Pictorial Essay

Imaging of Pigmented Villonodular Synovitis with Emphasis on MR Imaging

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Pigmented villonodular synovitis (PVNS) is a term given to a family of benign proliferative lesions of the synovium of the joint, bursa, and tendon sheath. It is seen in both localized and diffuse forms. The localized form typically involves the small bones of the hands and usually is termed nodular synovitis, giant cell tumor of tendon sheath, fibrous histiocytoma of synovium, or pigmented nodular synovitis. The diffuse form, the subject of this essay, usually occurs in the large joints and is termed PVNS. Pathologically, PVNS is characterized by multinucleated giant cells with a characteristic pigmentation due to both intra- and extracellular hemosiderin [1, 2]. The imaging studies of seven patients with PVNS were reviewed, and the findings seen on radiography, arthrography, sonography, bone scintigraphy, angiography, CT, and MR are illustrated. Several lesions that mimicked PVNS on MR are also shown, and their distinguishing features are discussed.

Materials and Methods

One hundred eight-two patients with musculoskeletal diseases were evaluated by MR at our institution. Sixty-four of these patients had soft-tissue tumors, of which seven were pathologically proved cases of PVNS. The diagnosis of PVNS was suggested preoperatively in all but one case. Four cases that mimicked PVNS on MR studies are discussed also. All patients with PVNS were evaluated by the orthopedic surgery service and had surgical biopsy. All patients had plain radiographs and MR examinations. In addition, five patients had CT. Angiography was performed in two patients, and five patients had three-phase bone scintigraphy. Arthrograms were available in two patients, and one patient was examined with real-time sonography.

MR studies were performed on a 1.5-T superconducting MR imager (Technicare Inc., Solon, OH) or a 0.6-T superconducting MR imager (Picker International, Highland Heights, OH). Images were obtained by using both T1-weighted (200–700/20–40 [TR/TE]) and T2-weighted (1400–2200/40–100) spin-echo sequences. The MR studies were compared with results of the other imaging techniques.

Results

There were seven pathologically proved cases of PVNS. The diagnosis of four abnormalities that mimicked PVNS on MR included hip and knee synovial chondromatosis, hemangioma of the elbow, and rheumatoid arthritis of the knee. The cases of PVNS were located at the knee (three cases), the hip (three cases), and the ankle (one case).

Plain radiographs showed normal bones on both sides of the joint in two cases. In four of the five remaining cases, either a soft-tissue mass or joint effusion in addition to erosive bone changes was discernible on the radiographs (Fig. 1A). The remaining patient had well-defined, sclerotic bone erosions without a joint effusion or soft-tissue mass. Four of the lytic bony changes were on both sides of the joint, and in one

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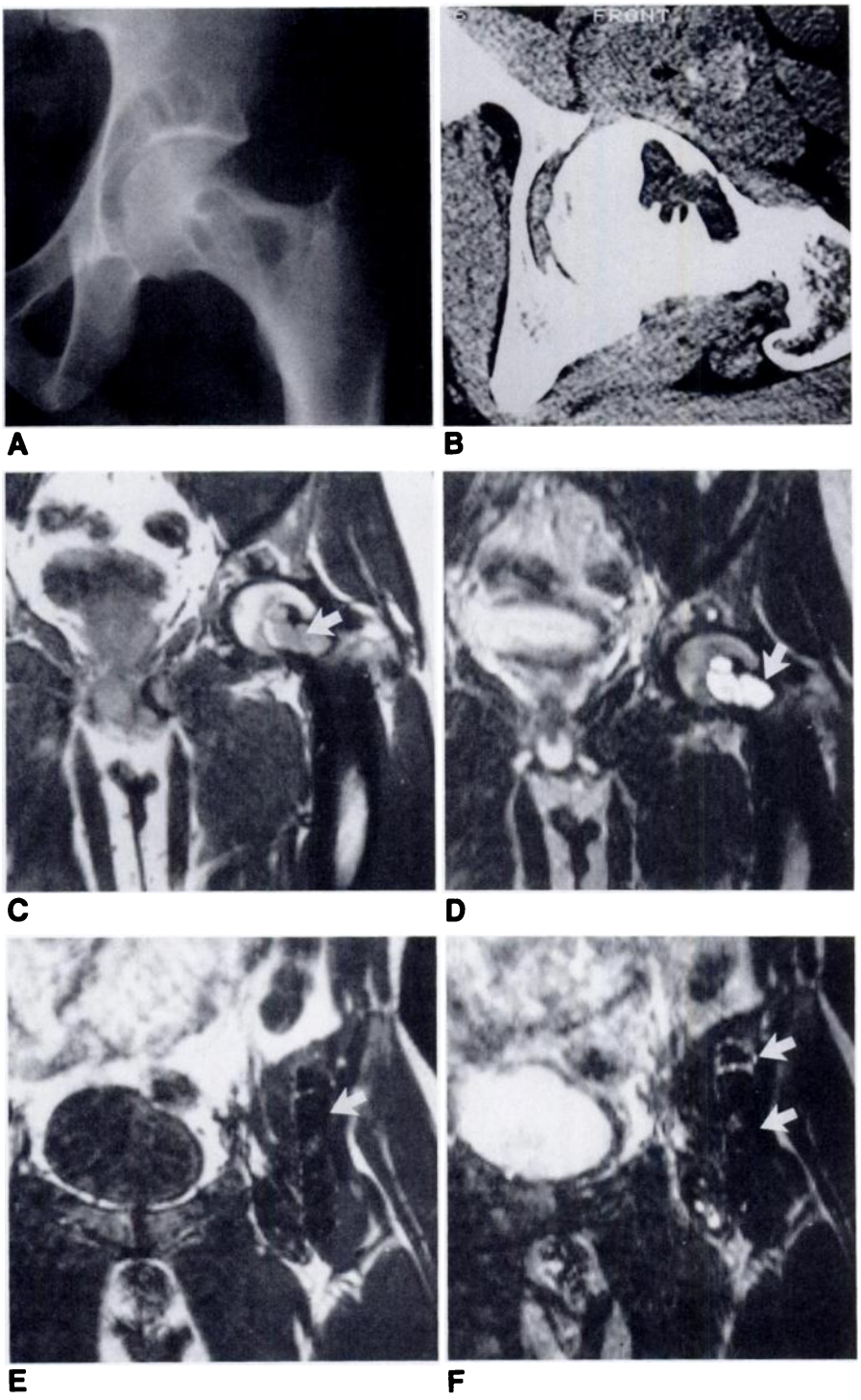


Fig. 1.—Pigmented villonodular synovitis of the hip.

***A*, Radiograph of left hip shows geographic lytic lesions with well-defined sclerotic margins on both sides of joint, consistent with synovial process.**

***B*, Corresponding axial image from noncontrast CT scan at level of femoral neck shows geographic lesion, which is primarily intraosseous with small defect in anterior cortex as only communication with joint space. Soft-tissue mass with focal region of increased density anteriorly (*arrow*) may represent calcification or deposition of hemosiderin.**

***C* and *D*, Coronal T1-weighted (700/33) (*C*) and T2-weighted (1000/100) (*D*) MR images show bony changes that correspond to those on plain films. Signal from region of bony defects shows typical mixed signal. Bony septa or ridges crossing lesion on plain film are seen here as fine linear streaks of signal void (*arrows*).**

***E* and *F*, T1-weighted (700/33) (*E*) and T2-weighted (1000/100) (*F*) MR images show area of markedly decreased signal intensity on both pulse sequences within soft tissues in distribution similar to area of increased flow on bone scan. Decreased signal is caused by deposition of hemosiderin within hypervascular tumor mass (*arrows*).**

case bone changes were apparent on only one side of the joint.

Three-phase bone scintigraphy was performed in five patients. All patients had increased flow and blood pool in the regions of the soft-tissue masses. Those patients with lytic defects seen on either plain-film radiography or CT had increased bone uptake of radionuclide on delayed images in the region of those defects. The large extraarticular soft-tissue components showed subtle areas of increased activity on delayed images in one case.

Real-time sonography, performed in one patient with PVNS of the knee, showed a complex mass within an enlarged bursa. The interior of the bursa contained fluid with echogenic synovial masses and septations (Fig. 2A).

The two angiograms showed vascular masses with numerous irregular vessels, "tumor" blush, and slight arteriovenous

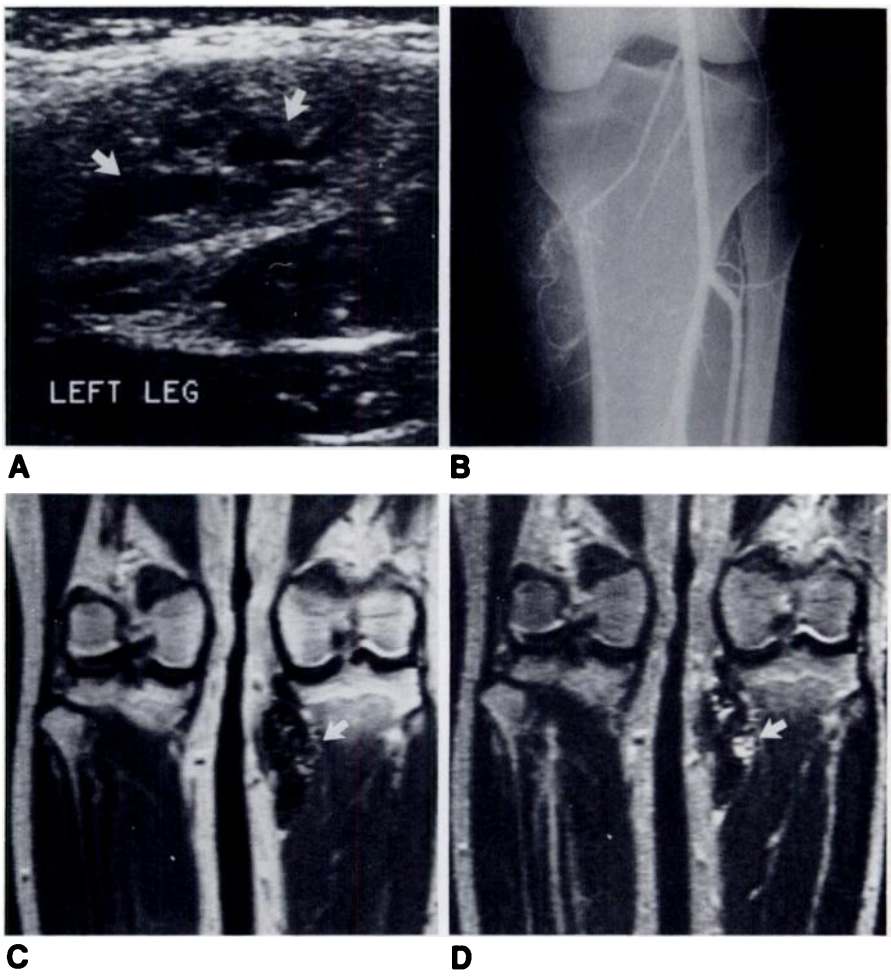


Fig. 2.—Pigmented villonodular synovitis (PVNS) of the knee.

***A*, Sonogram shows soft-tissue mass with both cystic and solid components (*arrows*).**

***B*, Arteriogram shows soft-tissue mass posterior and medial to proximal tibia. Mass has neovascularity with irregularity and puddling of contrast material as well as a "tumor blush." Mass is indistinguishable from malignant soft-tissue tumor.**

***C* and *D*, T1-weighted (480/22) (*C*) and T2-weighted (2000/80) (*D*) MR images reveal areas of markedly decreased signal on both spin-echo sequences suggesting calcification, flowing blood, or hemosiderin deposition (*arrows*). This is mixed with areas of prolonged T1 and T2 relaxation times consistent with synovial fluid. Lack of calcification or large vessels as noted on plain-film radiographs and angiogram indicate hemosiderin as cause of decreased signal on the MR images. This suggests PVNS as likely cause of soft-tissue mass.**

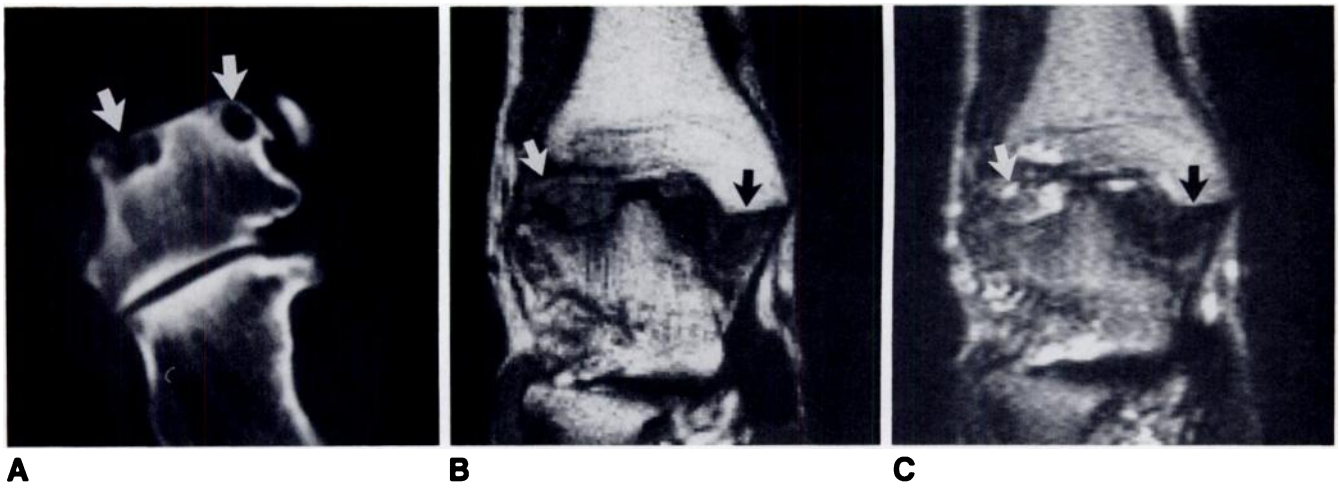


Fig. 3.—Pigmented villonodular synovitis (PVNS) of the ankle.

***A*, CT scan of right foot shows geographic lesions (*arrows*) in talus. Similar lesions were also present in distal tibia (not shown). Lesions have a sclerotic margin and may be mistaken for subchondral bone cysts.**

***B* and *C*, Coronal MR images, T1-weighted (400/22) (*B*) and T2-weighted (2000/100) (*C*), show diffuse involvement of talus, far exceeding that expected on plain films and CT scan. Intermediate signal intensity noted in lateral aspect of tumor (*white arrows*) is consistent with any synovial process; however, areas of decreased signal in medial aspect of talus (*black arrows*) are thought to be caused by hemosiderin within synovium, most consistent with PVNS.**

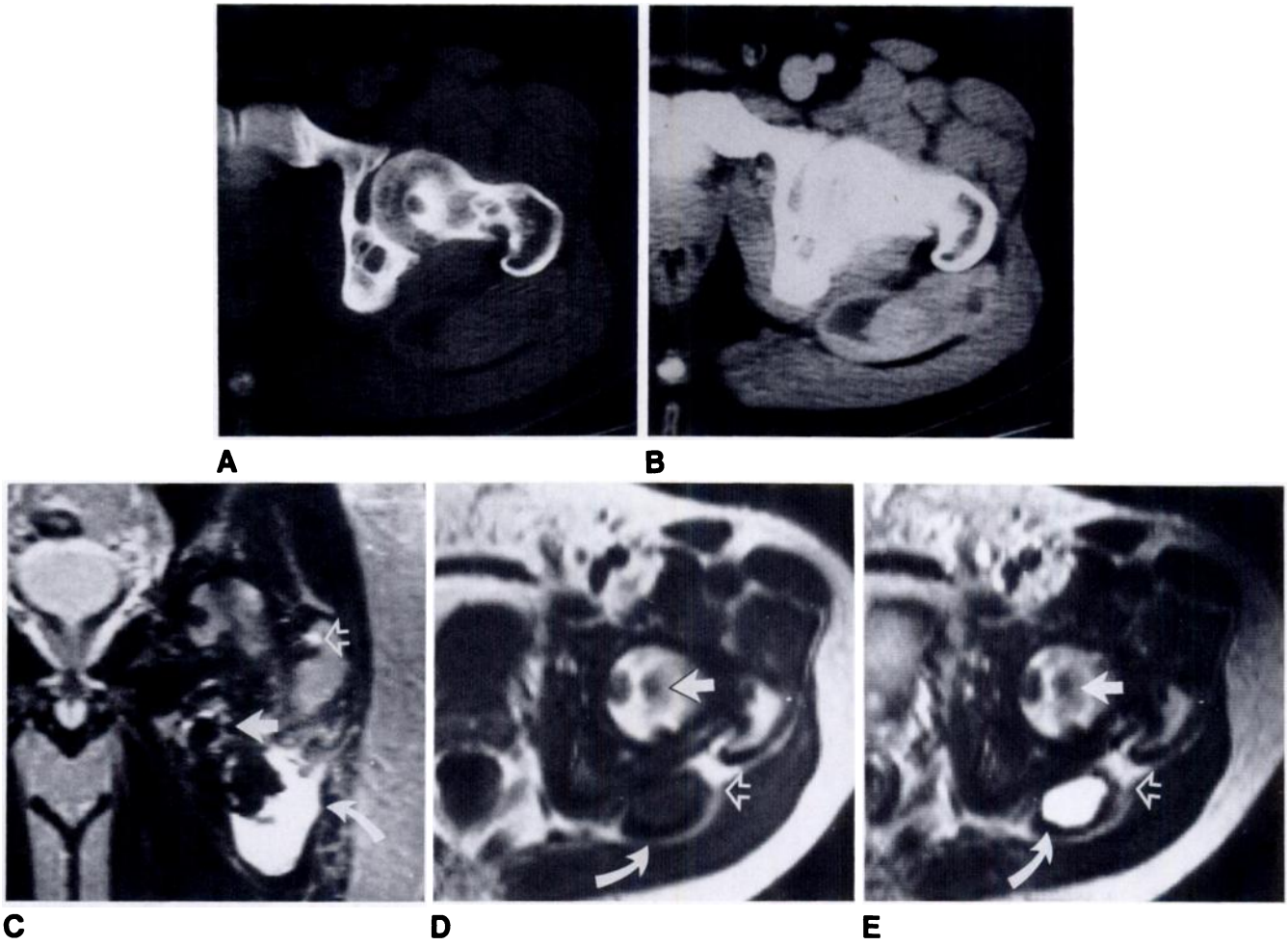


Fig. 4.—Pigmented villonodular synovitis (PVNS) of the hip.

***A*, Axial CT scan at level of femoral head and neck at bone window setting shows geographic lesions with sclerotic margins in both femur and acetabulum.**

***B*, CT scan. Soft-tissue window setting accentuates soft-tissue mass posterior to hip joint with rim enhancement, enhancing nodules, and synovial fluid.**

***C*, T2-weighted (2000/100) MR image in coronal plane reveals discrete lesions on both sides of hip joint space distant from articular surface, which would be more consistent with PVNS and atypical of degenerative or inflammatory arthritis. Note variability in signal intensity between synovial extraarticular mass (*solid straight arrow*) and intraosseous masses (*open arrow*) within same joint, as well as synovial fluid (*curved arrow*).**

***D* and *E*, Corresponding axial MR images (slightly inferior to *C*), T1-weighted (528/34) (*D*) and T2-weighted (2184/90) (*E*), show both intraosseous (*solid straight arrows*) and extraosseous (*open arrows*) tumor, as well as large posterior paraarticular synovial fluid collection (*curved arrows*) with rim of markedly decreased signal. Hypointense rim on MR corresponds to enhancing rim seen on contrast-enhanced CT study.**

shunting. The appearance was thought to be indistinguishable from a malignant neoplasm (Fig. 2B).

Five patients had CT scans with IV contrast material. Two studies were performed without and then with IV contrast material. Bone lesions were absent in one case and present on both sides of the joint in the remaining four patients with PVNS studied by CT. The lytic defects were sharply defined with sclerotic borders (Figs. 3A and 4A). Two of the lytic bone lesions were broad-based (Fig. 3A). Two patients had a primarily intraosseous soft-tissue mass with a narrow pedicle extending to the synovium (Fig. 1B). Soft-tissue masses and/or effusions were seen in all patients (Figs. 1B and 4B). Rim enhancement of the synovial mass was seen in two patients (Fig. 4B). On the two noncontrast CT scans, focal areas of hyperdensity within the soft-tissue mass did not show further enhancement after administration of contrast material (Fig. 1B).

In the two patients who had arthrograms, a large distensible

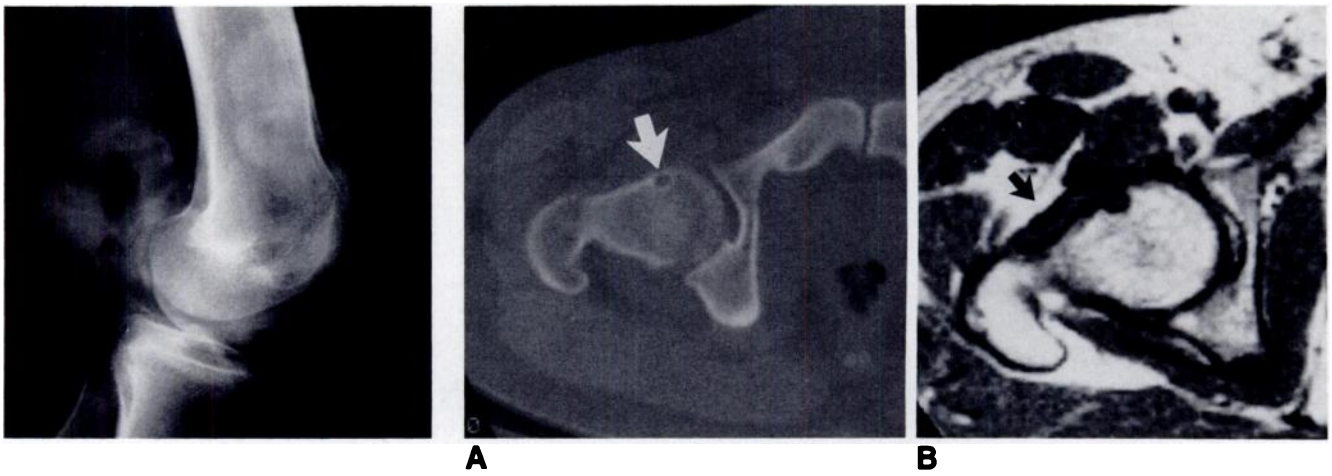


Fig. 5.—Pigmented villonodular synovitis of the knee. Double-contrast arthrogram shows diffusely enlarged joint with nodular masses within synovium. Aspiration of rust brown–tinged fluid is characteristic. Incidental note is made of fibrous cortical defect in distal femur.

Fig. 6.—Synovial chondromatosis simulating pigmented villonodular synovitis (PVNS).
A, CT scan shows well-defined erosion (*arrow*) of anterior aspect of femoral head. No definite synovial mass is identified.
B, T1-weighted MR image (600/200) shows synovial mass as cause of erosion. Signal intensity within mass is similar to that of skeletal muscle (*arrow*), suggesting lack of hemosiderin deposition, which would be atypical for classical PVNS. Biopsy-proved synovial chondromatosis. This is a nonspecific MR examination; however, homogeneous appearance was not seen in any of our patients with PVNS.

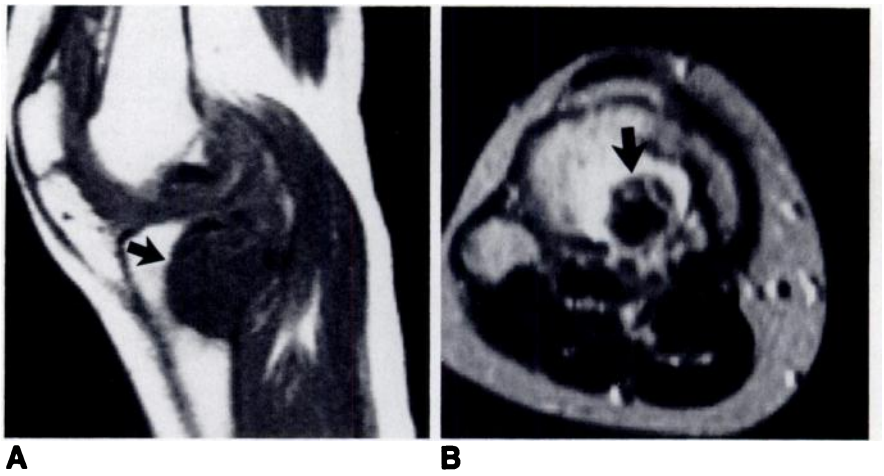
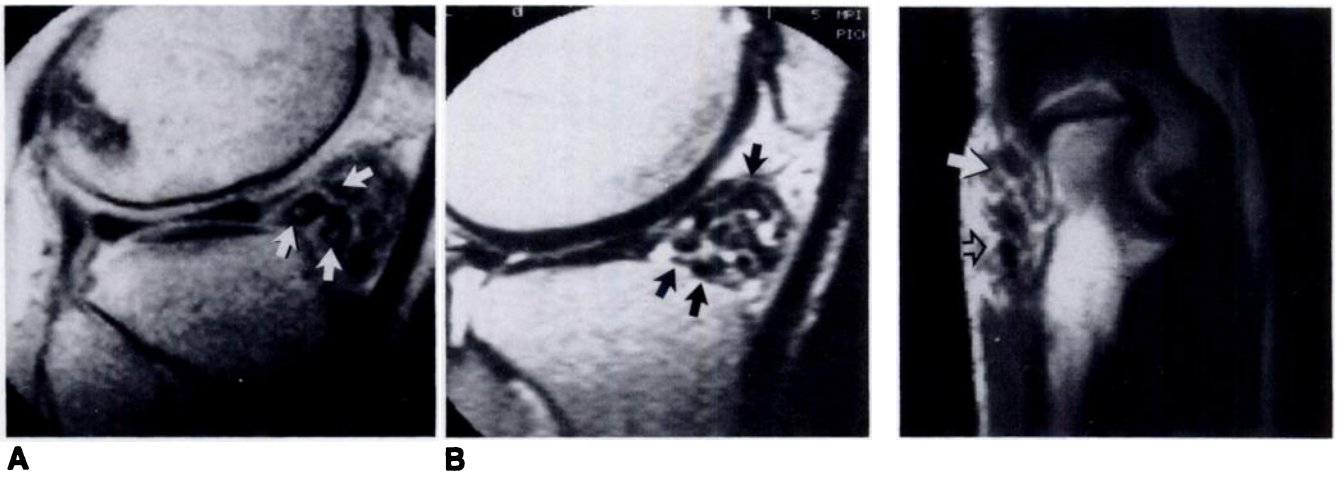


Fig. 7.—*A* and *B*, Rheumatoid arthritis simulating pigmented villonodular synovitis (PVNS). Sagittal T1-weighted (450/21) (*A*) and axial T2-weighted (2000/100) (*B*) MR images of patient with biopsy-proved rheumatoid arthritis show large bone erosion (*arrows*) with homogeneous signal intensity similar to adjacent skeletal muscle on sagittal T1-weighted image. Axial T2-weighted image reveals hypointense mass surrounded by area of hyperintense signal consistent with synovial fluid. Axial T2-weighted image is indistinguishable from T2-weighted images of patients with PVNS. However, homogeneous T1-weighted image is less typical and has not been observed by us in other patients with PVNS.

joint was present with multiple lobulated filing defects. Double-contrast arthrography enhanced the appearance of synovial nodules (Fig. 5).

The MR appearance of PVNS seen in these seven patients was that of a heterogeneous synovial process that in five cases extended away from the joint space (Figs. 1E, 1F, 2C, 2D, 3B, 3C, 4D, and 4E). The lesions contained significant areas of intermediate signal intensity and hypointensity when compared with skeletal muscle on all spin-echo sequences. The lytic bone lesions were seen as well on MR as on CT (Figs. 1C, 1D, 1F, 3B, 3C, and 4E). Joint effusions were present in four cases and were manifest as areas of low



A B

Fig. 8.—*A* and *B*, Osteochondromatosis simulating pigmented villonodular synovitis (PVNS). T1-weighted (700/12) (*A*) and T2-weighted (2100/100) (*B*) MR images of left knee show synovial mass with decreased signal intensity (*arrows*) similar to that seen in PVNS. Plain-film radiography showed round, calcified bodies within knee joint typical of osteochondromatosis.

Fig. 9.—Hemangioma mimicking pigmented villonodular synovitis (PVNS). Sagittal T1-weighted MR image (500/33) of soft-tissue mass adjacent to olecranon. Note that signal intensity on T1-weighted image is similar to that of skeletal muscle (*solid arrow*). Within mass, small, well-defined areas of decreased signal (*open arrow*) on both T1-weighted image and T2-weighted image (not shown) might be interpreted as area of hemosiderin deposition suggesting PVNS. Plain-film radiograph showed phleboliths corresponding to these areas, which strongly suggested pathologically proved hemangioma.

signal on T1-weighted images, with marked hyperintensity on T2-weighted images (Figs. 4C–4E).

Discussion

PVNS is a highly vascular synovial mass with a tendency to erode bone and to bleed [1, 2]. The vascularity of the mass is best appreciated on nuclear medicine flow studies and angiography. Unfortunately, the vascularity of the lesion mimics malignant soft-tissue diseases. The vascular nature of the mass is not apparent on MR. Areas of decreased signal intensity corresponding to vessels are not apparent within or around the soft-tissue masses on any MR examination. This may be due to either the size of the vessels or the lack of contrast between the flowing blood and the other larger areas of decreased signal thought to be a result of deposition of hemosiderin.

The masslike nature of PVNS frequently is manifested as bone erosion on both sides of the joint. This was seen in five of our seven patients. The CT appearance of these erosions often is that of an intraosseous mass. The tendency of the lesion to bleed results in deposition of hemosiderin, which results in decreased signal on both T1- and T2-weighted images. This was seen in all of our seven cases of PVNS and three of four cases previously reported in the literature [3, 4]. This appearance was not seen in two of four cases that mimicked PVNS on MR and were later shown not to be PVNS (Figs. 6 and 7). The two cases with hypointensity on all spin-echo sequences had significant calcified or ossified bodies in the joint spaces that were seen clearly on plain-film radiography and suggested that these were were not cases of PVNS (Figs. 8 and 9).

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