grafting. Radiographically it typically appears as an eccentric lucent epiphyseal or epi-metaphyseal lesion with a well circumscribed, sclerotic margin. On MR imaging, the tumor has low to intermediate signal intensity, lobular internal architecture and fine lobular margin on T2 weighted images (Fig. 10). On T1WI a low signal intensity rim corresponding to the sclerotic rim can be seen⁹⁾. Most chondroblastoma are associated with reactive zone of bone marrow and soft tissue edema that enhances intensely after contrast injection. However, the aggressive reactive edema is not specific for chondroblastoma and can be seen in other lesions like osteomyelitis, eosinophilic granuloma and osteoid osteoma⁹⁾.

Intra-articular osteoid osteoma

Cancellous and subperiosteal osteoid osteoma typically arises in an intra-articular or juxta-articular location¹⁰⁾.

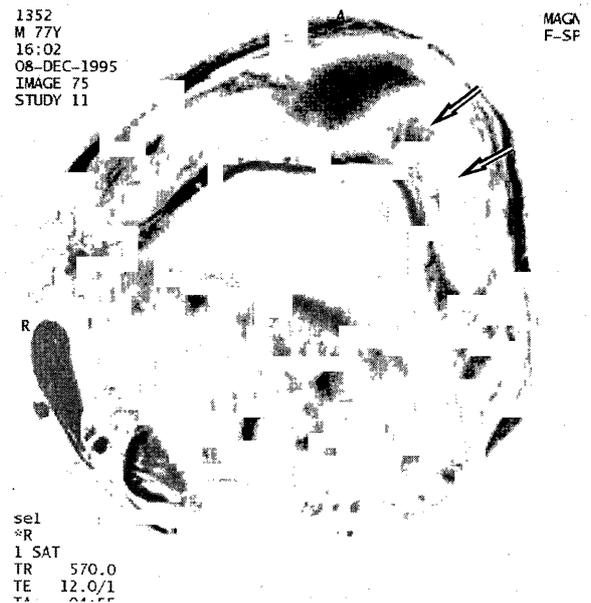


Fig. 9. Lipoma arborescens in 77 years old male with knee pain. Sagittal T1 (570/12 [TR/TE]) weighted image shows high signal intensity masses (arrows) projecting into the knee joint.

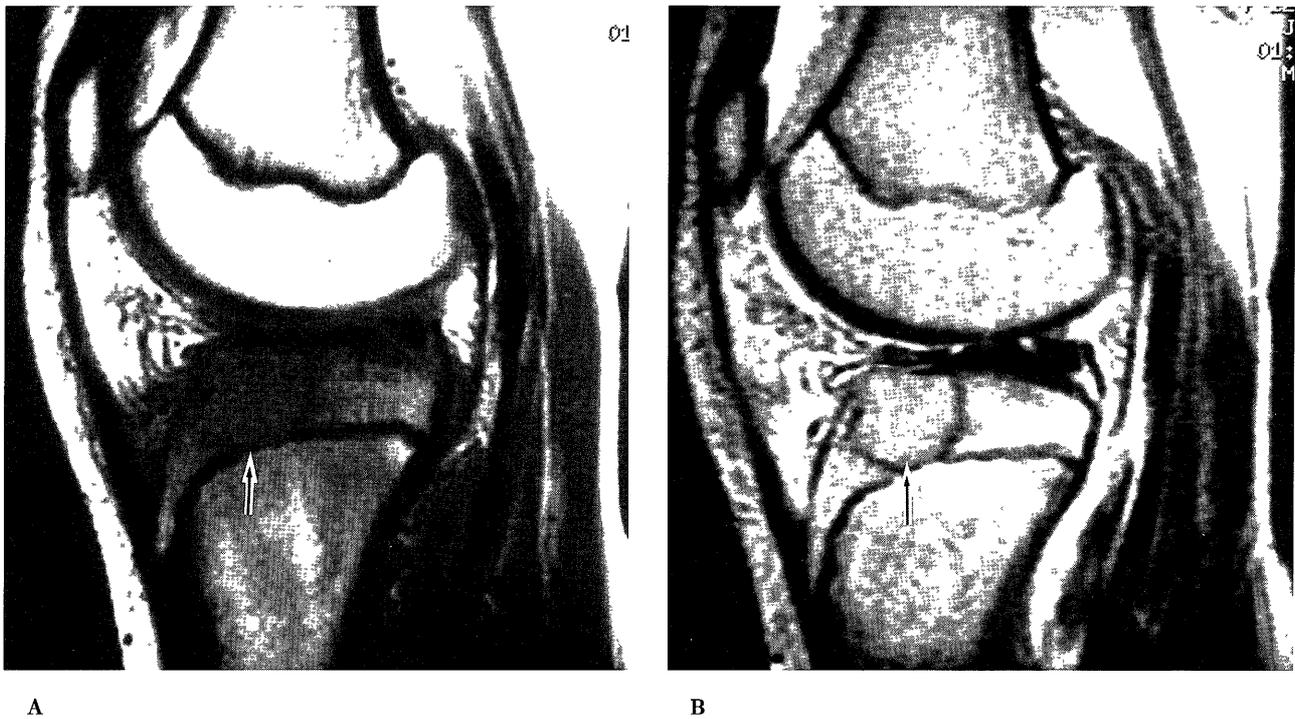


Fig. 10. Chondroblastoma in 12 years old female.

A, B. A well-defined epiphyseal lesion (arrow) with low signal on T1 (400/20 [TR/TE]) (A) and intermediate signal on T2 (2000/80) (B) weighted images is seen in the tibia. Edematous change is seen adjacent to the lesion. These findings are characteristic for chondroblastoma. Conventional radiograph of the knee was unremarkable.

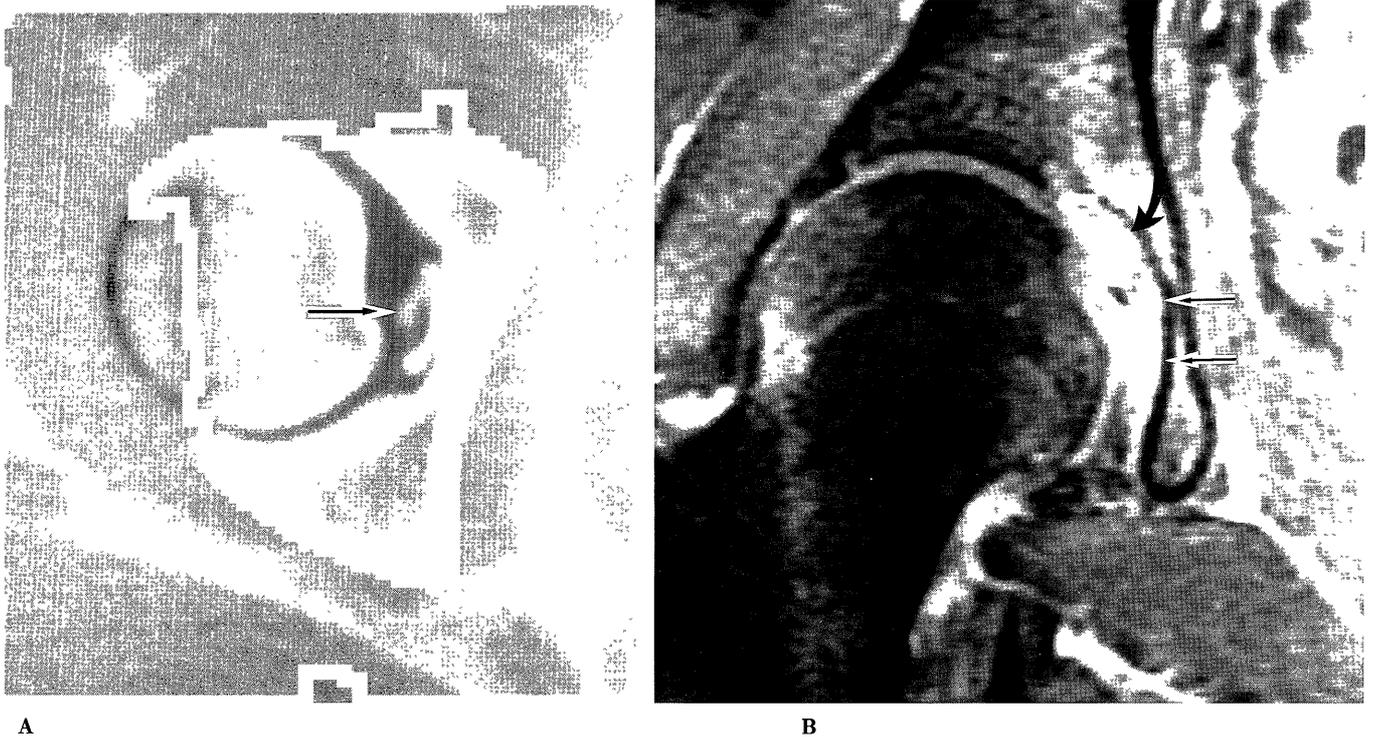


Fig. 11. Intra-articular osteoid osteoma in 15 years old boy with right hip pain.

A. Intra-articular location of the lesion (arrow) is clearly demonstrated on CT.

B. Fat saturated contrast enhanced T1 (600/15 [TR/TE]) shows synovial thickening in the hip joint (arrows) and bone marrow edema. The lesion (curved arrow) in itself is not well outlined.

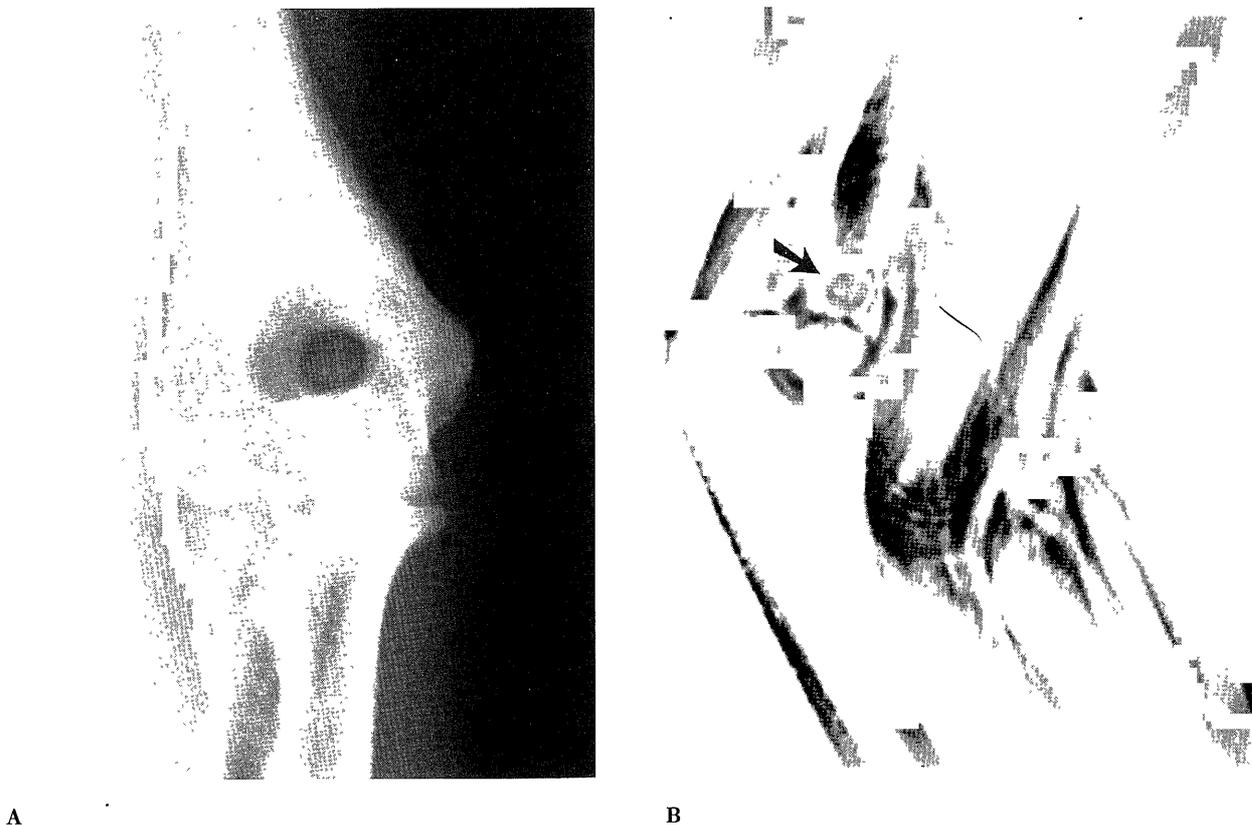


Fig. 12. 15 years old girl with intra-articular osteoid osteoma in the elbow.
 A. AP radiograph of elbow shows a well-defined radiolucent area with faint calcification (nidus) and periosteal reaction.
 B. Contrast enhanced T1 (400/20 [TR/TE]) weighted image shows ring like enhancement of the nidus (arrow), synovial thickening and minimal joint effusion.

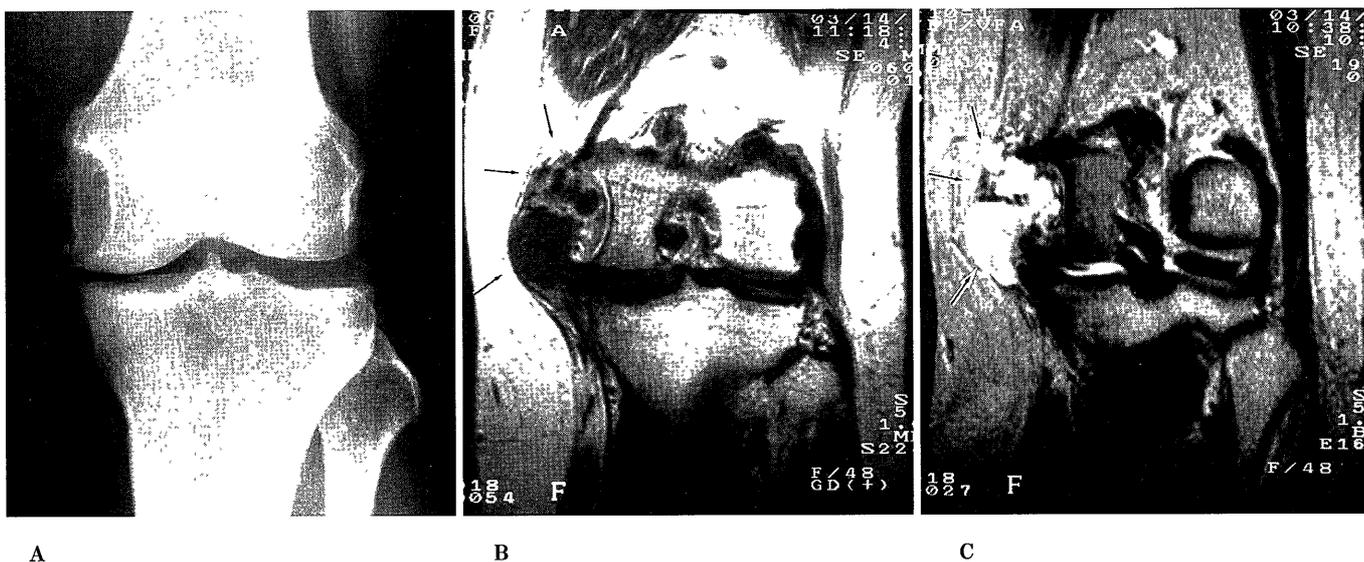


Fig. 13. Intra-osseous ganglion in the knee of 48 years old female.
 A. A large well-defined osteolytic lesion is seen in the medial femoral condyle on the AP radiograph.
 B,C. Contrast enhanced coronal T1 (600/15 [TR/TE]) (B) and T2 (1900/80) (C) weighted images of the knee show a multiloculated cystic lesion (arrows) with some extension to the soft tissue.

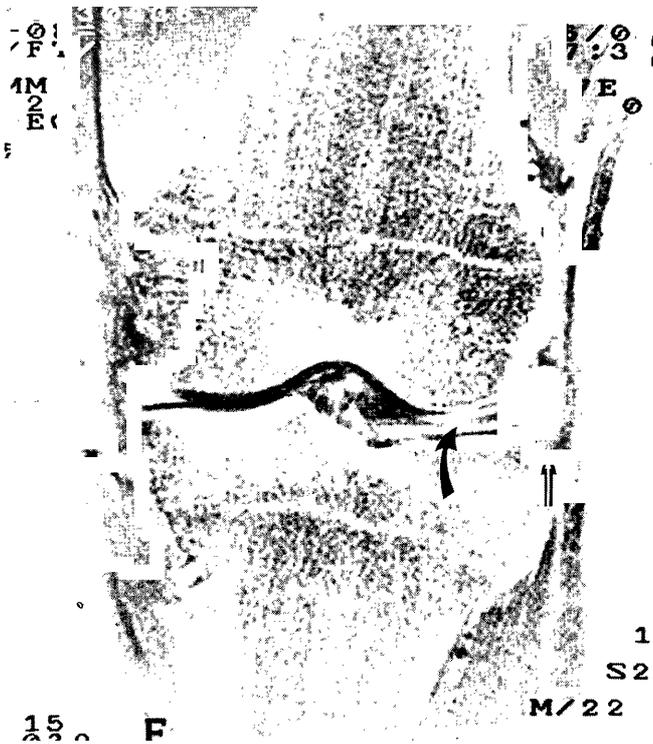


Fig. 14. Meniscal cyst in 22 years old male. Coronal T2* (600/15 [TR/TE]) weighted image shows a high signal well-marginated homogenous cystic lesion (arrow) adjacent to a horizontal tear of the lateral meniscus (curved arrow).

In young patients with monoarticular joint pain, osteoid osteoma should be considered in the differential diagnosis. Initial radiographs may be normal or positive findings are seen only retrospectively. On MRI a nidus usually demonstrates decreased signal intensity on both T1 and T2 weighted images. This is surrounded by an area of increased signal intensity on T2 weighted images, a pattern suggestive of bone marrow edema and local inflammation (Fig. 11). Synovial thickening and joint effusion are well demonstrated on MRI (Fig. 12). CT is considered to be superior to MRI for the identification and localization of the nidus.

Intra-osseous ganglion

Radiographically intraosseous ganglion appears as a well demarcated osteolytic subchondral lesion in the tubular bone. It shows low signal of T1 and high signal on T2 weighted images (Fig. 13). Differential diagnosis includes chondroblastoma, giant cell tumor and subchondral cysts associated with osteoarthritis.

Lesions Arising From Surrounding Structures

Meniscal cyst

Meniscal cyst is formed by extrusion of joint fluid through a horizontal meniscal tear into the adjacent tissues and indicates the presence of a meniscal tear¹¹. Lateral meniscal cysts are more common than the me-

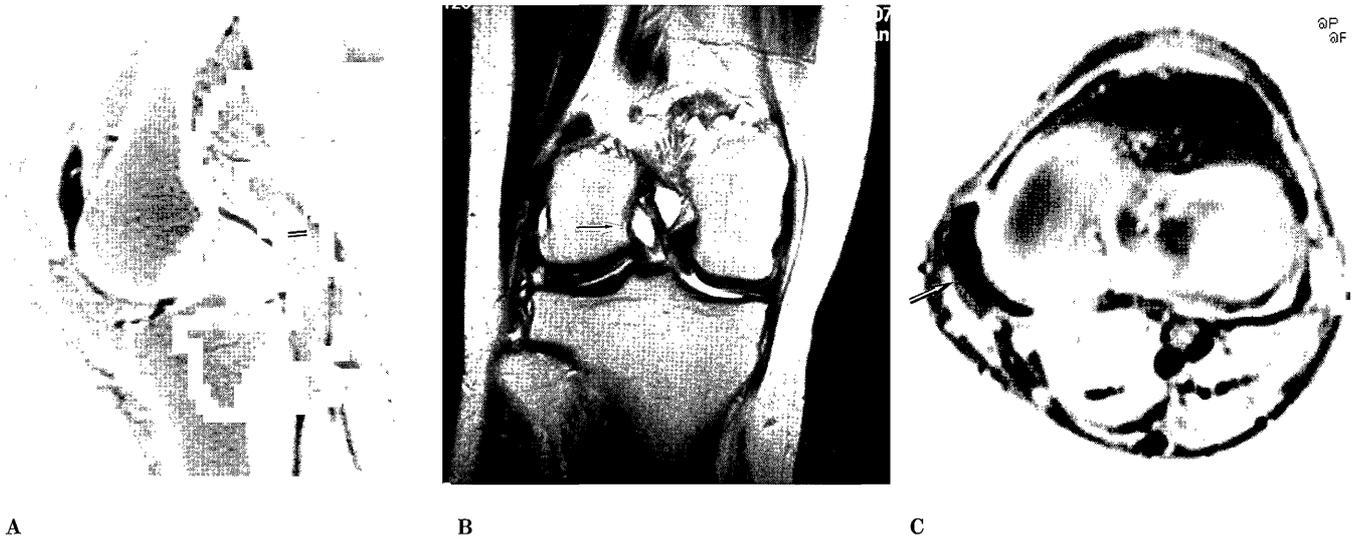


Fig. 15. Intraarticular ganglion cyst. A-C. Ganglion cysts associated with posterior cruciate (A), anterior cruciate (B) and medial collateral ligaments (C) are seen as well defined fluid collection (arrow) adjacent to the respective ligaments.

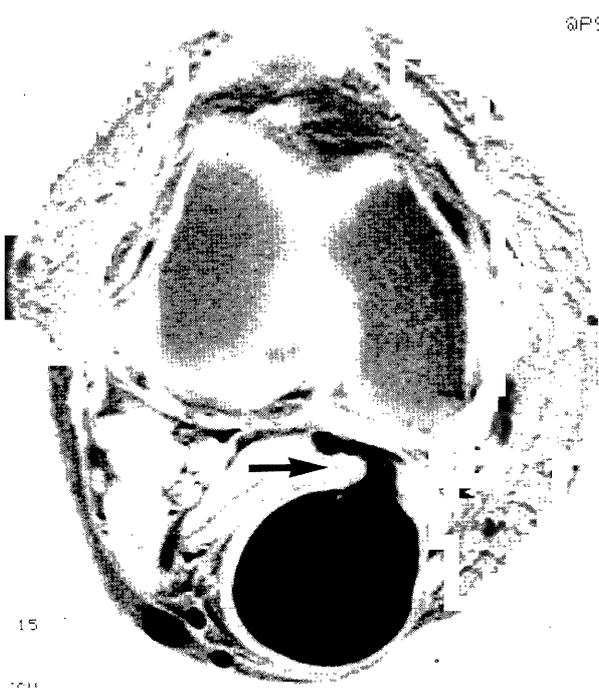


Fig. 16. Popliteal cyst in a 65 years old male. Axial T2 (4000/90 [TR/TE]) weighted image reveals typical MR appearance of a popliteal cyst between the tendons of medial head of gastrocnemius (straight arrow) and semimembranosus (curved arrow) muscles. Note contiguity of the cyst with the joint space.



Fig. 17. Ruptured popliteal cyst in a patient with history of rheumatoid arthritis. A ruptured popliteal cyst dissecting into the calf is seen on the sagittal T2 (4000/90 [TR/TE]) weighted image.

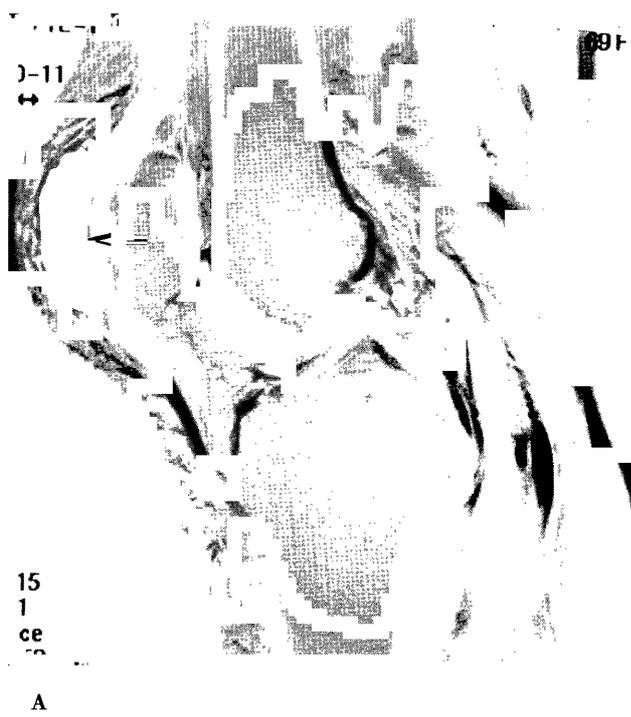
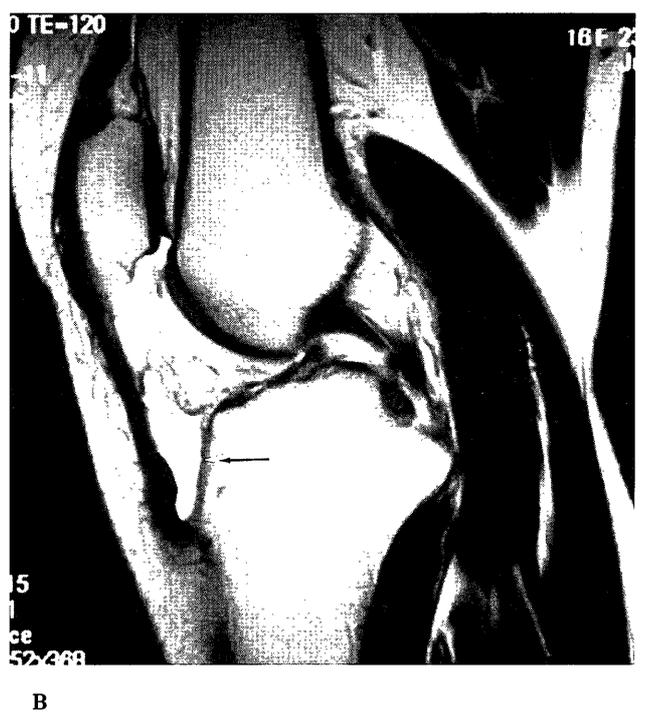


Fig. 18. Bursitis. A, B. Fluid collection (arrow) is seen in the distended prepatellar (A) and deep infrapatellar (B) bursa of two different patients on T2 (3650/120 [TR/TE]) weighted images.



dial ones. On MRI it appears as homogenous well-marginated mass with low signal on T1 and high signal on T2 weighted images (Fig. 14). It is differentiated from other isolated fluid collections about knee by identification of a meniscal tear extending to the lesion.

Intra-articular ganglion cyst

Intra-articular ganglion cyst may arise from the joint capsules, ligaments, bursa or subchondral bone. They are most frequently encountered about the wrist followed by knee, ankle and foot. In the knee most ganglia arise near the cruciate ligaments. On MR imaging cruciate ligament ganglion characteristically appears as a septated ovoid fluid collection adjacent to the ligament (Fig. 15).

Popliteal (Baker's) cyst

Popliteal cyst arises between the tendons of medial head of gastrocnemius and semimembranosus muscles and is usually frequently seen in patients with rheumatoid arthritis, osteoarthritis, meniscal tear etc. In

event of hemorrhage or rupture it mimics thrombophlebitis. On axial images the anatomical location of the cyst is well demonstrated and helps in its characterization (Fig. 16). MRI is particularly useful for the identification of the ruptured cyst (Fig. 17).

Bursitis

Enlargement and fluid collection in bursa can be associated with number of entities like rheumatoid arthritis, osteoarthritis, pigmented villonodular synovitis, trauma etc. MRI characteristic of bursitis is similar to that of other cystic lesions around the joints (Fig. 18). Knowledge of the exact anatomical location of bursas around the joints is necessary for the identification of bursitis and its differentiation from other cystic lesions.

Conclusion

Spectrum of diseases presenting as an intra-articular and juxta-articular mass lesion is diverse. These lesions are best evaluated by combination of different imaging modalities. While CT is the best for the detec-

Table: MRI appearance of intra-articular/ juxta-articular lesions

| | MR signal characteristics | | | Additional features |
|----------------------------------|---|--|----------------------|--|
| | T1WI | T2WI | Contrast enhancement | |
| Pigmented villonodular synovitis | Low | Low, very low on gradient echo (T2*) image | Present | Monoarticular, associated with hemarthrosis |
| Synovial osteochondromatosis | Low | High, calcified bodies appears as low signal areas | Present | Plain radiographs and CT useful for detection of calcification |
| Amyloidosis | Low | Low, intermediate on gradient echo (T2*) image | Present | History of chronic renal failure |
| Hemophilia | Low | Low | Present | Irregularity of joint margins, enlargement of epiphysis |
| Synovial Hemangioma | Low to intermediate, fatty septas appear as high signal | High | Present | Presence of phlebolith is characteristic |

T1WI: T1 weighted image

T2WI: T2 weighted image

tion of calcification and ossification, MRI is particularly well suited for the identification of the origin of these lesions, their morphology and relationships with the joint and surrounding structures. When considered together with history and clinical examination, MR imaging features help to arrive at a specific diagnosis.

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References

- 1) Bravo SM, Winalski CS, Weissman BN. Pigmented villonodular synovitis. *Radiol Clin North Am* 34:311-326, 1996
- 2) Kramer J, Recht M, Deely DM, Schweitzer M, Pathria MN, Gentili A, Greenway G, Resnick D. MR appearance of idiopathic synovial osteochondromatosis. *J Comput Assist Tomogr* 17:772-776, 1993
- 3) Cotten A, Flipo RM, Herbaux B, Gougeon F, Lecomte-Houcke M, Chastanet P. Synovial hemangioma of the knee: a frequently misdiagnosed lesion. *Skeletal Radiol* 24:257-261, 1995
- 4) Cobby MJ, Adler RS, Swartz R, Martel W. Dialysis related amyloid arthropathy: MR findings in four patients. *AJR* 157:1023-1027, 1991
- 5) Goldman AB, Bansal M. Amyloidosis and silicone synovitis: updated classification, updated pathophysiology, and synovial articular abnormalities. *Radiol Clin North Am* 34:375-394, 1996
- 6) Yulish BS, Lieberman JM, Strandjord SE, Bryan DJ, Mulopulos GP, Modic MT. Hemophilic arthropathy: assessment with MR imaging. *Radiology* 164:759-762, 1987
- 7) Suh JS, Lee JD, Cho JH, Kim MJ, Han DY, Cho NH. MR imaging of tuberculous arthritis: clinical and experimental studies. *J Mag Reson Imaging* 1:185-189, 1996
- 8) Ryu KN, Jaovisidha S, Schweitzer M, Motta AO, Resnick D. MR imaging of lipoma arborescens of the knee joint. *AJR* 167:1229-1232, 1996
- 9) Oxtoby JW, Davies AM. MRI characteristics of chondroblastoma. *Clin Radiol* 51:22-26, 1996
- 10) Kransdorf MJ, Stull MA, Gilkey FW, Moser RP Jr. Osteoid osteoma. *RadioGraphics* 11:671-696, 1991
- 11) Janzen DL, Peterfy CG, Forbes JR, Tirman PFJ, Genant HK. Cystic lesion around the knee joint: MR imaging findings. *AJR* 163:155-161, 1994