REVIEW

# Radiology of crystal arthropathies

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## Introduction

Major crystal arthropathies include gout, calcium pyrophosphate dihydrate crystal deposition disease (CPPD) (pseudogout) and calcium phosphate hydroxy apatite crystal disease (Table 1). The diagnosis can be made on conventional films. However, early diagnosis can be made by advanced imaging such as ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI) and Pet CT. The most common disorder is gout where monosodium urate crystals are deposited in the synovium, cartilage, skin and bone.

The literature is replete with articles on crystal arthropathies. This paper is confined to the pictorial essay and review of our own experiences.

**Table 1:** Crystal arthropathies.

| |
|---|
| *Common* |
| Monosodium urate crystals |
| Calcium pyrophosphate dihydrate crystals |
| Calcium phosphate hydroxyapatite crystals |
| Calcium oxalate aluminium phosphate in end stage renal failure patients on dialysis |
| *Less common* |
| Ochronosis (Alcaptonuria) |
| Primary oxalosis |
| Cholesterol deposited in rheumatoid arthritis and osteoarthritis |
| Xanthine |
| Cysteine |
| Lysophospholipase (Charcot-Leyden) |

## Monosodium urate crystals

Clinically, gout is more common in men. Post menopausal women can also get affected by gout. The most common sites for gouty deposits are the feet, particularly the first metatarsophalangeal joints. Podagra is the common name attributed to the pain in the feet. However, hands, knees and other joints may also be involved. Tophus means monosodium urate crystal deposition in the soft tissues in juxta-articular area and may extend into the bone. Ingestion of excess of alcohol particularly wine is attributed to the causation and aggravation of gout. It was once called King's disease as it is considered to be a life style disease.

The metabolism of gout involves purine and its derivatives. The primary form is due to increased

production of uric acid from glycine and poor renal excretion. Monosodium urate crystals are birefringent under polarised microscope.

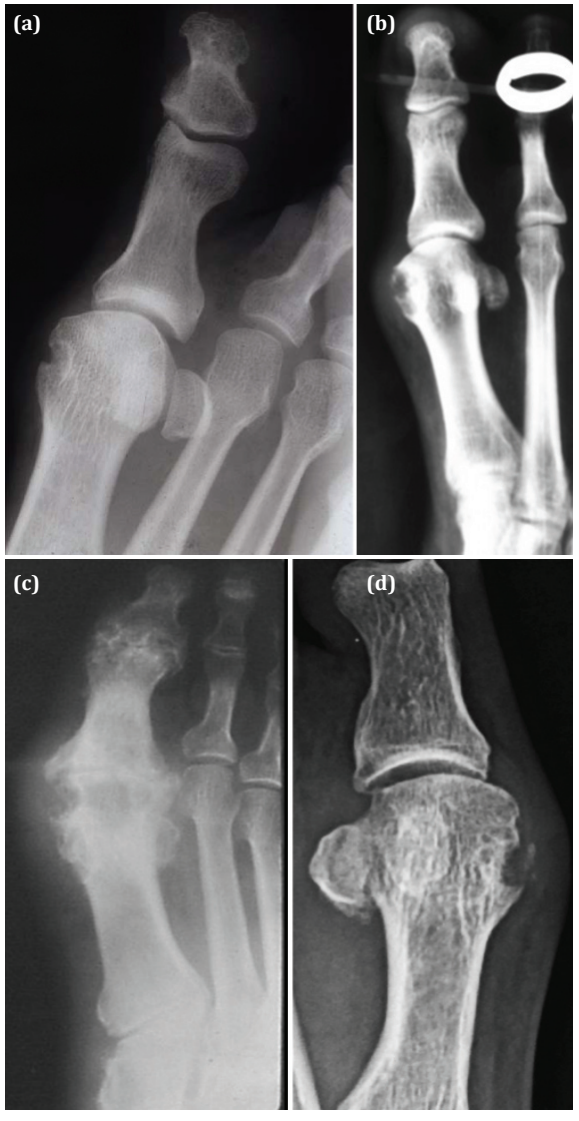
Radiologically, conventional radiographs are adequate to make a diagnosis in chronic stages of gout. The parameters include lack of para-articular osteoporosis and discrete peripheral erosions with eccentric soft tissue swellings. The peripheral erosions may have overhanging edges. The soft tissues may show tophi with calcifications. The joint space is narrowed due to cartilage destruction. Later, degenerative changes occur with subluxation of the joint. Osteophytes may be seen. The joints involved are of the feet, hands, wrists, elbows, knees and heels in that order. However, gout may affect any synovial joint including sacroiliac and facet joints. Tophi in bone may resemble benign neoplasms. Bone infarcts are common and radiologically manifest as serpiginous calcifications in the metaphysis and these are to be distinguished from enchondromas. Osteonecrosis may also be noted in phalangeal and metatarsal bones of feet.

**Radiological manifestations of gout (Figures 1a,b,c,d)**

- Asymmetrical polyarticular distribution
- Joints: 1st MTP joints and metacarpo phalangeal joints of hands
- Less common: bones, tendons and bursae
- Characteristic radiologic changes occur in the chronic stage
- Predilection for the small joints of the hands and feet
- Chondrocalcinosis is present in 5%
- Joint effusion (earliest sign)
- Preservation of joint space until late stages of disease
- Absence of periarticular osteopaenia
- Eccentric erosions

The typical appearance is the presence of well-defined "punched-out" erosions with sclerotic margins in a marginal and juxta-articular distribution, with overhanging edges. The bony lesions are described as pseudotumors of gout (Figures 2a,b,c,d). These may also be noted in knee joints (Figures 3a,b).

Gout may be rarely associated with rheumatoid arthritis, psoriasis, chronic renal failure,




**Figures 1a,b,c,d:** Gout - Eccentric erosions with overhanging margins of first metatarsals.

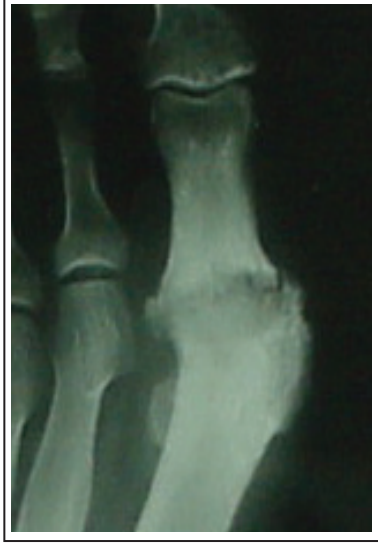
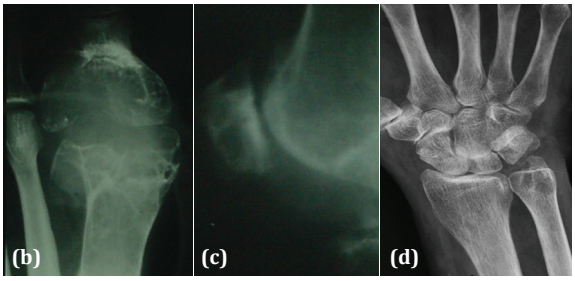
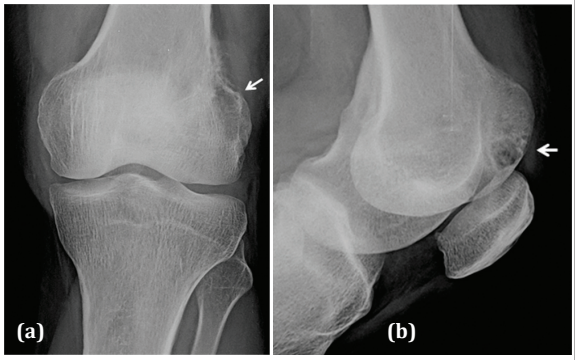


**Figure 2a:** Gout - Erosion and eburnation around first metatarsophalangeal joint.

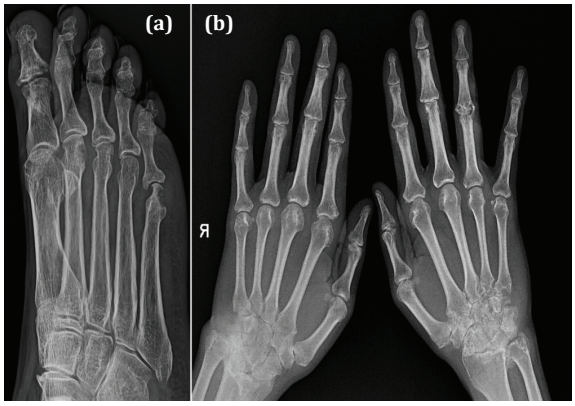



**Figures 2b,c,d:** Pseudotumors of gout in metatarsals, patella and ulna.




**Figures 3a,b:** Gout - 46F - Gouty deposit in lateral condyle of femur.

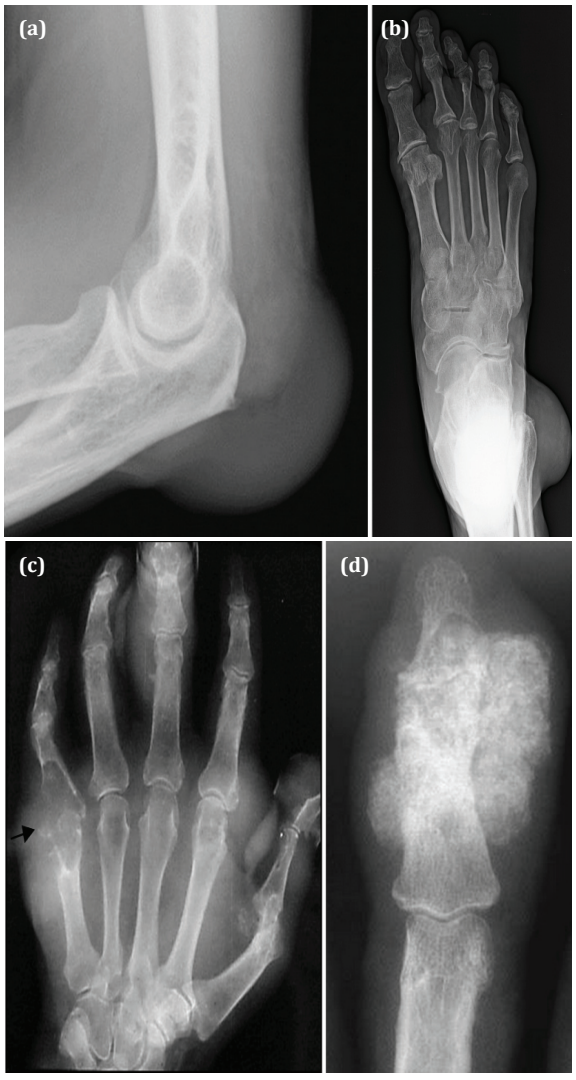
hyperparathyroidism and myelofibrosis (Figures 4a,b).




**Figures 4a,b:** Gout in association with rheumatoid arthritis.

Radiological changes in surrounding soft tissues (Figures 5a,b,c,d)

- Tophi: pathognomonic
- Olecranon and prepatellar bursitis
- Periarticular soft tissue swelling due to crystal deposition in tophi around the joints is common
- The soft tissue swelling may be hyperdense due to the crystals, and the tophi can calcify (uncommon in absence of renal disease)




**Figures 5:** Gout– (a,b) Soft tissue bursal swellings; (c,d) Gout with calcific tophi.

## Calcium pyrophosphate dihydrate crystal deposition disease (CPPD)

This is also called pseudogout as the clinical symptoms simulate gout. However, serum uric acid levels are normal. This is encountered in middle age with slight female predilection. Symptoms may be acute or chronic. This affects mainly knees, wrists, shoulders, hip and fibrocartilage of symphysis pubis. Tendon sheaths, bursae and ligaments may also be involved. Calcium pyrophosphate dihydrate crystals are deposited in synovium and cartilage. Hyaline and fibrocartilage calcifications are typical. Articular erosions may simulate gout. Finally, degenerative joint changes occur. CPPD often involves non-weight bearing joints such as hand, wrist and patellofemoral joint.

## Radiological features

Hyaline and meniscal calcifications are encountered in the knee and other joints (Figures 6a,b). No juxta-articular osteoporosis is noted. Para-articular structures may also show calcification (Figures 6c,d,e). This may lead to degenerative arthritis. Vertical and linear calcifications in the cartilage of symphysis pubis are classical (Figure 6f). Chondrocalcinosis may also be seen in other disorders (Table 2).

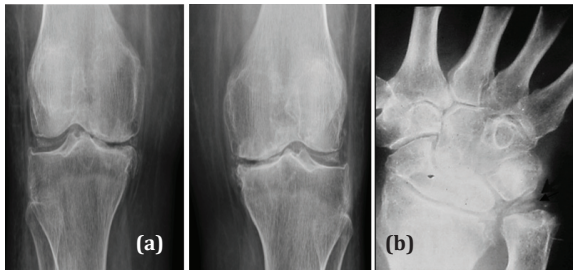
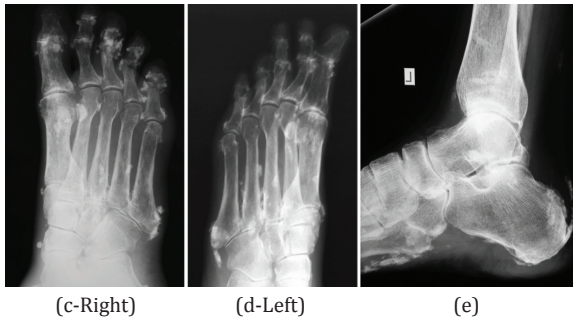



**Figure 6a:** CPPD – Calcified menisci of the knees.

**Figure 6b:** CPPD – Calcified triangular cartilage at the ulna.



(c-Right) (d-Left) (e)

**Figure 6:** Pseudo-Gout (CPPD) – (c,d) Note the para-articular calcifications in the feet; (e) note the calcification of the ligaments with enthesopathy.

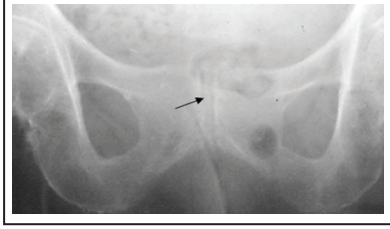


**Figure 6f:** CPPD – Calcified fibrocartilage at symphysis pubis.

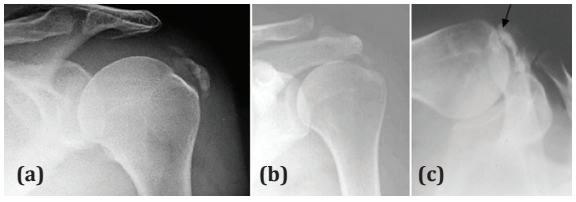
**Table 2:** Chondrocalcinosis is also seen in the following disorders.

| | |
|---|---|
| 1. Acromegaly | 7. Lupus |
| 2. Gout | 8. Ochronosis |
| 3. Hemochromatosis | 9. Post traumatic |
| 4. Hyperparathyroidism | 10. Pseudogout (CPPD) |
| 5. Hypoparathyroidism | 11. Wilson disease |
| 6. Hypothyroidism | |

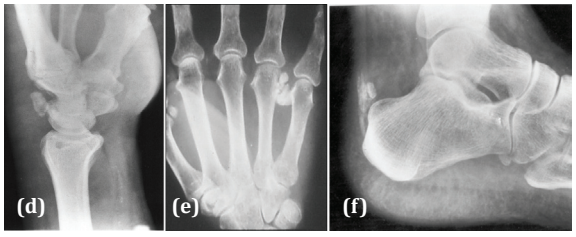
But, CPPD crystals may not be seen in the above entities

## Calcium phosphate hydroxy apatite crystal deposition disease

This disorder is quite common in males, the sites being tendinous insertions. Shoulder is the most common site. However, this has been observed in hands, hips, elbows etc. Calcium phosphate crystals over which hydroxy apatite crystals are deposited (Figures 7a,b,c,d,e,f). Radiological findings are 1) Amorphous calcifications, 2) Punctate calcifications, 3) Nodular calcifications, 4) Plaque like calcifications, 5) Curvilinear calcifications.




**Figures 7a,b,c:** Calcific deposits in supraspinatus tendinitis and rotator cuff




**Figures 7d,e,f:** Calcium hydroxy apatite crystal deposition disease in the wrist, hands and heel.

## Calcium oxalate aluminium phosphate crystal deposition disease (COAPCD)

In patients with chronic renal disease specially treated with dialysis COAPCD crystals are deposited in the soft tissues of the periarticular areas. No specific description is noted. However, it may be amorphous mass are multiple speckled calcifications (Figure 7g).

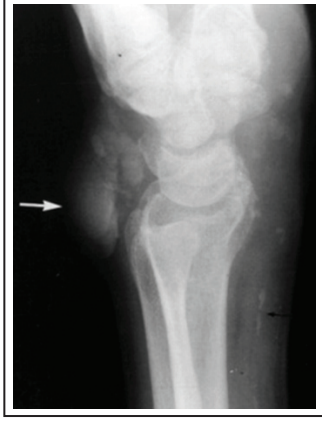


**Figure 7g:** Periarticular calcifications in chronic renal failure under dialysis calcium oxalate aluminium phosphate crystals.

## Ochronosis (Alcaptonuria)

This is a rare metabolic disorder generally observed at 3rd and 4th decades of life. It is characterised by homogentisic aciduria, arthritis and ochronosis. Symptoms are mainly caused by secondary degenerative joint changes in spine, shoulders and hips. Progressive stiffening of the spine is noted, although, it is not as severe as seen in ankylosing spondylitis. It is clinically diagnosed in the neonates where there is blackish stain in the diapers.

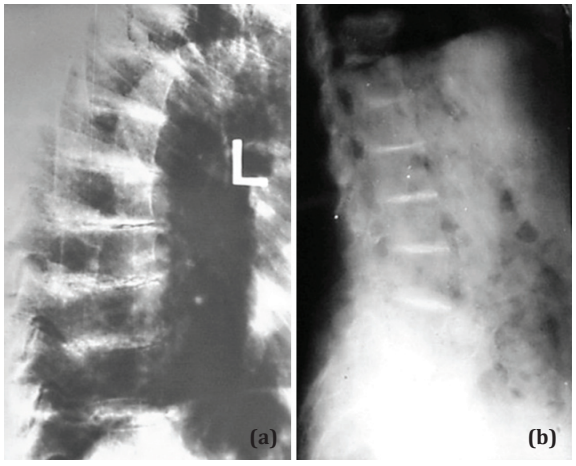
Pathophysiology is accumulation of homogentisic acid in various tissues. Deficiency of homogentic acid oxidase (HGO), which catalyses the conversion of HGO to maleylace to acetic acid. HGO accumulates in the cells and body fluids. It is excreted in sweat and urine. When it is deposited in tissues, it oxidises to form brownish black granules which are deposited in deeper layers of articular cartilages.

## Radiological findings

Osteoporosis is pronounced in vertebral column. Calcification is also noted in soft tissues as in nose, bursae and tendon sheaths, meniscal calcifications are also common in knees and wrists. Calcification of intervertebral disks with marginal osteophytes (Figures 8a,b), and subchondral sclerosis, cysts and eburnation around joints are seen (Figure 8c).

## Conclusion

Among various crystal arthropathies, gout is most common. Conventional radiological findings are typical in some of these crystal arthropathies. Calcium pyrophosphate crystal deposition disease (CPPD) is also common with calcified menisci. However, calcified menisci may also be seen physiologically in old age and may be asymptomatic. Calcium hydroxy apatite crystal deposition disease is often seen in the tendons attached to rotator cuff of the shoulder, although it can occur in any place of tendon attachment. In chronic renal disease with patients undergoing dialysis calcium oxalate aluminium phosphate crystals may be deposited around joint. Ochronosis is a hereditary disorder and involves the axial skeleton commonly and is associated with osteoporosis. The other crystal arthropathies are not common. Radiological findings are typical when correlated with clinical findings.




**Figures 8a,b:** Ochronosis – Note the osteoporosis and calcified disks.

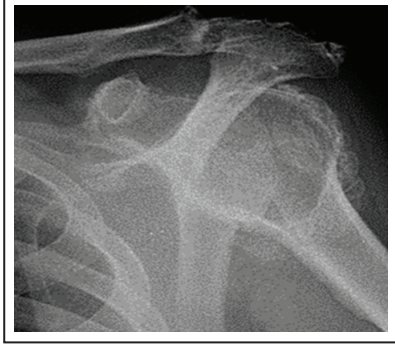


**Figure 8c:** Ochronosis involving the shoulder joint.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## Conflict of interest

Author declares no conflict of interest.

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