

# Chapter 1

## Radiographic Approach to Arthropathy



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Radiographs remain the initial and often only imaging method in diagnosis and management of musculoskeletal diseases, using techniques that have changed only minimally since Wilhelm Conrad Roentgen obtained a radiograph of his wife's hand in 1895. Other imaging modalities, particularly ultrasound and magnetic resonance imaging (MRI) have enhanced our understanding of pathogenesis, diagnosis, and management of joint diseases. Nonetheless, radiographic analysis of the hands in rheumatologic diseases remains a central pillar in evaluation of patients with joint pain and/or dysfunction, particularly inflammatory arthropathies.

Radiographs are relatively inexpensive, readily available, provide excellent spatial resolution, and allow rapid assessment of multiple joints. As with all image interpretation, evaluation of radiographs in the setting of arthropathies should be approached in a systematic fashion to ensure that subtle abnormalities are not overlooked in favor of more obvious changes. The approach can be divided into the following four basic categories: joint surface and bone contour changes, bone density, abnormalities in osseous alignment, and soft tissue changes. Radiographs of the hands are generally considered the most fundamental and informative part of imaging in the setting of arthritis. We will use the hand to outline our recommended approach for assessing suspected joint disease. Figure 1.1 is a normal radiograph of the hand. We will begin by demonstrating some of the important changes in the hands using the framework of the four basic categories.

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**Fig. 1.1** Normal AP hand radiograph



## Articular Surface and Bone Contour Abnormalities

Pathologic changes centered at the joint, including joint space narrowing and erosive changes, are a common feature of most arthropathies and therefore, a good place to begin. The joint space represents radiolucent cartilage, and narrowing of this space implies some level of concomitant cartilage destruction. Joint space assessment typically is descriptive in clinical practice in contrast to assessment in clinical trials, in which formal scoring systems, such as the Larson, Sharp, and Sharp modified van der Heijdes methods are used to assess radiographic progression and possible treatment response. As a general rule of thumb, inflammatory arthropathies cause uniform joint space narrowing, whereas degenerative arthropathies will typically result in asymmetric joint space narrowing.

The joint spaces in the hand should be compared to the neighboring joint using a horizontal scanning pattern. Rheumatoid arthritis is well known for appearing symmetric and bilateral (Fig. 1.2), whereas degenerative and crystalline arthropathies typically manifest in an asymmetric joint involvement (Fig. 1.3).

The end-stage manifestation of cartilage and joint space narrowing is osseous bridging or “ankylosis.” The presence of bony ankylosis may indicate an aggressive inflammatory arthropathy, most commonly seen in psoriatic arthritis and juvenile idiopathic arthritis in the peripheral joints, and seen in ankylosing spondylitis in the spine. Bony ankylosis is occasionally seen in rheumatoid arthritis, but is seen in neither primary osteoarthritis nor crystalline arthropathies.



**Fig. 1.2** PA view of both hands demonstrates asymmetric joint space narrowing and marginal osteophyte formation (arrows) in this former basketball player



**Fig. 1.3** Posteroanterior view of both hands demonstrates symmetric narrowing of the radiocarpal joints bilaterally with relative sparing of the remaining joint spaces

The contours of the bone may also provide important clues. While assessing bony contour, assess for the presence, morphology, and location of erosions. Active inflammatory arthropathy typically results in erosions which are absent of sclerotic borders. Erosions occur in up to 80% of patients with rheumatoid arthritis, up to 70% within the first 2 years in the natural history of disease. An early erosion will appear as focal discontinuity of the subchondral bone. Early inflammatory erosions occur in the juxta-articular or marginal region, as this area is relatively devoid of overlying hyaline cartilage, therefore making the cortex prone to destructive changes associated with active synovitis. Active inflammatory arthropathy typically results in erosions which are absent of sclerotic borders, often within 6–12 months of onset of the disease. An erosion with a sclerotic border, often described as an indolent erosion, may indicate an inflammatory or infectious arthropathy in remission. An erosion with corticated margins can represent a manifestation of gout. A gouty tophus may result in adjacent periosteal elevation. This periosteal elevation may result in bone formation, resulting in a hallmark “over-hanging edge” which is nearly pathognomonic for gout (Fig. 1.4).

**Fig. 1.4** AP radiograph of the distal hand demonstrates numerous randomly distributed areas of erosive changes (arrow heads). These erosions demonstrate sclerotic borders. Adjacent soft tissue swelling (arrows) is also evident



**Fig. 1.5** AP view of the hand demonstrates periostitis arising from the distal shafts of the second and fourth proximal phalanges



Additional osseous contour abnormalities should also be assessed, for example the presence of periosteal new bone formation or the presence of osteophytes. In psoriatic arthritis or reactive arthritis, periosteal new bone is deposited along the shaft of the phalanx or in the metaphysis in close proximity to an erosion (Fig. 1.5), resulting in “fluffy periostitis.” It is an important radiographic feature, which can distinguish rheumatoid arthritis from seronegative spondyloarthropathies.

The presence of osteophytes, which are bone extensions from a normal articular surface, also indicates the presence of a reparative response, characteristic of osteoarthritis. Reparative changes can also manifest as subcortical cystic changes. Subcortical cysts can occur in virtually all arthropathies, therefore is often not beneficial in differentiating between them. A preponderance of subcortical cystic changes can indicate the diagnosis of calcium pyrophosphate dihydrate crystal deposition disease (CPPD), although large subcortical cysts can also be seen in rheumatoid arthritis or pigmented villonodular synovitis (PVNS).

When articular surface or bony contour changes are identified, it is beneficial to compare the findings with prior radiographs. The time course of radiographic changes can provide important clues to the nature of the process. Radiographic manifestations of an infectious or neuropathic arthropathy can progress over a few weeks, inflammatory arthropathy can occur in several months, whereas a degenerative or crystalline-induced process such as gout may take several years to manifest.

## Abnormalities in Bone Mineral Density

Bone density is another important variable in initial radiographic evaluation. Osteopenia is a nonspecific but early radiographic change of active inflammatory disease. Radiographs can detect early osteopenia which neither ultrasound nor MRI can visualize. In evaluation of the hand, overall mineralization can be made more objectively by assessing the relative ratio of the cortex compared to the overall width of the shaft. The sum of the two cortices of the shaft should equal at least one half the width of the overall shaft in a normally mineralized digit. Age-related osteoporosis is the most common cause of diffuse loss of bone mineral density. It can also be seen as a sequela of steroid therapy, renal failure or infiltrative marrow process. Juxta-articular demineralization can be a sign of an underlying inflammatory arthropathy, though has no objective criteria, and is therefore prone to high inter-observer variability (Fig. 1.6).

Focal osteoporosis may indicate active inflammation which leads to hyperemia and focal decrease in calcium, often indicative of septic arthritis when involving a single joint. Conversely, there may also be areas of increased bone mineral density, either in a focal or diffuse distribution. Increased mineralization in the subchondral areas, often referred to as subchondral sclerosis is a reparative response often seen in the setting of osteoarthritis. Central areas of increased density can be seen in the setting of metastatic disease, Paget's disease, bone infarcts (Fig. 1.7), or multiple bone islands, known as osteopoikilosis.



**Fig. 1.6** AP views of both hands demonstrate diffuse periarticular osteopenia

**Fig. 1.7** AP view of the hand demonstrates patchy sclerosis within the third and fourth phalanges (arrows)



## Abnormalities in Osseous Alignment

Malalignment in the setting of joint disease indicates joint damage often as a result of untreated or poorly controlled inflammatory activity. It is an imaging and clinical hallmark of inflammatory arthropathies, particularly rheumatoid arthritis. Defects in bony alignment occur as a result of chronic synovitis and complex biomechanical forces from the supporting tendons and ligaments which are exacerbated by the patient's attempts to avoid pain by keeping the joint in the least painful position. The pattern of deformity may be specific for a particular disease and the severity of the may also give clues to the extent of the process. The common deformities are illustrated in Figs. 1.8, 1.9, and 1.10.

## Soft Tissue Changes

The surrounding soft tissues can provide important clues as to the presence of the type of underlying joint disease. Diffuse swelling of a digit is most commonly seen in the setting of psoriatic or reactive arthritis, referred to as a “sausage digit”. The term sausage digit refers to the clinical and radiological appearance of diffuse fusiform swelling of a digit due to soft tissue inflammation from underlying arthritis. Symmetrical soft tissue swelling around a specific joint is a manifestation of synovitis that accompanies inflammatory arthropathies. This may be the earliest radiographic manifestation of an inflammatory arthropathy and should prompt a closer examination of the bony contours around that joint. Asymmetrical soft tissue swelling around a joint, in contrast, is a less specific finding. It may be a manifestation of localized soft tissue masses, such as rheumatoid nodules or gouty tophi (Fig. 1.11).

**Fig. 1.8** AP view of the hand demonstrates prominent ulnar deviations centered at the second and third MCP



**Fig. 1.9** Lateral view of the hand depicts swan neck deformity- characterized by DIP flexion (arrows) and PIP hyperextension





**Fig. 1.10** Hitchhiker's thumb depicts flexion of the metacarpophalangeal joint and extension of the interphalangeal joint of the thumb



**Fig. 1.11** Numerous prominent focal areas of periarticular soft tissue swelling demarcating areas of gouty tophi

**Fig. 1.12** Prominent coarse calcifications surrounding within the soft tissues of several digits most notably surrounding the first and third phalanges. In addition, there are distal erosive changes of the 2nd–fourth distal phalanges, described as distal acro-osteolysis



Alternatively, it may be due to the presence of an osteophyte or suggest the presence of a focal subluxation, such as in the setting of lupus. Loss of soft tissues is an important observation. Note the combination of loss of distal soft tissue, known as acro-osteolysis and the randomly distributed deposits of dense calcium within the soft tissues. This is a common manifestation of scleroderma. Calcium deposits are commonly seen in the soft tissues of patients with scleroderma (Fig. 1.12) or CREST syndrome but may also be seen in patients with acute bursitis, or dermatomyositis.

The presence of soft tissue calcifications and their distribution also help narrow the differential diagnosis. The presence of calcifications in hyaline and fibrous cartilage, as shown in Fig. 1.13, in the triangular fibrocartilage of the wrist is an important observation.

When seen in multiple distinct joints, for example in the wrist and knee, the diagnosis of calcium pyrophosphate deposition disease (CPPD) can be made. Vascular calcifications are often seen in the hands and feet in patients with long-standing diabetes or renal failure (Fig. 1.14).

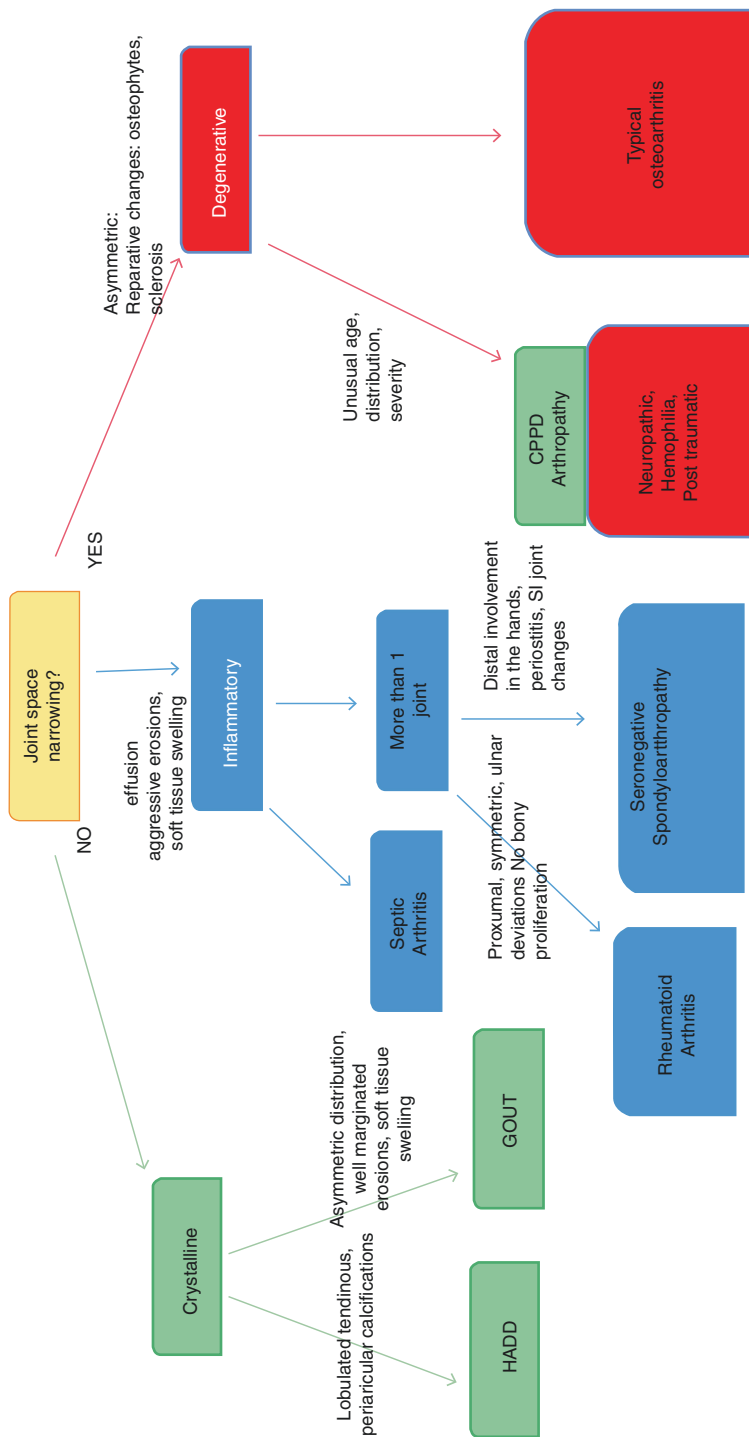
Once these observations are made, one can use the following framework to help determine which category the imaging findings most favor (Fig. 1.15).

**Fig. 1.13** AP radiograph of the wrist demonstrates amorphous calcifications (white arrow) in the expected region of the triangular fibrocartilage complex (TFCC)



**Fig. 1.14** AP view of the hand demonstrates extensive stippled linear calcifications within the soft tissues of the digits (consistent with vascular calcifications)





**Fig. 1.15** A basic roadmap to differentiate the most common arthropathies encountered in clinical practice. The colors subcategorize the most common arthropathies into inflammatory (blue), degenerative (red), and crystalline (green). This is not an exhaustive guide but can serve as a framework for approaching radiographs of patients with suspected joint disease

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