Pictorial review of gouty arthropathy

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Learning objectives

To illustrate the imaging findings of typical and atypical cases of gout on plain radiograph, ultrasound, magnetic resonance imaging (MRI) and computed tomography (CT).

Background

Gout is a metabolic disorder of purine metabolism. It is manifested by hyperuricemia with deposition of monosodium urate (MSU) crystals in synovial fluid, leukocytes and peri-articular soft tissue, resulting in recurrent arthritis. Gout almost always involves the first metatarsophalangeal joint (MTPJ). The small joints of the hand are randomly affected. Other common sites of involvement include the foot, ankle, wrist, elbow and knee. Additionally, extra-skeletal urate deposition is frequently seen in tendons, bursae, pinnae and subcutaneous tissue.

The radiologic changes of gouty arthropathy are usually not seen until 6-12 years after the initial attack. MRI, ultrasound and CT play an essential role in early detection of joint/bone erosion and assessing the extent of soft-tissue involvement.

Findings and procedure details

Classic radiographic features (Figure 1 to Figure 6)

The classic radiographic findings are peri-articular and intra-osseous punched-out erosions with thin sclerotic borders and overhanging edges. The long standing tophus causes erosion to the adjacent joint and bone, giving rise to the "rat bite" appearance. Joint space is preserved till the late stage and osteoporosis is not a feature of gouty arthropathy. Tophi is one of the features which appear as eccentric, dense, lobulated soft tissue masses at the peri-articular region with varying degree of calcification. Extra-skeletal urate deposits also show similar radiographic features with peri-articular gouty tophi.

Atypical radiographic features

Proliferation of the bones (Figure 7)
Occasionally, the affected bones may undergo proliferative bone changes which are characterized by a club-shaped configuration and diaphyseal thickening, mainly involving the metatarsals, metacarpals and phalanges. When the disease activity involves the wrist, it may cause enlargement of the ulnar styloid process. Changes of secondary osteoarthritis such as subchondral sclerosis and osteophytes are common in gouty arthritis.

**Intraosseous calcification (Figure 8)**

Intraosseous calcifications have been observed in about 6% of patients with chronic gouty arthritis. This phenomenon is secondary to intraosseous deposition of urate crystals. In most cases, the calcium penetrates from the peri-articular region into the adjacent spongiosa. Punctate or circular calcifications are observed at the subchondral or subligamentous regions, most commonly in the hands and feet.

**Ankylosis of the joint (Figure 9)**

Bony ankylosis is an extra-ordinary event in gouty arthritis and rarely reported in the English literature. It has been observed in patients who developed early onset of severe gout i.e. adolescence or early adulthood. Suboptimal treatment of uric acid levels in chronic tophaceous gout is a known predisposing factor of bony ankylosis in gout. The carpus, tarsus and ankle are the most common sites for ankylosis. The fusion involves the margin as well as the entire articular surface of the joint. The pathophysiology is unclear. Hughes et al postulated that cartilage and subchondral bone destruction followed by crystal uric acid deposition are the preceding changes prior to bony ankylosis. Ankylosis is an irreversible event despite optimization of the antihyperuricaemic agent.

**Ultrasound (Figure 10 to Figure 12)**

Ultrasound is useful in detecting early changes of gout and for guiding fluid aspiration of the joint. It is fast gaining popularity for early detection of urate deposition in the joints. On ultrasound imaging, crystal deposits appear as an irregular echogenic layer on cartilaginous surface. The cortex of the subchondral bone forms another echogenic layer, giving rise to the "double contour" sign. This finding can be seen in asymptomatic hyperuricemic patients or in patients with history of gouty arthritis. Gouty tophus appears as a heterogenously hyperechoic soft tissue mass with an anechoic halo. Varying degree of calcification may be noted in the tophi. Apart from all these capabilities, ultrasound is also valuable in the assessment of tophus infiltration into bursa, tendon, fascia and nerve.
Other non-specific sonographic features of gout include peri-articular erosion, synovitis and joint effusion. The degree of hyperaemia detected on colour Doppler is directly related to the inflammatory activity of the disease. The snowstorm appearance of synovial fluid is believed to be attributed to floating microtophi within.

**Computed tomography (CT) (Figure 13 & 14)**

CT is not routinely employed in assessing gout due to its high cost and radiation. However, CT is excellent in detecting gouty tophi and articular erosions involving the deeper joints; such as the spine, base of skull and pelvis. Tophus is a lobulated hyperdense mass with attenuation value of 160-170 Hounsfield units for non-calcified tophus.

**Magnetic resonance imaging (MRI) (Figure 15 & 16)**

Owing to its high image contrast resolution, MRI allows for excellent assessment of gout involving soft tissues; namely bursa, tendon, fascia and nerve. In addition, gout affecting deeper joints and its soft tissue extension are well depicted on MRI. The tophus is isointense on T1-weighted images and of low to intermediate signal intensity on T2-weighted images. Some of the tophi have cysts within. The enhancement characteristics of tophi range from homogeneous to inhomogeneous patterns. Some lesions also display peripheral enhancement.

**Uncommon sites of the disease (Figure 17 & 19)**

The shoulder, acromioclavicular and sternoclavicular joints, hip, sacroiliac joint and spine are rarely affected by gout in decreasing order of frequency. Gout is a known causal factor of bone infarction. This complication is attributed to urate crystal deposition at the vascular basement membrane, resulting in ischemic necrosis of the femoral or humeral heads. However, the incidence is extremely low. Sacroiliac joint involvement in gout is more commonly observed in those with early-onset of the disease. Spinal cord compression and paraspinal collection have been reported in the spinal manifestation of gout.

**Gout mimicking other pathology (Figure 20 & 22)**

In atypical cases, gouty arthropathy may mimic osteomyelitis, infective arthritis, inflammatory arthropathy and even soft tissue sarcoma.
Fig. 1: Ball-catcher's radiograph of the hands shows polyarticular punched-out peri-articular erosions with multiple eccentric nodular soft tissue swelling consistent with chronic tophaceous gout. There is bilateral asymmetric joint involvement with varying degree of severity.
Fig. 2: Radiograph of second and third digits shows punched-out peri-articular erosions with overhanging edges (yellow arrows). Most of the erosions exhibit sclerotic margins (black arrow). Lobulated peri-articular soft tissue swelling (asterisk) represents tophus.
**Fig. 3:** Radiograph of 1st and 2nd digits shows punched-out peri-articular erosions with overhanging edges (yellow arrows). Most of the erosions exhibit sclerotic margins (black arrow). Multiple lobulated peri-articular soft tissue swelling (asterisks) represent tophi.
Fig. 4: Right foot radiograph shows typical tophaceous gout of the foot with polyarticular punched-out erosions and eccentric tophi.

Fig. 5: (a) Anteroposterior and (b) lateral radiographs of the right elbow in a gout patient show multiple intradermal urate deposits (arrows).
Fig. 6: Bilateral knee radiograph in anteroposterior projection shows multiple tophi deposits in the medial collateral ligament (blue arrows), lateral collateral ligament (red arrows) and iliotibial tract bursa (yellow arrows) on both sides.
Fig. 7: Left foot radiograph in (a) AP and (b) oblique views. At the forefoot, there are advanced changes evident in the second metatarsophalangeal joint (circle) with club shaped expansion, joint space narrowing, sclerotic and thickened phalanx as well as multiple periarticular and intraosseous erosions.
**Fig. 8:** Bilateral hand radiograph in oblique view shows multiple nodular intraosseous calcifications involving the phalanges, carpal and metacarpal bones. Multiple periarticular punched-out erosions are seen at the wrist, metacarpophalangeal (MCPJs) and proximal interphalangeal joints (PIPJs). Dense nodular tophi (blue arrow) are eccentrically located near the joints. Fixed flexion deformity of the left third and fourth PIPJs are attributed to tophi infiltration of these flexor tendons.
Fig. 9: Computed tomography of bilateral knees and ankles in a 65-year-old gentleman with history of chronic hyperuricemia shows bony ankylosis (yellow arrows) of bilateral proximal tibio-fibular syndesmosis, right calcaneo-navicular joint and lateral malleolus.
Fig. 10: Ultrasound of the plantar aspect of two metatarsophalangeal joints show (a) double contour sign due to urate deposits on the cartilage and (b) normal cartilage morphology.
Fig. 11: Ultrasound of the left knee. (a) There is a soft tissue nodule of heterogeneous hyperechoic echotexture with surrounding halo located at the anterolateral aspect of
quadriceps tendon. There are specks of calcifications seen within the lesion. (b) On colour doppler, the surrounding tissue is hyperaemic.

Fig. 12: Ultrasound of the big toe shows periarticular erosion (arrows) in (a) axial and (b) longitudinal views.
Fig. 13: Computed tomography 3D reconstruction of the lower limb arteries shows multiple chunky tophi distributed at the peri-articular region of the hips, knees, ankles and small joints of the feet (yellow arrows). In addition, tophi are deposited in the left lateral fascial septa of the left thigh (white arrow), quadriceps tendon (green arrow) and Achilles tendon (blue arrow).
**Fig. 14:** (a) CT of the knees of the same patient depicted in figure 13 shows multiple dense tophi causing peri-articular erosion. (b) Gouty tophi infiltrate both quadriceps tendons (yellow arrows). There is synovial thickening with left knee joint effusion (asterisk). (c,d) Ultrasound of the knees shows calcified gouty tophi (red arrow) and thickened synovium with multiple tiny crystalline deposits, giving rise to snowstorm appearance (asterisks).
Fig. 15: MRI left knee of the same patient depicted in figure 11. (a) On Proton density sequence in sagittal view, the tophus (yellow arrow) exhibits hypointense to intermediate signal. (b) One T1 weighted axial image, it displays hypointense signal (orange tracing) and partially infiltrates the quadriceps tendon (green tracing). (c) On T1 weighted fat saturation sequence, there is minimal effusion (blue asterisk) in the suprapatellar fossa. (d) With gadolinium contrast, the lesion (yellow arrow) shows heterogeneous enhancement with reactive synovitis (yellow asterisk) of the knee joint.
**Fig. 16**: Magnetic resonance imaging of the wrist. (a) T1-weighted images show carpal tunnel distension by gouty tophi (yellow arrow). (b) There is associated intratendinous extension into the flexor digitorum superficialis tendon (red arrow). (c) T1-weighted fat suppression post gadolinium images show heterogeneous enhancement of the tophi (yellow arrow). (d) The flexor digitorum superficialis tendon is distended with tophi which intervenes with normal laminated tendon fibres (red arrow).
Fig. 17: A gout patient with left shoulder pain. (a) The AP view radiograph shows joint space narrowing, articular erosion with subchondral sclerosis of the left glenohumeral joint. (b) CT scan demonstrates dense lobulated tophi at the peri-articular region (white arrows). (c) The tophi appear calcified on ultrasound (yellow arrows).
Fig. 18: Computed tomography pelvis in bone window (a) There is a large, well-defined, hyperdense juxta-articular gouty tophus (white arrow) at the right hip causing erosion of the greater trochanter with overhanging edge (yellow arrow). (b) A calcified tophus deposit is visible at the fascial septa of the left thigh (white arrow). A normal appearing right thigh fascial septa is noted (blue arrow). (c) A tophus is noted posterior to the left L5-S1 facet joint (green arrow).
Fig. 19: A 29-year-old gentleman with 10 year history of primary hyperuricemia and multiple chronic tophaceous gout of the extremities. (a) Plain radiograph shows a lytic lesion at the medial end of the left clavicle consistent with tophaceous gout. (b) Six months later, the lesion becomes more conspicuous with a thin sclerotic margin (arrows). (c) Computed tomography of the lumbar spine in the same patient shows erosion of bilateral facet joints with dense and calcified tophi (yellow arrows).
Fig. 20: Magnetic resonance imaging of the left ankle shows a well-defined oval mass lateral to the lateral malleolus (white arrow). It is isointense on T1-weighted image (a) and heterogeneously hypointense on T2-weighted image (b). The lesion
enhances heterogeneously on post-gadolinium T1-weighted fat suppression image (d) as compared to the pre-contrast image (c). There is no erosion of the adjacent bone and joint. Histology of the lesion was consistent with gouty tophus.

**Fig. 21:** Radiograph of the index finger shows diffuse periarticular soft tissue swelling at the proximal interphalangeal joint (PIPJ) with destruction of the periarticular subchondral bone. The joint space of the PIPJ is narrowed. Bone fragments and faint calcification are noted within the soft tissue (white arrow). A diagnosis of septic arthritis was made. However, needle aspiration of the swelling revealed chalky material within indicating tophus.
**Fig. 22:** Radiograph of the left hand in AP projection of the same patient depicted in figure 17 shows fusiform swelling of the 4th digit with periarticular erosion (white
arrows). There are other periarticular erosions noted at the intercarpal joint and 2nd metacarpophalangeal joint (black arrow). Without the history of chronic tophaceous gout of the left shoulder, the hand radiograph could be mistaken as rheumatoid arthritis or psoriatic arthropathy.
Conclusion

We present a pictorial review of the varying facets of imaging findings in gouty arthropathy for both typical and atypical cases.

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References


