CME Article

MR imaging of tophaceous gout revisited

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ABSTRACT

Gout is the most common form of microcrystalline arthropathy, and does not usually pose a diagnostic challenge when patients have a typical presentation, appropriate biochemical picture and classical radiographic appearance. However, magnetic resonance (MR) imaging is increasingly used as the first-line imaging modality in patients with first presentation of joint pain or mass, and tophaceous gout is frequently a forgotten differential diagnosis. This article serves to review the MR imaging characteristics and appearance of gouty tophi in various joints, their clinical presentations and complications, as well as the common differential diagnoses.

Keywords: complications, differential, gout, magnetic resonance imaging, tophi

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INTRODUCTION

Gout is the most common microcrystalline arthropathy, accounting for approximately 5% of the arthritic population, with a worldwide distribution. Causes of hyperuricaemia have traditionally been divided into primary (inborn defects of metabolism) and secondary. Secondary causes are more common and include disorders that lead to increased turnover of nucleic acids or impairment in renal excretion, as well as adverse effects from certain drugs. The disease manifests in four clinical stages: asymptomatic hyperuricaemia, gouty arthritis, intercritical gout and chronic tophaceous gout.

Chronic tophaceous gout manifests when there is localised precipitation of monosodium urate crystals in the soft tissues, with reactive inflammatory cells and foreign body giant cells. This may occur in the tendons, ligaments, bursae, synovial spaces, cartilage and bone. The most common locations include the pinna, olecranon bursa and first metatarsophalangeal joints.

Gout does not usually pose a diagnostic challenge when patients have a typical presentation, appropriate biochemical picture and classical radiographic appearance. However, magnetic resonance (MR) imaging is increasingly used as the first-line imaging modality in patients with first presentation of joint pain or mass, and gout is frequently a forgotten differential diagnosis. This article serves to review the MR imaging characteristics and appearance of gouty tophi in various joints, their clinical presentations and complications, as well as the common differential diagnoses.

MR IMAGING FEATURES

Chronic tophaceous gout typically presents as juxta-articular soft-tissue masses, frequently causing periarticular erosions with 'over-hanging' edges, and is associated with synovial thickening. The MR imaging appearance of gouty tophi varies. Their appearances on T2-weighted sequences range from homogenously low to homogenously high signal, depending on the degree of hydration and calcification. The most common appearance on a T2-weighted sequence is a heterogenous low to intermediate signal intensity pattern. T2-weighted hypointensity has been attributed to the presence of calcium, crystal and fibrous tissue, whereas tophi with high water content appear hyperintense. Its T1-weighted appearance is more consistent, with usually homogenously low to intermediate signal intensity. Enhancement pattern is also varied, with homogenous enhancement being the most common appearance, reflecting hypervascularity of the tophus. Peripheral enhancement has also been reported, likely due to the enhancement of granulation tissue surrounding a tophus.

The synovium is usually only visualised as a thin structure on MR imaging. Again, the MR imaging signal intensity of thickened synovium in chronic tophaceous gout is variable, with the most common appearance being intermediate to low signal intensity on T2-weighted sequences. Variable and occasionally intense enhancement usually reflects hypervascularity of the synovium. This is not specific to chronic tophaceous gout, and synovial thickening from other pathologies would have similar appearances.

When an acute flare is present, periarticular oedema, synovitis and joint effusions, as well as enhancement of the marrow and periarticular soft-tissue structures are the typical manifestations, although they are not exclusive to gout and may be seen in other inflammatory arthropathies. A recent study by Carter et al demonstrated that MR imaging can detect early joint erosions in gout that are not radiographically apparent. However, it is important to note that despite these findings, the authors did not suggest

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the routine use of MR imaging as the gold standard in the diagnosis of early-stage gout.[1]

HAND AND FEET

Gouty arthropathy is typically a disease of the small peripheral joints, with the lower limbs being more frequently affected than the upper limbs. Involvement of the first metatarsophalangeal joint is the classical manifestation of gout.

Case 1 presented with a two-week history of an ill-defined swelling over the lateral aspect of the fifth metacarpophalangeal (MCP) joint. The radiographs of the hand were essentially unremarkable, with no obvious periarticular erosion or calcification. MR imaging demonstrated marrow oedema centred at the fifth MCP joint (Fig. 1a) and thick enhancing synovium with rim-enhancing hypodensity within it (Fig. 1b). An infective synovitis was initially raised, given the pattern of enhancement and the extensive marrow and periarticular oedema. However, this was subsequently proven histologically to represent tophaceous gout with active inflammation.

In the wrist and ankle, deposition of gouty tophi within the flexor and extensor tendons and tendon sheaths may lead to tendon rupture[2,3] and contractures. Compressive neuropathies have also been reported. Involvement of the carpal tunnel floor and median nerve may lead to carpal tunnel syndrome,[4] while ulnar tunnel[5] and tarsal tunnel[6] syndromes are less common. Case 2 had severe and advanced gouty arthritis of the wrists and hands, and presented with bilateral carpal tunnel syndrome (Figs. 2a & b) and rupture of the extensor tendons in two fingers (Fig. 2c). Intrinsic carpal ligament disruptions have also been reported.[7]

Other soft tissue masses in the extremities can usually be distinguished from their MR imaging characteristics. Ganglion cysts and lipomas are usually diagnosed with ease based on their typical MR imaging features of fluid and fat signals, respectively. Occasionally, ganglion cysts may have altered signal if they contain proteinaceous or haemorrhagic contents. Benign peripheral nerve sheath tumours are also common, and their classical appearance of a fusiform mass with a 'dural tail' may aid in differentiating these lesions from tophi. Haemangiomas and vascular malformations usually present with fluid levels, flow voids (high-flow malformation) or phleboliths (slow-flow malformation). Giant cell tumour of the tendon sheath would present with susceptibility from haemosiderin. Malignant lesions of the distal extremities are rare.

ELBOW

Involvement of the elbow joint in chronic tophaceous gout is not uncommon. Typically, patients present with elbow swelling from subcutaneous gouty tophi or olecranon bursitis. Intra-articular presentation of chronic tophaceous gout is rare, and is often an overlooked differential in the absence of visible cutaneous tophi. The MR imaging appearance of intra-articular tophi in the elbow is nonspecific, and may demonstrate a more infiltrative appearance.

A review of the literature yielded only a handful of case reports on intra-articular tophi in the elbow joint. One patient was reported to have presented with a slowly-

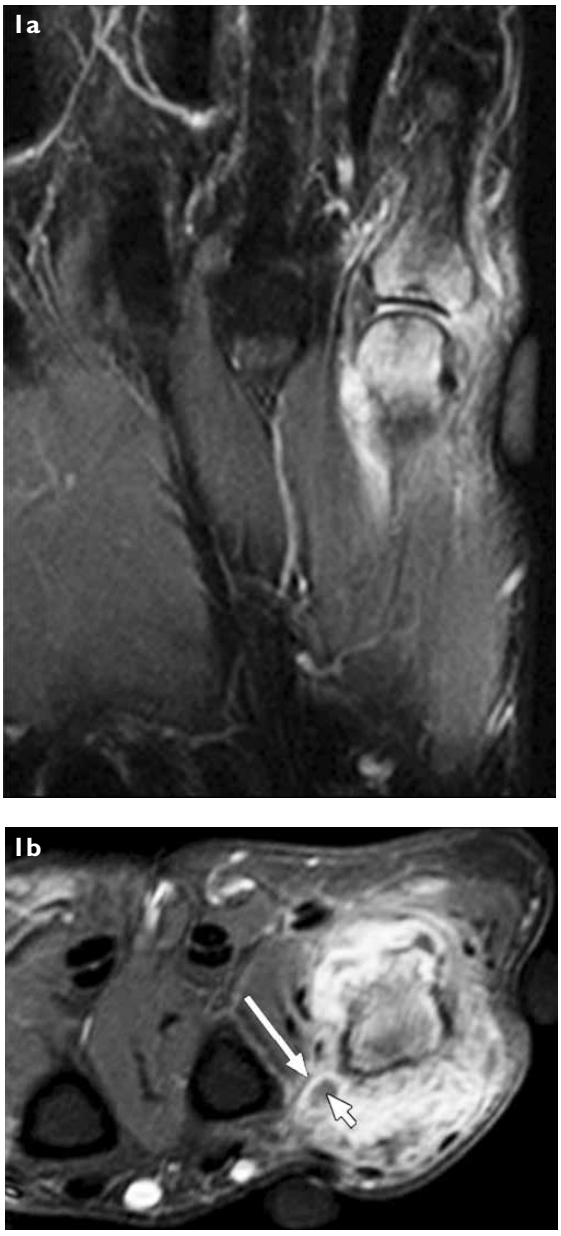

Fig. 1 (a) Coronal TIRM image of the left hand shows marrow and periarticular oedema of the fifth metacarpophalangeal joint, with associated synovitis. (b) Post-contrast fat-saturated axial T1-W MR image of the left hand shows thickened and enhancing synovium (white arrow), with low signal intensity tophi (arrowhead) interspersed between.

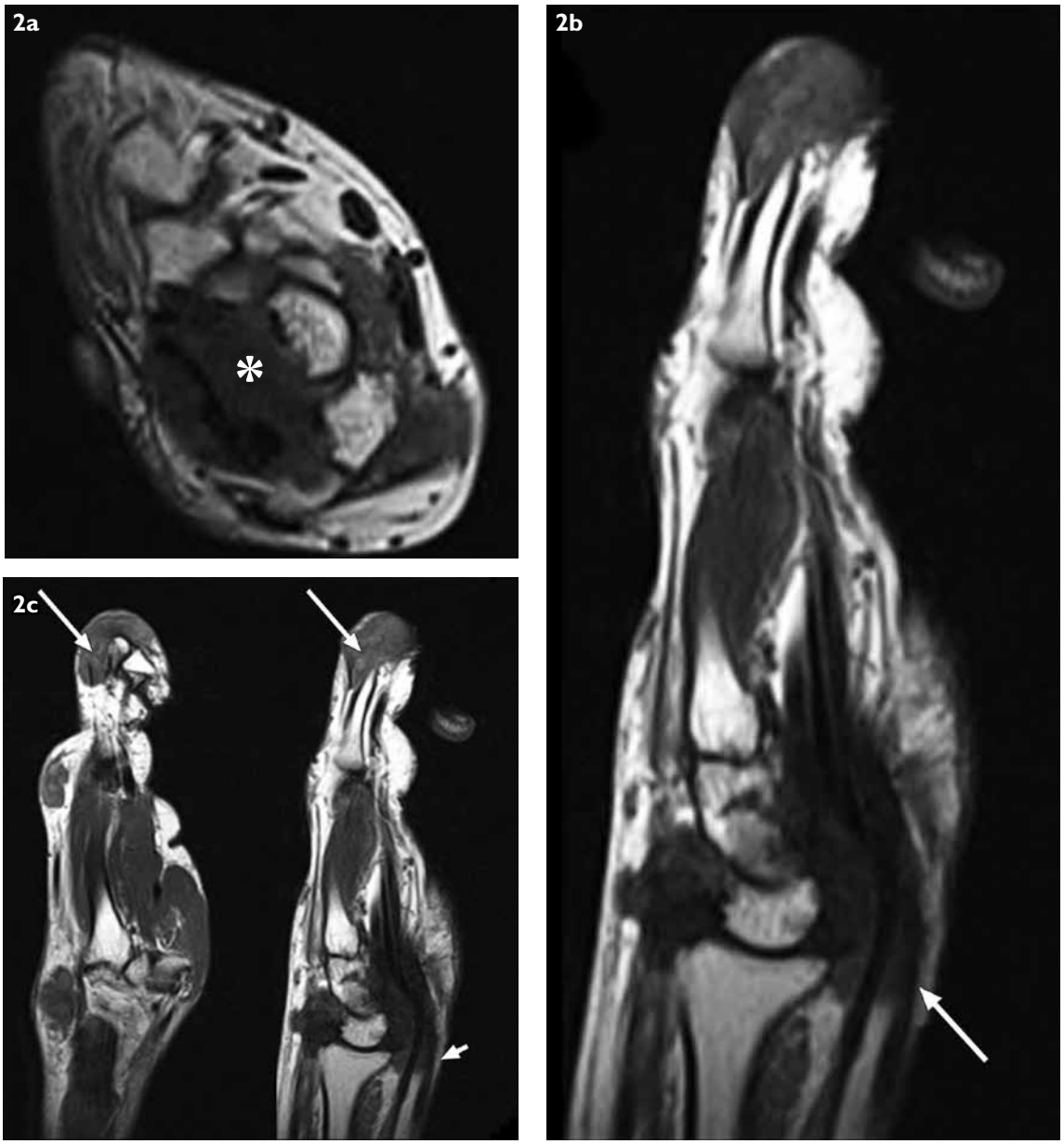

Fig. 2 (a) Axial T1-W MR image of the left hand shows that the carpal tunnel is filled with gouty tophi (asterisk) surrounding the flexor tendons. The median nerve cannot be seen separately. (b) Sagittal T1-W MR image of the left hand shows the median nerve entering the carpal tunnel where it is encased by the tophus (white arrow). (c) Successive sagittal T1-W MR images of the index finger show abrupt truncation of the central slip of the extensor tendon (white arrows) within the gouty tophus, resulting in flexion deformity. Note the median nerve entering the carpal tunnel where it is encased by the tophus (arrowhead).

enlarging elbow mass with intermittent locking.[8] The MR image demonstrated a mass with imaging characteristics similar to those of the muscle, and the preoperative diagnosis was that of an oedematous accessory anconeus epitrochlearis. More interesting is Case 3, who presented clinically with gradual ulnar neuropathy and no cutaneous mass (Fig. 3). The MR image demonstrated a soft-tissue mass in the cubital fossa encasing an oedematous and enhancing ulnar nerve. The MR imaging appearance was nonspecific, but when correlated with the elbow radiographs, which showed amorphous periarticular calcifications, we were able to make a probable diagnosis of tophaceous gout, which was also proven histopathologically. To the best of our knowledge, there has only been one other case report of gouty tophi causing cubital tunnel syndrome.[9] Most pathological processes of the elbow in the clinical setting are usually related to trauma, inflammatory or infective processes, which can usually be distinguished by history, classic radiological findings and laboratory workup.

KNEE

In the knee, the peri- and intra-articular structures are typically involved, and visible subcutaneous tophi are

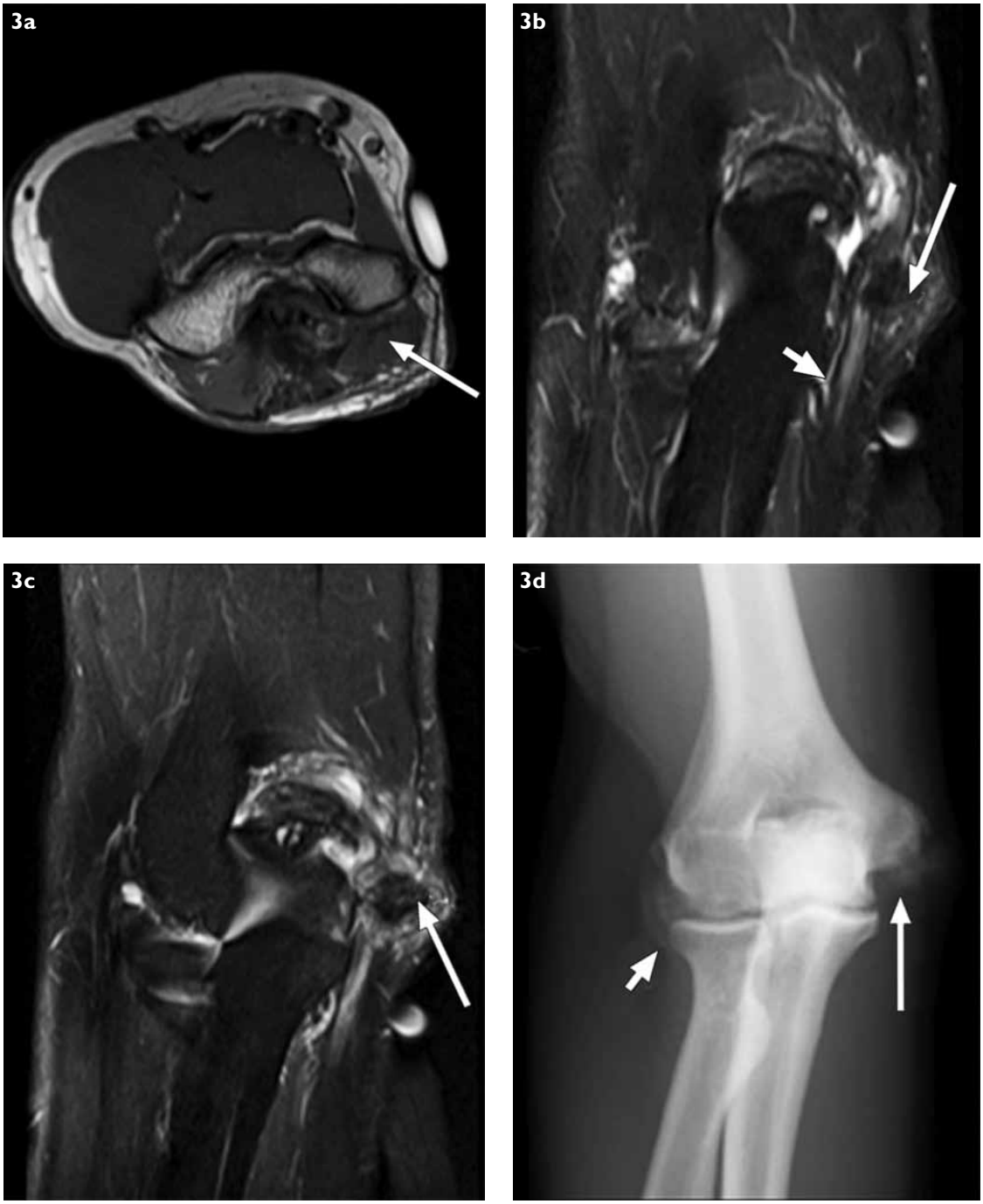

Fig. 3 (a) Axial T1-W MR image of the left elbow shows that the ulnar nerve is inseparable from the isointense soft tissue mass (white arrow) in the cubital tunnel. (b) Fat-saturated coronal T2-W MR image of the left elbow shows the ulnar nerve compressed by the tophus (white arrow). Distal to the compression, the ulnar nerve is thickened and oedematous (arrowhead). (c) Post-contrast, fat-saturated coronal T1-W MR image of left elbow shows enhancement of the granulation tissue surrounding the tophus (white arrow), giving rise to a rim-type pattern of enhancement. (d) Frontal radiograph of the left elbow shows erosion of the medial humeral condyle, with associated amorphous periarticular calcification (white arrow), corresponding to the location of the soft-tissue mass seen on the MR images. Calcification of the radiocapitellar joint is also present (arrowhead).

unusual. The most common locations include the supra-, pre- and infrapatellar bursae, anterior joint recess, intercondylar fossa and roof.[10] Involvement of the anterior cruciate ligament has also been reported.[11] Even less common is the deposition of gouty tophi in the medial patellar plicae, in which only one case report exists in the literature.[12] Case 4 had extensive infiltration of both the cruciate ligaments, encasement of the medial collateral ligament and displacement of the lateral collateral ligament, as well as infiltration of the ligamentum patellae (Fig. 4). Bony involvement manifests as pressure erosions, seen in the anterior tibial tubercle, tibial condyles, femoral plateaus and patella, while intraosseous deposits of tophi are seen as bone cysts. Involvement of the patella has also been reported.[13]

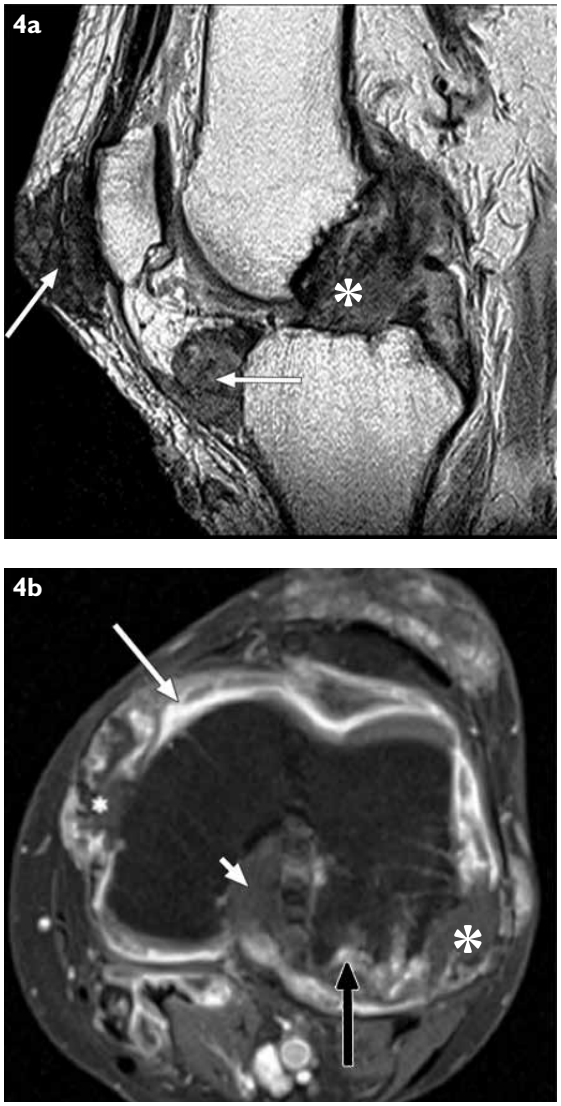

Fig. 4 (a) Sagittal PD image of left knee shows a lobulated mass at the intercondylar notch, infiltrating the anterior cruciate ligament (asterisk). Similar masses of intermediate signal are seen in the Hoffa's fat pad and anterior to the patella (white arrows). (b) Post-contrast, fat-saturated axial T1-W MR image of the left knee shows a non-enhancing tophus of intermediate signal surrounding the medial and lateral collateral ligaments (asterisk), as well as infiltrating the intercondylar notch (arrowhead). Note the erosion of the posterior lateral femoral condyle (black arrow) and thickened enhancing synovium (white arrow), reflecting synovitis.

Most patients with tophaceous gout in the knee present with limitations in range of motion and internal derangement. Pain is associated with an acute flare. The absence of visible subcutaneous tophi and the infrequent involvement of the knee in gout lead to reduced index of clinical suspicion. More common pathologies of the knee joint that may demonstrate a similar MR imaging appearance include pigmented villonodular synovitis (PVNS), chronic infectious arthritis, haemophiliac arthropathy and synovial chondromatosis. Significant susceptibility from haemosiderin deposition is seen in PVNS and haemophilliac arthropathy. The extent of bone loss is usually more marked in both haemophiliac arthropathy (with widening of the intercondylar notch) and chronic infectious arthritis. Synovial osteochondromatosis mirrors bone marrow on MR imaging, or may be calcified.

SPINE

Involvement of the axial skeleton is rare. A review of the literature reveals a number of case reports and small case series describing tophaceous gout involving the spine. The lumbar spine is the most commonly affected region. All parts of a vertebral segment may be involved, including the epidural space, discovertebral junction, posterior elements, ligamentum flavum and facet joint. It is thought that degenerate joints are predisposed to the deposition of gouty crystals.

Uncomplicated tophaceous gout of the spine typically manifests as back pain. Gouty tophi involving the epidural and intradural space may result in spinal cord[14] or cauda equina[15] compression, while encroachment into the exit foramina results in compressive neuropathy.[16] Case 5 presented with chronic low back pain and chronic cauda equina syndrome manifested by longstanding bladder dysfunction (Fig. 5).

Spinal tophaceous gout is frequently mistaken for metastases[17] or infective processes such as discovertebral infections[16] and epidural abscesses.[15] Some imaging features may help to distinguish these conditions from gout, although they are by no means exclusive. A metastatic or infective process generally causes more destructive changes, with ill-defined and irregular margins, while bony erosions from tophaceous gout are generally well-defined and well-marginated, giving rise to the typical 'over-hanging' appearance on radiographs. There is usually minimal inflammatory change in the intervertebral disc and vertebra immediately adjacent to the gouty tophi, unlike in infectious and metastatic conditions. Clinical correlation may shed some light, but definitive diagnosis may only be made histologically.

OTHER JOINTS

Involvement of large joints is rare, with only isolated reports of tophus deposition in the shoulder and hip. There are two reports of gouty tophi deposition in the rotator cuff with complications of subacromial impingement. Pathological fracture of the femoral neck, ilium and pubic bones from deposition of gouty tophi and aseptic loosening of total hip prosthesis have been reported. A few case reports of involvement of the sacro-iliac joints also exist in the literature.

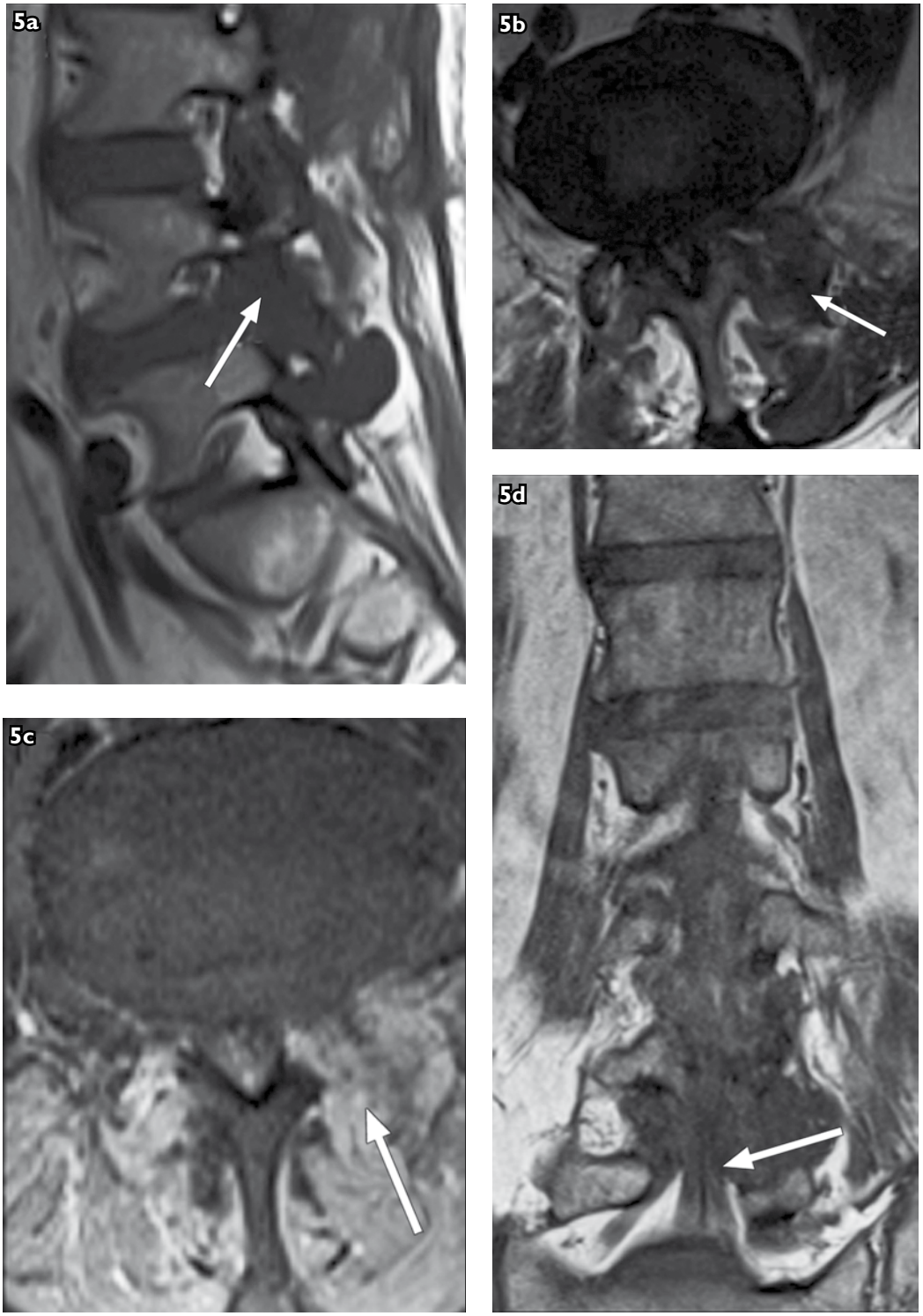

Fig. 5 (a) Sagittal T1-W MR image of the lumbar spine shows the L4/5 facet joint replaced by a well-defined lobulated T1-W hypointense tophus (arrow). (b) Axial T2-W MR image of L4/5 shows that the tophus is of intermediate signal intensity (arrow). (c) Post-contrast, fat-saturated axial T1-W MR image of L4/5 shows that homogenous enhancement of the tophus is most common (arrow). (d) Coronal T1-W MR image of the lumbar spine shows the tophus causing indentation of the thecal sac and spinal canal stenosis (arrow).

FURTHER WORKUP

When tophaceous gout is suggested based on MR imaging findings in atypical joints or in patients whose formal diagnosis of gout has not been established, further workup would be necessary. Clinical history, risk stratification for gout, and biochemical and haematological workup should be performed. Radiographic examinations are inexpensive, easily available and should always be performed; correlation for the more established radiographic findings of gout is useful. Calcifications

are found in 50% of gouty tophi, and are generally better appreciated on radiographs. Computed tomography (CT) and sonography are unlikely to confer additional information after MR imaging. Nuclear medicine studies do not seem to be a reliable method for differentiation of tophaceous gout, infections and malignancies. All three pathologies, including tophaceous gout,[17] would demonstrate uptake on Technetium 99-m bone imaging. Triple-phase bone imaging is unable to differentiate gouty tophi from infectious processes, as both demonstrate uptake on all three phases. One case report also described fluorodeoxyglucose (FDG)-avidity of vertebral tophi in an MR/CT-positron emission tomography fusion study, which was subsequently confirmed histopathologically.[18]

The ultimate diagnosis of tophaceous gout is histological. Image-guided needle biopsy may be performed to avoid surgical risks, although the sensitivity is limited and non-diagnostic results are not infrequently obtained. The decision for surgical exploration and excision would depend on the need to confirm benignity (in cases where malignancy remains a differential, such as in the spine) and for relief of symptoms (such as patients with compressive neuropathy or internal derangement of the knee).

CONCLUSION

Gout is known as the 'great mimicker' and may present as a diagnostic challenge. Formation of gouty tophi in unusual locations and with atypical presentations may fox clinicians and radiologists alike. When interpreting an MR image of joint-related masses, gouty tophi should remain a possible differential given its varied and nonspecific MR imaging appearance.

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SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME
Multiple Choice Questions (Code SMJ 201111B)

	True	False
Question 1. Regarding the MR imaging appearance of gouty tophi:		
(a) The most common T2-weighted appearance is heterogenously low to intermediate signal intensity.	☐	☐
(b) The T2-weighted appearance is more consistent than the T1-weighted appearance.	☐	☐
(c) Peripheral enhancement excludes gouty tophi as a differential diagnosis.	☐	☐
(d) Their appearance is varied.	☐	☐
Question 2. Regarding gouty tophi of the small joints of hands and feet:		
(a) Involvement of the first metacarpophalangeal joint is the classical manifestation of gout.	☐	☐
(b) The lower limbs are more frequently affected than the upper limbs.	☐	☐
(c) They may lead to tendon rupture and contracture.	☐	☐
(d) They may lead to compressive neuropathies.	☐	☐
Question 3. Regarding gouty tophi of the knee:		
(a) Intra-articular involvement excludes gouty tophi.	☐	☐
(b) Patients may present with limitations in range of movement and internal derangement.	☐	☐
(c) They are usually associated with visible cutaneous tophi.	☐	☐
(d) The presence of susceptibility artifacts favours gouty tophi over pigmented villonodular synovitis and haemophiliac arthropathy.	☐	☐
Question 4. Regarding gouty tophi of the spine:		
(a) The cervical spine is the most commonly affected region.	☐	☐
(b) Degenerate joints predispose to deposition of gouty crystals.	☐	☐
(c) They may result in spinal cord or cauda equina compression.	☐	☐
(d) The differentials include metastases and infections.	☐	☐
Question 5. Regarding other imaging of gouty tophi:		
(a) MR imaging should always be interpreted in conjunction with plain radiographs.	☐	☐
(b) Gouty tophi do not demonstrate uptake on Technetium 99-m bone imaging.	☐	☐
(c) Triple-phase bone imaging is unable to differentiate gouty tophi from infectious processes.	☐	☐
(d) Gouty tophi do not demonstrate FDG-avidity.	☐	☐

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(1) Log on at the SMJ website: http://www.sma.org.sg/cme/smj and select the appropriate set of questions. (2) Select your answers and provide your name, email address and MCR number. Click on "Submit answers" to submit.

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