

RADIOLOGIC MANIFESTATIONS OF RHEUMATIC JOINT DISEASES IN THE PLAIN RADIOGRAPH

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ABSTRACT

In the assessment of radiologic manifestations of joint diseases, rheumatoid arthritis (RA) is the disease to which all others are compared. Knowledge of its characteristics form the basis of the other conditions. To understand the changes seen on the plain radiograph, it is essential to understand its pathophysiology first so that the manifestations of each disease can be appreciated more fully.

Due to space constraint, I shall only discuss the main forms of rheumatic joint disease. Other examples of erosive arthropathies, although not rheumatic in origin, will also be included as they form part of the differential diagnosis of an erosive arthropathy, eg gout and psoriasis.

Keywords : metacarpo-phalangeal, distal interphalangeal, proximal interphalangeal, metatarso-phalangeal.

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PATHOPHYSIOLOGICAL CONCEPTS ⁽¹⁾

RA is a systemic disease and at the joint level, the major pathophysiological responses to the disease include immune, inflammatory and healing reactions. These mechanisms are also shared by the rheumatoid variants and other forms of arthropathies.

Joints can only respond to injury in a limited number of ways. These are seen radiologically as soft tissue swelling, joint effusion, malalignment, cartilage loss, osteopenia, bone production and erosions.

When evaluating the radiograph, it is important to bear the following in mind:

1. It is a point in time reflecting the summation of many pathophysiological mechanisms active up to that moment. It varies from person to person and from joint to joint. However, by and large, a recognisable pattern is present and sequential radiographs may prove useful especially if the initial ones are normal.
2. Synovial membrane and cartilage are two unique features of synovial joints. The response to injury by the articular cartilage is cartilage loss and joint space narrowing. The loss of cartilage is multifactorial.
3. Rheumatoid arthropathies begin in the synovium. This is manifested radiologically as soft tissue swelling and oedema, joint effusion and synovial hypertrophy. There is also local hyperaemia giving rise to periarticular osteopenia. Malalignment is another important manifestation of soft

tissue involvement/laxity resulting in various subluxations and deformities.

4. Bone erosions are due to direct mechanical action of hypertrophic synovium and granulation tissue. The earliest change is loss of articular cortex manifested as a "dot and dash" appearance (best seen in the metacarpal heads) Larger marginal erosions come later. They are predictable in their distribution and are primarily located at the margins of joints, where bone is not covered by cartilage, often near capsular and ligamentous attachments. In areas of high stress eg hip, mechanical factors accelerate the bone loss.

An organised approach is necessary when one is confronted with a radiograph. This will maximise both the findings and interpretation.

1. *Soft tissues*
There may be generalised or focal increase or decrease of soft tissue volume or density. The soft tissue abnormality may be the only finding seen in the early stages. Focal changes are generally more useful. There may be soft tissue masses or calcification.
2. *Joint alignment*
Malalignment is a direct result of soft tissue disease with attendant capsular, ligamentous and tendinous laxity. Therefore it is logical to study malalignment next. There are five main categories : flexion, extension, deviation, subluxation and dislocation. The character, number, degree and location are important diagnostic clues. Early documentation and characterization by the radiologist at a time when they are still correctable prevents further dysfunction and disfiguration.
3. *Cartilage space*
The articular cartilage is the final soft tissue structure before bone is reached. Only three changes can occur across the joint space : increase in width, decrease in width and ankylosis. The cartilage may also mineralize.
4. *Bone mineral integrity*
Like soft tissue abnormalities, it may be generalised or focal, increased or decreased. Generally, the changes are osteopenia, erosions, periosteal new bone formation and other types of new bone production. The presence, character, location and distribution again, aid in the diagnosis.

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5. *Distribution Pattern*

The number of joints involved, the involvement of the extremities (which particular joint is important) and/or the axial skeleton and the pattern of involvement are all essential clues to the diagnosis.

6. *Integration*

The radiographs should not be read in isolation but must be integrated with the clinical and biochemical data. The radiographs may be entirely normal in the early course of the disease and sequential films may be necessary both in establishing the diagnosis as well as in the further management of the disease process.

I) INFLAMMATORY (SYNOVIAL) ARTHROPATHIES

Rheumatoid Arthritis (RA)

Classically, the changes in the hand and wrist. The changes are bilateral and symmetrical. The usual sites are the metacarpophalangeal (mcp) joints, the 2nd and 3rd proximal interphalangeal (pip) joints, the ulnar styloid process and the distal radio-ulnar joint. Malalignment is common, occurs early, is progressive, has characteristic appearance and can take place without any bony erosions. The radiographic changes are best classified as early or late.⁽²⁾

Early Changes:

- i) *periarticular soft tissue swelling*
 - bilateral, symmetrical and spindle shaped. Typically at the pip joint.
 - subcutaneous rheumatoid nodules over extensor surfaces of ulna, olecranon and the tendo-Achilles. Seen in 15 - 25%
- ii) *periarticular osteopenia*
 - due to disuse and local hyperaemia
- iii) *widened joint space*
 - due to effusion
- iv) *periosteal elevation and ossification* (< 5% in adults)
 - confined to the joint, as a result of effusion
 - away from the joint, as a result of tenosynovitis
- v) *marginal bone erosions*
 - result of cartilage destruction
 - locally, carpal bone erosions are observed
 - more frequently than metacarpal erosions
- vi) *pseudocysts*
 - erosions away from the articular surface
 - due to actual pannus infiltration
- vii) *narrowed joint space*
 - due to destruction of cartilage
 - may be the only sign
- viii) *subluxation*
 - due to soft tissue laxity
 - the atlanto-axial joint being the most crucial and well known
- xi) *changes in the ulnar styloid and distal radioulnar joint*
 - one of the earliest manifestation
 - under recognised

Late signs:

These are dramatic but are of little aid in diagnosis.

- i) *flexion and extension contractures of the extremities*
 - boutenniere and swan neck deformities in the phalanges
 - ulnar and/or volar subluxation of the hands
- ii) *marked narrowing and destruction of the joint space*
 - “main -en-lorgnette” or opera glass hand
- iii) *bony ankylosis*
 - mainly involving the carpal bones and radio-carpal joint
- iv) *extensive destruction of bone ends*
 - distal clavicle, metacarpals and metatarsals

RA of the foot is as common as the hand. Soft tissue swelling are seen about the metatarso-phalangeal (mtp) joints

but actual effusions are rare. Malalignments are similar and tend to be severe. Cartilage loss can also be severe especially of the intertarsal joints. Osteopenia tends to become generalized early.

The elbow is a frequent site of involvement (25%). The rest of the joints that are involved with RA include the knee, shoulder, hip (protrusio acetabuli) and ankle. Except for the cervical region, the spine is usually spared.

Complications of the disease include malalignments, fractures, avascular necrosis and ruptured popliteal cysts. There are also complications related to medical therapy and surgical interventions.

Fig 1 - Rheumatoid arthritis. Typical radiograph of late RA with erosions, subluxations, dislocations, contractures and ankylosis.



Juvenile Chronic Polyarthritis

The distribution of involved joints differ with a predilection of those joints undergoing the most rapid growth (ie the larger joints). Synovitis and soft tissue swelling are prominent and persist for a long time. Cartilage and bone destruction occur late and when severe, is followed by ankylosis. Periosteal reaction is a prominent feature and can be florid. It is seen mainly in the metacarpal and phalangeal shafts. Late onset disease in the wrist has a distinctive pattern of cartilage loss, fine erosions and ankylosis and the final stage is that of extensive fusion. Because the disease occurs in young patients, there may be premature appearance of the epiphysis and later, epiphyseal overgrowth because of the local hyperaemia.

Complications include growth disturbances and ankylosis. These result in underdeveloped vertebral bodies and intervertebral disks, contractures, limb length discrepancy and mandibular growth disturbance.

II) DIFFUSE CONNECTIVE TISSUE DISEASE

Systemic Lupus Erythematosus (SLE)

It is a chronic disease with acute exacerbations and remissions. The radiographs are usually normal. When abnormal, the most characteristic abnormality is soft tissue swelling with nonerosive malalignment. Severe hyperextension of the thumb (right angled deformity) is often present and when seen should suggest the diagnosis of SLE.

Caution:

It is extremely difficult to record the deformity on film since the arthritis is mild and the mere pressure of the hand against the cassette straightens the deviated and subluxed fingers. Since the least pressure is exerted on the 1st and 5th fingers, these may be the only ones that maintain their abnormal alignment. Thus severe and extensive clinical disease can be rather subtle

on the radiograph! On the other side of the coin, ulnar deviation can be produced by the radiographer in an attempt to separate the fingers. Generally when the ulnar deviation is secondary to positioning rather than to pathology, the 5th finger shows the greatest amount of deviation. If, in doubt, look for other signs of arthritis⁽³⁾.

Fig 2 - Systemic lupus erythematosus. Ulnar deviation and flexion contractures of both fifth fingers. Note the absence of erosions which distinguishes it from RA.



Scleroderma (Progressive Systemic Sclerosis)

Can be diagnosed confidently when there is soft tissue resorption, subcutaneous calcification and osseous destruction. Soft tissue atrophy is said to be present if the vertical thickness of the finger tip is 20% or less of the width of the base of the distal phalanx. Oblique films will demonstrate the abnormal skin over the knuckles and fingers to advantage. Because of the tight skin, flexion contractures also result. Calcific deposits occur in 10-20% and 75% involve the hands⁽⁴⁾. The incidence appears to be related to the severity of involvement of the skin rather than to the duration of the disease. Classic small punctate calcification is seen in the tip of the phalanx whereas the amorphous deposits are more generalised and sheetlike deposits are mainly seen in the synovium or joint capsule. The dominant hand and more active fingers bear the brunt of the calcification making repeated trauma the likely cause. Resorption of the distal phalangeal tufts occurs in 80% and a distinct transverse band may be seen. Articular involvement is eventually seen in 45% and may be an initial symptom in 10%⁽⁴⁾. The dip and pip joints are the ones usually affected. There is periarticular osteopenia, nonspecific joint space narrowing and erosions.

Fig 3- Scleroderma. There is atrophy of the finger tips. The amorphous calcification is typical.



Mixed Connective Tissue Disease (MCTD)

As with the clinical picture, there is radiographic overlap. The features are those of scleroderma (tuft resorption and dip joint erosions), RA (erosive arthritis) and SLE (deforming nonerosive arthritis). The radiographs may be entirely normal or show progressive erosive disease.

III) ARTHRITIS ASSOCIATED WITH SPONDYLITIS

Ankylosing Spondylitis(AS)

Two types of joints are involved⁽⁵⁾

1. Fixed amphiarthrodial joints

There is an osteitis in the bones adjacent to the cartilage which is later replaced by fibrous tissue and bone.

The *sacro-iliac (SI) joint* is classically involved. There are 3 stages : sclerosis (on the iliac side primarily) is followed by joint space irregularity and widening (due to destruction of cartilage) and finally bony ankylosis. The changes are bilateral and usually symmetrical. "Squaring" of the vertebra is the second most common change.

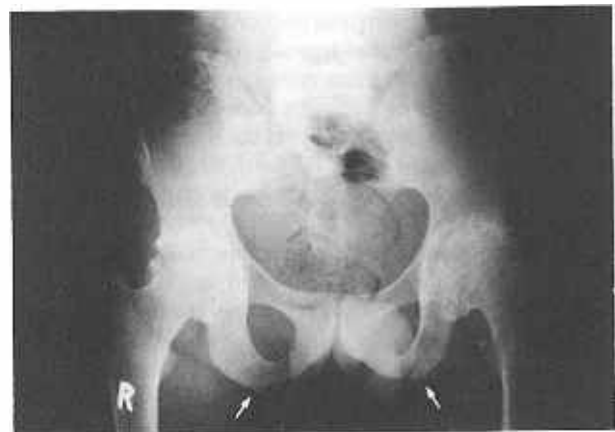
The soft tissue anterior and adjacent to the vertebrae become ossified and together with the gracile syndesmophytes give a bamboo spine appearance.

Periostitis, or "whiskering" is common and is found at certain tendinous insertions- ischial tuberosities, iliac crests , ischiopubic rami... etc.

2. Freely movable diarthrodial joints

The changes resemble RA. Atlanto-axial subluxation may develop in 2% of patients (compared with 20-25% in severe RA and 45% in PA with spondylitis)⁽⁶⁾. Increase in bone density at the site differentiates it from RA. Temporomandibular joint involvement occurs in 30% and is in distinguishable from RA. The hips are involved in 40% (90% bilateral) and radiologic abnormalities are seen in 50%. Abnormalities include axial migration of the femoral head (63%), concentric joint narrowing (50%), rufflike femoral osteophytosis(36%) and protrusio acetabuli in 30%⁽⁵⁾. The shoulders and knees are also affected and the peripheral joint in 33-50%. Complications include fractures and pseudoarthrosis.

Fig 4- Ankylosing spondylitis. There is complete symmetrical ankylosis of both sacro-iliac joints, whiskering of both ischial tuberosities (arrows) and involvement of both hips.



Reiter's Syndrome (RS)

The clinical history and examination cannot be overemphasized as the radiologic features are indistinguishable from AS, PA or RA. The involvement of the foot however far exceeds those of the hand.

1. Acute changes

Has a predilection for weight bearing joints - knees, ankles and small joints of the foot. The findings are nonspecific

and consist of articular soft tissue swelling, periarticular osteopenia and widening of the Achilles' and patella tendons. Periosteal reaction of the metatarsal and proximal phalangeal shafts, the undersurface of the calcaneum and the fibula and tibia at the ankle and knee are also common. Joint space narrowing occurs in 50%.

2. *Chronic changes - again nonspecific*

- Calcaneum - spur formation periosteal new bone formation, erosions, periostitis and osteitis.
- Peripheral joints - mainly the mtp and ip joints of the foot, also knees and ankles
 - marginal erosions and periarticular osteopenia
- SI joints and pubic symphysis - may take years to develop.

IV) DEGENERATIVE JOINT DISEASE

Primary Osteoarthritis (OA)

The commonest form of arthritis. The denominator here is the articular cartilage. Joint space narrowing is the earliest sign although by itself is insufficient for the diagnosis of OA. The presence of osteophytes typically characterizes OA. Degenerative, subchondral cysts are another radiographic hallmark. Bone sclerosis and cortical buttressing both reflect the sites of concentrated stress. Loose bodies and subluxation may be present. The changes seen are different in different joints and individual descriptions are necessary. Only the hips, knees, hands and cervical spine will be touched.

1. *Hip*

Most are due to secondary OA (osteonecrosis ,30%; burned out RA and AS,30%; congenital dislocation, 25% and slipped epiphysis 10%) and cases once diagnosed as pure primary OA are declining⁽³⁾. New bone formation is a prominent feature and joint space narrowing is typically in the superolateral aspect with the femoral head being pushed upwards and outwards. There is cortical buttressing on the undersurface of the femoral neck. Pseudocysts are also common.

2. *Knee*

One of the commonest joint involved. Early changes show spiking and broadening of the tibial spine and small osteophytes are seen on the superior and inferior margins of the articular surface of the patella. Later, both the medial and lateral femorotibial compartments will be involved. Joint space is decreased typically more in the medial compartment giving it a varus deformity and a standing radiograph is necessary for accurate assessment. "Scooping out" or a particularly large erosion of the anterior surface of the femoral shaft, just above the condyles, is not uncommon in advanced cases and is commoner in women.

3. *Hand*

Heberden nodes may be traumatic or idiopathic. They are best seen in the lateral view where large spurs are seen arising from the dorsal aspect of the proximal ends of the distal phalanges and the distal ends of the middle phalanges. When extreme, the joint space is destroyed and there is marked irregularity of the articular surfaces. The changes are not confined to the dip joints and the pip joints may be involved. The mcp joints are classically spared. When osteophytes are absent, the presence of a subcortical white line and the lack of erosions or thinning of the underlying trabeculae differentiate it from RA.

Carpometacarpal joint of the thumb. This is a common site and is frequently affected. Marked subluxation may occur. RA seldom affects this joint and is an important differentiating point. Erosive OA of the pip and dip joints in mid-

dle-aged women may be difficult to differentiate from RA radiographically but there is usual sparing of the mcp joints and the wrist. Blood serology is often helpful.

4. *Cervical spine*

There is true OA of the posterior intervertebral joints with osteophytic lipping of the uncovertebral joints. The disc space is decreased and the osteophytic outgrowths will encroach on the foramina and cause brachialgia, particularly at the C5/C6 and C6/ C7 levels. Oblique radiographs usually help to depict the anatomy better.

V) OTHERS - EROSIIVE ARTHRITIS THAT NEED TO BE CONSIDERED/EXCLUDED

Psoriasis

Seven percent of psoriatic patients will have arthritis⁽⁵⁾. Radiographically, there are three main types:

1. true psoriatic arthritis (PA)
2. psoriatic arthritis mimicking RA - absence of RF and subcutaneous nodules
3. concomitant RA and PA - not uncommon

There is asymmetrical disorganization of the dip joints without deossification. There is no ulnar drift. This classical form is easy to differentiate from RA. However, in other cases both the dip and the pip joints are involved and at times, there is gross destruction of the metacarpal and metatarsal heads. There is also ankylosis. The hands are invariably involved with the feet to a lesser extent. Periosteal reaction (linear or fluffy) is frequent. A single joint may be involved. Bilateral SI joint changes are common and cannot be differentiated from AS. It is asymmetrically involved in 25%. The spine involvement is similar to RS, with asymmetrical and incomplete syndesmophyte formation. The syndesmophytes of PA have a broader base and are more irregular than the gracile ones of AS. Squaring of the lumbar vertebrae may be present.

In a patient with psoriasis, not all changes in the joints are due to psoriatic arthropathy. There may be concomitant RA or OA. More bone destruction is seen in PA, than other arthritis, including RA.

Gout

The radiographic findings are late and are seen long after the clinical diagnosis has been made. The sodium biurate crystals are deposited in relatively avascular tissue – cartilage, synovium, ligaments, bursae and subcutaneous tissue.

Fig 5 - Gout. Late stage with well defined erosions well away from the 1st mtp joint. The erosions have a sclerotic rim with overhanging edges. Note the lack of periarticular osteopenia. A large, tophi (arrows) is also present.



The 1st mtp joint is the most frequently affected. Periarticular soft tissue swelling appears first. Well circumscribed, punched-out erosions with sclerotic margins and overhanging margins are next. These are found classically away from the joint margins distinguishing it from the marginal erosions of RA. In the hand, the dip and pip joints are typically involved. Cartilage loss is late manifestation. Peri-articular osteopenia is conspicuous by its absence.

Complications

Bone ischaemia and infarction occur commonly. Dissecting synovial cysts in the popliteal space may mimic RA.

CONCLUSION

1. Know the normal hand.
2. Look at the soft tissue, the alignment, mineralization and cartilage space.

3. Determine if it is a monoarticular or a polyarticular disease.
4. Note the joints that are mainly involved.
5. Decide if it is inflammatory (rheumatoid types or its variants), degenerative or metabolic.
6. There maybe more than one pathology present.

REFERENCES

1. Grainger RG, Allison DJ, Diagnostic Radiology, Churchill Livingstone; Edinburgh, London, Melbourne, New York 1986.
2. Greenfield GB, Radiology of Bone Diseases (4th ed) Philadelphia :JB Lippincott; 1989.
3. Forrester DM, Brown JC. The Radiology of Joint Disease (3rd ed): WB Saunders; Philadelphia, London, Toronto, Sydney, Tokyo, Hong Kong. 1987.
4. Taveras JM, Ferrucci JT, Radiology: Diagnosis-Imaging -Intervention: Philadelphia: JB Lippincott; 1986.
5. Chapman S, Nikielny R. Aids to Radiological Differential Diagnosis (2nd Ed): London: Bailliere Tindall : 1990.
6. Edeiken J. Roentgen Diagnosis of Disease of Bone (4th ed): Baltimore, London: Williams and Wilkins, 1989.

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