Arthritis

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Overview

Correct diagnosis of arthritis (Fig. 1) involves consideration of numerous factors, including clinical features [age and sex of the patient, duration of symptoms, clinical appearance of involved joint or joints, presence or absence of associated diseases (e.g., skin disease, uveitis, urethritis)], laboratory values (e.g., markers for inflammation, serum rheumatoid factor, serum uric acid level), and various imaging features. Radiographs represent the

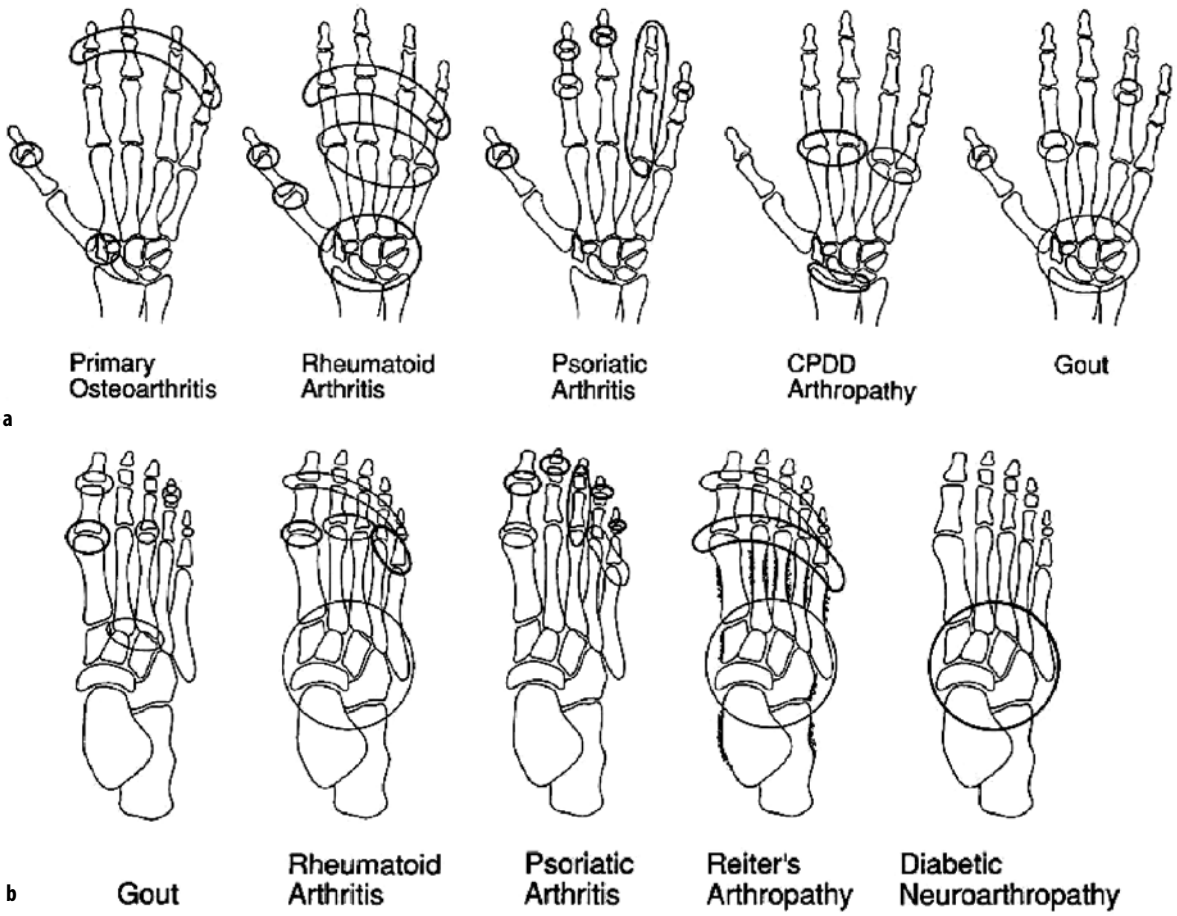

Fig. 1 a, b. Sites and distribution of common arthritides of the hand (**a**) and foot (**b**). The more common sites are encircled with *bold lines* and the less common sites with *lighter lines*. Note the periosteal reaction (new bone formation) classically identified in reactive arthritis (Reiter's arthropathy). Note also the potential for "sausage digit" distribution in psoriatic arthritis. When joints are encircled in isolation, the distribution is random and may be isolated to any joint (Courtesy of Lee F. Rogers, MD)

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mainstay for diagnosis and follow-up of joint damage, although magnetic resonance imaging (MRI) and sonography can be useful evaluation tools, especially in the early stages of disease. Many imaging features have to be systematically assessed to establish a correct diagnosis: (1) the distribution of joint involvement [monoarticular or polyarticular, symmetrical or asymmetrical, proximal or distal, associated axial involvement, associated enthesis (ligament and tendon attachment to bone) involvement]; (2) soft tissue swelling (periarticular, fusiform, nodular); (3) joint space narrowing (uniform, non-uniform, none); (4) bone erosion (marginal, central, periarticular, well-defined, none); (5) bone production (osteophytes, enthesophytes, periosteal new bone); (6) calcification (periarticular, chondrocalcinosis); (7) subchondral cysts; (8) periarticular osteoporosis.

In recent years, there has been a significant change in the management of the inflammatory arthritides, with the advent of powerful and effective biological therapies. The use of these drugs has led to a dramatic improvement in patient lifestyle and morbidity from this disease group, which previously resulted in relentless joint destruction. To achieve these outcomes, drug therapy must be initiated before irreversible joint damage has occurred. This requires early diagnosis, often before conventional radiographs show manifestations of the disease. This has led to increasing use of more advanced imaging techniques, principally MRI and ultrasound, to diagnose and manage these conditions. Intense research activity is currently centered on the use of these techniques to detect disease progression and remission; in the future they might become important tools in therapeutic decision-making.

Rheumatold Arthritis

Rheumatoid arthritis is characterized by proliferative, hypervascularized synovitis, resulting in bone erosion, cartilage damage, joint destruction and long-term disability. Diagnosis is based on clinical, laboratory and radiographic findings. The disease typically begins in the peripheral joints, usually the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints, the wrists, and the metatarsophalangeal (MTP) joints, with a predominantly symmetrical distribution. As the disease progresses, it affects more proximal joints.

The initial radiographic manifestations are soft tissue swelling and periarticular osteoporosis. These features represent indirect evidence of synovial inflammation, and their assessment is quite subjective. More specific are marginal erosions of bone that occur at the so-called bare areas between the peripheral edge of the articular cartilage and the insertion of the joint capsule. In the early stages of the disease, these may occur at the radial aspect of the second and third metacarpal heads, at the ulnar styloid process, and at the metatarsal heads, especially at the lateral aspect of the fifth metatarsal head. This is followed by diffuse narrowing of PIP, MCP, MTP and wrist joints. Unfortunately, these features represent late consequences of synovitis. Characteristically, the distal interphalangeal (DIP) joints are spared. There is no osseous proliferation and no involvement of entheses.

The development of new, powerful, but expensive therapeutic agents for rheumatoid arthritis, such as the anti-tumor necrosis factor agents, has created new demands on radiologists to identify patients with aggressive rheumatoid arthritis at an early stage. MRI and sonography can be useful tools in evaluating these patients. Sonography is a quick and inexpensive way to detect synovitis and tenosynovitis, whereas MRI is a more global way to evaluate the small synovial joints of the appendicular skeleton, and is more sensitive than radiography in detecting synovitis, bone marrow edema and bone erosions. MRI is also an excellent means to assess spinal complications of rheumatoid arthritis, in particular subluxation at the atlantoaxial joint. Both MRI and sonography may be used to demonstrate the soft tissue changes of rheumatoid arthritis, such as tenosynovitis and rheumatoid nodules.

Seronegative Spondyloarthropathies

The seronegative spondyloarthropathies are represented by ankylosing spondylitis, psoriatic arthritis, reactive arthritis (Reiter's syndrome), colitic arthritis and undifferentiated spondyloarthropathies. Affected persons usually have a negative serum rheumatoid factor, but a significant percentage has the HLA-B27 antigen. These diseases frequently cause symptoms in the axial skeleton, but the appendicular skeleton may also be affected, in isolation or in combination. Radiographically, these diseases differ from rheumatoid arthritis by the absence or mild nature of periarticular osteoporosis, the involvement of entheses with erosions and with new bone formation, and the asymmetrical involvement of the peripheral skeleton.

Ankylosing Spondylitis

Involvement in ankylosing spondylitis starts and is most typical in the axial skeleton (spine and sacroiliac joints), but the appendicular skeleton may also be involved, especially the feet. Radiography may demonstrate arthritis and enthesitis with erosive changes and osseous proliferation. MRI is well suited for demonstrating the early spinal and sacroiliac changes of ankylosing spondylitis. High T2 signal change (edema like) seen at the corners of vertebral bodies and in the subchondral bone of the sacroiliac joints is a typical feature. Later, erosive change at the sacroiliac joints and ultimately fusion in the sacroiliac joints and spine may be seen. Costovertebral disease is a common finding on MRI. Sites of previous inflammatory change may be evident as fatty change within the bone marrow, typically seen at the corners of the vertebral bodies. At an early stage of the disease, sonography and MRI may be useful in showing peripheral inflammatory changes at the

entheses, including extra-articular sites such as the calcaneal attachments of the Achilles tendon and plantar fascia. While sonography will show synovitis and erosive change along with enthesophytes, MRI will also demonstrate edema-like change within the bone marrow.

Psoriatic Arthritis

The extent of arthritis does not correlate with the degree of psoriatic skin disease and, in some cases, the skin manifestations may follow the arthritis by several years or may never develop. Psoriatic arthritis tends to involve the small joints of the hands and feet. The process is characteristically asymmetrical. Involvement of the DIP joints of the hands and toes, usually in association with psoriatic changes of the nails, or involvement of one entire digit (MCP + PIP + DIP, "sausage digit"), is very suggestive of psoriatic arthritis. This arthritis is not necessarily associated with periarticular osteoporosis, and erosions are often small. In contrast, extensive osseous proliferation at entheses and periostitis are common.

At an early stage, sonography and MRI may show synovitis, tenosynovitis and bursitis that are similar to those seen in rheumatoid arthritis. In addition, MRI may demonstrate extensive signal abnormality in the bone marrow and soft tissues far beyond the joint capsule, related to enthesitis. These features may be useful in patients with inflammatory polyarthralgia of the hands for differentiating rheumatoid arthritis from psoriatic arthritis. Sacroiliitis is common and resembles that seen in ankylosing spondylitis, except that it is more often asymmetrical. Spinal involvement is less common, and the paravertebral ossification that occurs in psoriatic spondylitis is typically broad, coarse and asymmetrical in contrast to the symmetrical syndesmophytes of ankylosing spondylitis.

Reactive Arthritis (Reiter's Syndrome)

Reactive arthritis is characterized by urethritis, conjunctivitis and mucocutaneous lesions in the oropharynx, tongue, glans penis and skin, as well as arthritis. In general, the radiographic manifestations are similar to those of psoriatic arthritis, except that the axial skeleton is not as commonly involved, and changes in the upper extremities are exceptional. The most prominent involvement is in the lower extremities, particularly the feet.

Colitic Arthritis

Arthritis occurs in approximately 10% of patients with chronic inflammatory bowel disease, more commonly in ulcerative colitis than in Crohn's disease. The most common manifestation is sacroiliitis, which is similar to but not as extensive as that in ankylosing spondylitis, with bilateral symmetrical involvement. Patients are rarely symptomatic, and the radiographic findings of sacroiliitis are often noted incidentally on abdominal radiographs obtained as part of a small bowel or colon examination. Peripheral arthritis is uncommon.

Degenerative Joint Disease (Osteoarthritis)

Osteoarthritis is characterized by degeneration and shredding of articular cartilage. It mainly affects the interphalangeal joints of the fingers (sparing the MCP joints) and the weight-bearing joints (hips and knees). Degenerative joint disease occurs in two major forms: a primary form, which is a generalized disease affecting all of the aforementioned joints, and a secondary form limited to joints affected by previous localized trauma or other joint disease. The radiographic and pathologic changes are similar in the two forms.

The general radiographic features of osteoarthritis are nonuniform joint space narrowing, subchondral sclerosis of bone, marginal osteophytes and subchondral cysts. Narrowing of the joint space in osteoarthritis is almost invariably uneven and more pronounced in that portion of the joint where weight-bearing stresses are greatest. In general, the greater the degree of narrowing, the more severe the associated findings of subchondral sclerosis and osteophytosis. Calcified or ossified fragments (loose bodies) may be identified within the joint and are particularly common in the knee.

Clinical and radiographic features are usually straightforward, and MRI is not used for primary diagnosis. It should be recognized that some MRI features may be misleading, including extensive edema of subchondral bone marrow, signal changes of subchondral bone located on only one side of a joint, enhancement of subchondral cysts after intravenous gadolinium administration, and heterogeneous signal intensity of joint fluid.

Erosive Osteoarthritis

Erosive osteoarthritis is an inflammatory form of osteoarthritis that occurs primarily in postmenopausal women. It is usually limited to the interphalangeal joints of the hand. Clinically, the joints are acutely inflamed. Erosions of the central portion of articular surfaces are prominent and are superimposed on the standard radiographic features of osteoarthritis. They are often more pronounced at the PIP joints. Involved joints may eventually undergo osseous ankylosis, which does not occur in noninflammatory osteoarthritis. Inflammatory changes of these joints may also be demonstrated by MRI.

Metabolic Joint Disease

Gout

Gouty arthritis is characterized by recurring acute attacks of arthritis involving one or more joints, with an increase in the serum level of uric acid and resulting deposition of

sodium urate. The first MTP joint is the joint most often affected. Involvement of the tarsometatarsal and carpometacarpal joints frequently occurs. Over time, chronic tophaceous gout develops with a typical asymmetrical joint involvement. The tophaceous deposits occur in periarticular soft tissues and sometimes in synovium and subchondral bone. These can produce hard masses that may cause ulceration of the overlying skin and extrusion of chalky material.

Radiographic features include eccentric nodular soft tissue swelling. Soft tissue masses are especially suggestive of tophi when they have high density on radiographs due to microcalcifications often related to chronic renal disease. Soft tissue tophi may produce erosion of subjacent bone, including deposition in the olecranon bursa that may be associated with erosion of the olecranon.

Erosions are suggestive of gout if they are located at a distance from any joint. In many cases, though, they may be intra-articular and may be marginal in location, mimicking rheumatoid arthritis. However, other features are helpful for the diagnosis of gout: erosions are often large in size (greater than 5 mm), they are frequently oriented along the long axis of the bone, they are characteristically surrounded by a sclerotic border due to the long duration of disease, and there may be an "overhanging edge" of new bone partially surrounding them. Also, there is commonly relative preservation of joint space, and there is not extensive osteoporosis.

Sonography may demonstrate soft tissue tophi before they are radiographically evident. They appear as hyperechoic or heterogeneous masses, sometimes with acoustic shadowing due to calcifications. They may demonstrate hyperemia on power Doppler evaluation. The double contour sign, which is a hyperechoic irregular band over the superficial margin of cartilage, and the presence of hypo- to hyperechoic inhomogeneous material surrounded by a small anechoic rim, might also be suggestive of gout. Sonography may also be used to guide aspiration of a joint. Computed tomography (CT) may be helpful to confirm the high density of a soft tissue tophus (often about 160 Hounsfield units), which is less than the density of hydroxyapatite deposits in calcific tendinitis. MRI features may be misleading, as there may be hypointense masses within the synovium on T2-weighted images, mimicking pigmented villonodular synovitis.

Calcium Pyrophosphate Dihydrate Crystal Deposition Disease

Calcium Pyrophosphate Dihydrate (CPPD) crystal deposition disease is generally observed in middle-aged and elderly patients. It may be associated with two types of radiographic features, which are frequently combined: articular/periarticular calcification and arthropathy.

Calcification

Chondrocalcinosis is the presence of intra-articular calcium-containing salts, most commonly CPPD, within hyaline cartilage and/or fibrocartilage. Calcium within the fibrocartilage is characteristically somewhat irregular, as seen in the menisci of the knee or the triangular fibrocartilage of the wrist. Calcification of hyaline cartilage along an articular surface appears as a fine, linear radiodensity closely paralleling the subjacent cortical margin. Capsular, synovial, ligament, and tendon calcifications are less frequent. Many affected persons are asymptomatic, but, in others, intermittent acute attacks of arthritis resemble gout (pseudogout). The correct diagnosis is established by the identification of typical CPPD crystals in synovial fluid. Sonography may also be helpful by demonstrating multiple sparkling hyperechoic dots without acoustic shadows in the joint fluid that are very suggestive of CPPD crystals.

Pyrophosphate arthropathy

The joints most commonly involved are the knee, the radiocarpal and midcarpal joints of the wrist, and the MCP joints of the hand, the shoulder and the hip. The joint changes that occur in this disorder resemble osteoarthritis, with joint space narrowing, bone sclerosis and subchondral cyst formation. The unusual distribution of these findings, the small size of the osteophytes contrasting with the severity of the arthropathy, and the presence of chondrocalcinosis allow a specific diagnosis to be made. Involvement of the MCP joints, particularly the second and third, is characteristic of this disorder. Hemochromatosis also affects the MCP joints in a similar fashion, but all MCP joints are characteristically affected, and there may be large "hook-like" osteophytes along the radial aspect of the metacarpal heads.

Neuropathic Osteoarthropathy

Neuropathic osteoarthropathy has a variety of causes. Nowadays, this most frequently occurs in patients with diabetes mellitus. In these patients, findings are confined almost exclusively to the ankle and foot. Calcification of the smaller arteries of the foot is a frequent and important clue to the presence of underlying diabetes but may not always be evident. Fractures or fracture-dislocations of the tarsal bones or metatarsals are particularly common manifestations of diabetic neuropathic disease. Often such fractures or dislocations are incidental findings on radiographs obtained for the evaluation of infection of the foot or complaints of swelling without a history of trauma. Less commonly, the neuropathic process appears to be initiated by a traumatic event that results in a fracture or dislocation. CT may be useful to assess the extent of microtraumatic changes of joint surfaces. MRI may demonstrate extensive abnormal signal intensity changes of bone that may mimic infection, but the distribution of arthropathy is typically widespread, contrasted with the localized nature of osteomyelitis associated with adjacent soft tissue infection.

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