



Cystic lesions of the humeral head on magnetic resonance imaging: a pictorial review

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Abstract: Cystic lesions of the humeral head are commonly encountered on routine shoulder magnetic resonance imaging (MRI). Differential diagnoses include degenerative lesions, calcific tendinitis with osseous involvement, perianchor cysts, abscesses and less often, tumours. Degenerative lesions, including subcortical and subchondral cysts, are the most commonly encountered. These may be associated with rotator cuff disease and degenerative joint diseases or considered part of ageing depending on the location of the cystic lesions. For instance, cysts of the bare area of the humeral head are considered benign age-related entities, whereas cysts of the greater or lesser tuberosity may herald rotator cuff disease. Infectious lesions, particularly osteomyelitis and intraosseous (Brodie's) abscesses, are intramedullary in location and should be suspected in the context of clinical features such as fever and radiological features such as the penumbra sign. Perianchor cysts are postoperative lesions associated with the use of suture anchors in surgeries such as rotator cuff tear repairs. They generally self-resolve over 18 to 24 months. On MRI, the distribution, morphology, and signal characteristics can help point towards a specific diagnosis. The patient's demographic, clinical presentation, and past surgical history can be discriminatory. Knowledge of different cystic lesions in the humeral head and underlying aetiology can be useful in helping the radiologist develop a more thorough search pattern for associated conditions. Determining the underlying cause of cysts can have important implications on management, such as when differentiating perianchor cysts from infection. This pictorial review outlines the differential diagnoses of humeral head cysts on MRI and provides a diagnostic approach for the radiologist.

Keywords: Humerus; magnetic resonance imaging (MRI); cysts; musculoskeletal; bone

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Introduction

Cystic lesions of the proximal humerus are commonly encountered on routine shoulder magnetic resonance imaging (MRI). True cysts are defined as fluid-filled structures or lesions with an epithelial lining, whereas pseudocysts are fluid-filled lesions without epithelial lining. In this paper, the terms “cyst” and “cystic lesion” are used to encompass both true cysts, pseudocysts and other lesions which could mimic the appearance of a cyst on MRI, with increased signal on fluid sensitive sequences.

Cystic lesions observed in humeral heads are most commonly degenerative cysts in subcortical or subchondral locations, with other differentials being calcific tendinitis with osseous involvement, perianchor cysts, abscesses or tumours. *Table 1* highlights how common these different causes of cystic lesions are.

On MRI, the location, distribution and morphology of cystic lesions can help point towards a specific diagnosis which carries its own clinical relevance. Knowledge of this may help target the search for underlying pathology that may be causing the cysts. One example would be the lesser tuberosity cyst, which can occur in the context of subscapularis tendinosis. Noting the patient’s demographic, presentation and past surgical history is also valuable. Other imaging modalities such as X-rays, are often complementary.

With a wide spectrum of causes, it is important for the radiologist to have an approach to differentiate the cystic lesions associated with underlying pathology and the ones requiring further investigation and management, from those that do not warrant intervention. This pictorial review aims

to provide the radiologist with an approach to various cysts and cyst-like lesions that can be identified on imaging, with specific focus on MRI.

Differential diagnosis

Using the surgical sieve, the cystic lesions in the humeral head can be further categorised into: degenerative changes (which includes both subcortical cysts in various characteristic locations in humeral heads and subchondral cysts), depositional lesions, iatrogenic lesions, infections and tumours.

Degenerative lesions

Subcortical cystic changes of the humeral tuberosities (shown in *Figures 1–4*) have an incidence of 15% to 45% in asymptomatic shoulders, with an association with ageing and rotator cuff pathology (2). They may be further divided based on location, into bare-area, lesser tuberosity, anterior greater tuberosity and posterior greater tuberosity cysts (2,7).

On MRI, subcortical cysts are seen at the tuberosities and bare area of the humerus as round lesions with low T1 and high T2 signal. These should be differentiated from vascular channels which are connected to tubular structures (2).

Bare-area cysts, located in the posterosuperior humeral head, are most common and are associated with ageing (2,7). They are typically pseudocysts communicating with the joint space and likely represent a normal anatomical variant, with no correlation with rotator cuff tears (2,7,8).

Lesser tuberosity cysts are also more frequent with older age and may be associated with subscapularis tears (2). In

Table 1 Frequency data on different causes of cystic change of the humeral head

Lesion	Frequency data
Common lesions	
Subchondral cystic change	Prevalence of 72% (1)
Subcortical cystic changes of humeral tuberosity	Prevalence of 15–45% (2)
Perianchor cystic change	Prevalence of 60% following rotator cuff surgery at 6 months (3)
Rare lesions	
Calcific tendinitis	Prevalence of 3% in the general population (4); osseous involvement occurs in 5% of these cases (5)
Osteomyelitis	Annual incidence of 0.0076%, with humeral involvement in 5.5% of cases—Brodie’s abscess occurs in a minority of these cases (6)
Bone tumours	Depends on the specific tumour

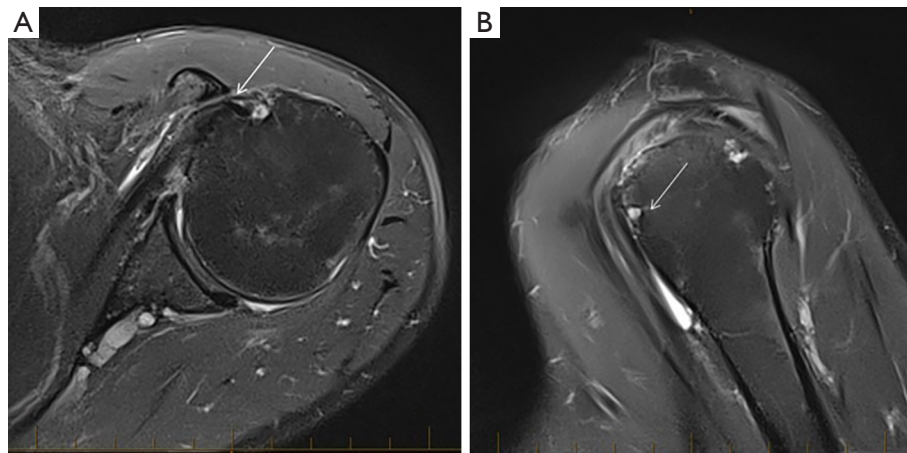


Figure 1 A 64-year-old male with shoulder pain worsened by adduction. Axial PDFS image of the left shoulder (A) demonstrates a narrowed subcoracoid space (3 mm, arrow) with tendinosis and fraying of the subscapularis at the attachment. Coronal PDFS image (B) shows associated subcortical cyst (arrow) in the lesser tuberosity at the site of the attachment. This is compatible with subcoracoid impingement. PDFS, proton density fat saturated.

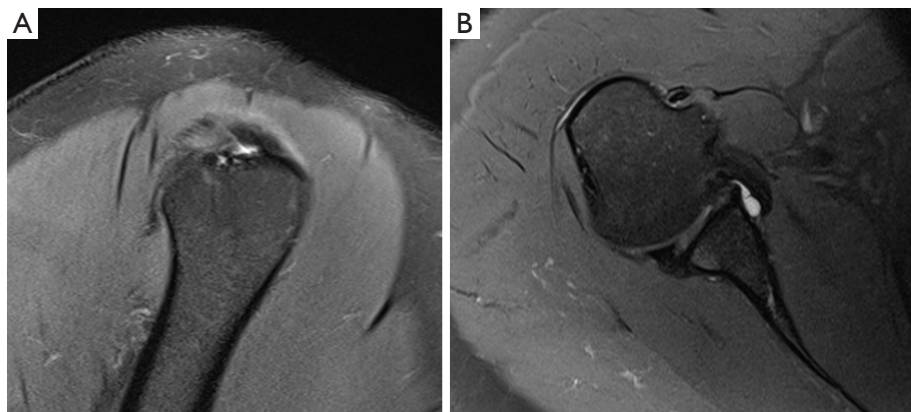


Figure 2 Posterosuperior impingement in a 37-year-old softball thrower with pain and instability. Sagittal PDFS (A) and axial PDFS (B) of the right shoulder with infraspinatus tendinosis and rim-vent tear at the posterior interval, and subcortical cysts in the humeral head posterosuperiorly. On axial projection, there is a Bennett's lesion in the posterior glenoid rim and subtle circumferential labral tear at the base and paralabral cyst more anteriorly. This can be observed in overhead athletes with which posterosuperior impingement is associated. PDFS, proton density fat saturated.

the younger demographic, they may also be associated with subcoracoid impingement (shown in *Figure 1*), which occurs when the subscapularis tendon is impinged between the coracoid process and the lesser tuberosity (9). This syndrome presents with anterior shoulder pain aggravated by adduction and internal rotation, and physical examination reveals point tenderness at the subcoracoid area (9).

On MRI, there may be increased soft tissue noted in

the subcoracoid space due to compression and oedema of the subscapularis tendon. The distance between the coracoid tip and the closest point on the proximal humerus should be noted, with a distance of less than 6.8 mm supporting impingement (9). However, as the sensitivity of MRI in detecting subcoracoid impingement is low, direct arthroscopic observation may be needed to establish this diagnosis in patients with supportive clinical features and equivocal imaging (9). The first-line management is

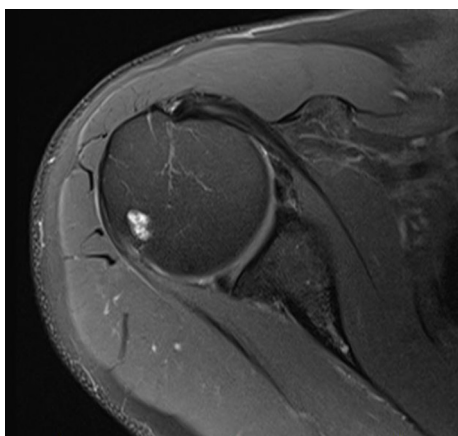


Figure 3 Axial PDFS. Posterosuperior impingement in a 40-year-old, with history of push-ups and gym dips. There is rounding of the posterior labrum with subtle posterior labral tear at base. Infraspinatus tendinosis is present, associated with subcortical humeral head cysts. This is consistent with posterosuperior impingement. PDFS, proton density fat saturated.

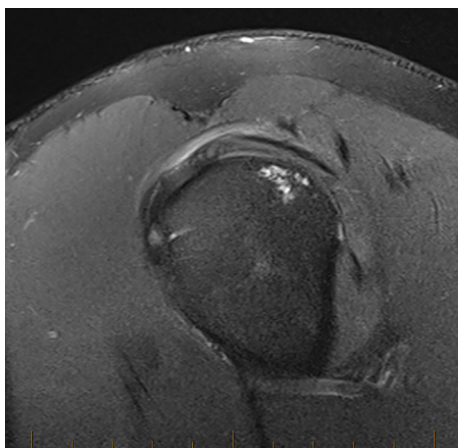


Figure 4 Sagittal PDFS. Infraspinatus tendinosis in a 35-year-old man with shoulder pain. Undersurface fraying and subcortical cysts are present. PDFS, proton density fat saturated.

physiotherapy and activity modification, with surgery being considered if conservative measures are unsuccessful (9).

Anterior greater tuberosity cysts located near the insertion of the supraspinatus, and posterior greater tuberosity cysts located near the insertion of the infraspinatus, are associated with the presence of supraspinatus and infraspinatus tendon tears (2). Their pathogenesis is unclear, but theories include the cysts being an inflammatory reaction to microavulsive cuff tears, or a result of synovial fluid contacting the bone

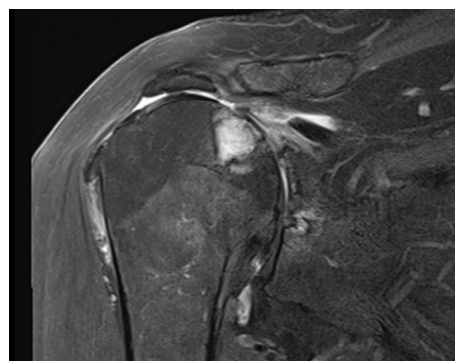


Figure 5 Subchondral cyst in a 70-year-old female with massive cuff tear and secondary osteoarthritis (coronal PDFS). PDFS, proton density fat saturated.

while intact tendons would have normally served as a barrier against this (2,10). However, given they are also common in asymptomatic shoulders, some suggest these cysts may be a normal variant unrelated to shoulder pathology or ageing (2). The majority of humeral tuberosity cysts are asymptomatic and require no treatment, although bone grafting may be needed in large cases interfering with rotator cuff repair (10).

Posterior greater tuberosity cysts may be associated with posterosuperior (internal) impingement (shown in *Figures 2,3*), which describes the compression of the supraspinatus and infraspinatus tendons between the greater tuberosity and the posterosuperior glenoid rim (11,12). It classically occurs in overhead athletes and presents with posterior shoulder pain worsened by external rotation and abduction (11,12). MRI findings include cystic change at the site of infraspinatus attachment, undersurface tears of the anterior infraspinatus and posterior supraspinatus fibres and fraying or tearing of the posterosuperior glenoid labrum (12). Physiotherapy is the mainstay of management, with surgery in selected cases (11).

Subchondral cysts of the proximal humerus occur in the context of degenerative glenohumeral joint diseases, such as osteoarthritis (shown in *Figure 5*), rheumatoid arthritis, avascular necrosis (shown in *Figure 6*), crystal deposition disease, haemophilic arthritis, intraosseous ganglia and trauma (1). They are not true cysts as they lack an epithelial lining (13). The bony contusion theory posits that subchondral cysts develop from focal bone necrosis induced by abnormal stress on bony surfaces in a degenerated joint, whereas the synovial fluid intrusion theory suggests that they develop as a result of synovial fluid infiltrating the bone through damaged cartilage (1,13). Subchondral cysts

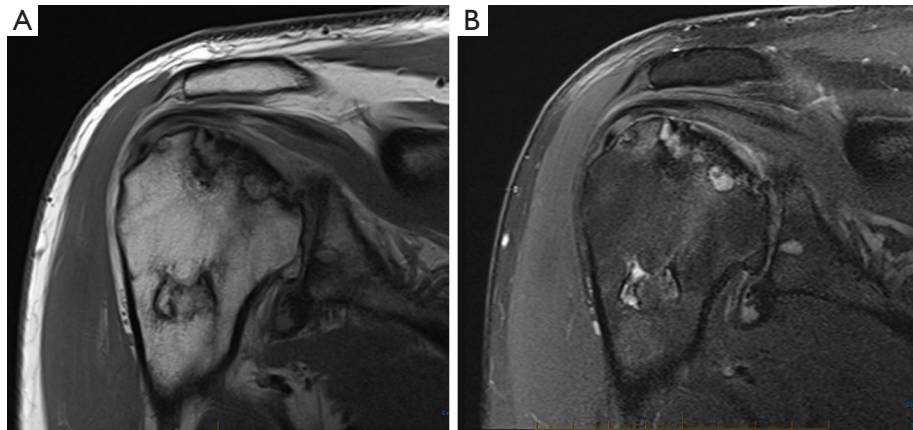


Figure 6 Avascular necrosis in a 50-year-old patient, an abalone diver for 25 years, presenting with shoulder pain and stiffness. Coronal PD (A) and PDFS (B) shoulder show secondary subchondral bone collapse and perilesional subchondral cysts. PD, proton density; PDFS, proton density fat saturated.



Figure 7 Intraosseous extension of calcific tendinitis in a 45-year-old woman with right shoulder pain. Axial PDFS sequences of the right shoulder performed 2 years apart, demonstrating crystal deposition in infraspinatus tendon (A) with intraosseous extension in the more current image (B). PDFS, proton density fat saturated.

are generally considered asymptomatic, although there may be a weak correlation between bone marrow oedema, which these cysts are associated with, and pain severity in osteoarthritis (14,15). The patient's clinical features and management will vary depending on the underlying cause.

The subchondral cyst differs from the aforementioned subcortical cyst as it is situated deep to or at the articular surface of the humeral head lined by cartilage. On MRI, subchondral cysts show fluid-like signal and, in early stages, a bone marrow oedema pattern of T2 fat-suppressed hyperintensity of bone marrow (16). The diagnosis should be considered when associated features of degenerative joint diseases, such as cartilage erosion/thinning and osteophytes,

are present (13). These subchondral cysts can affect the bone stock of the humerus that can in turn, have implications for type of joint replacement performed. Hence, if extensive, it may be worthwhile conveying the size and extent of these cysts for the orthopaedic referrer. Bone stock can be better assessed on computed tomography (CT) (17).

Depositional lesions

Osseous involvement in calcific tendinitis can produce cyst-like change in the humerus (shown in *Figure 7*) (4). Calcific tendinitis is a common disease, affecting 3% of adults, characterised by the deposition of calcium hydroxyapatite

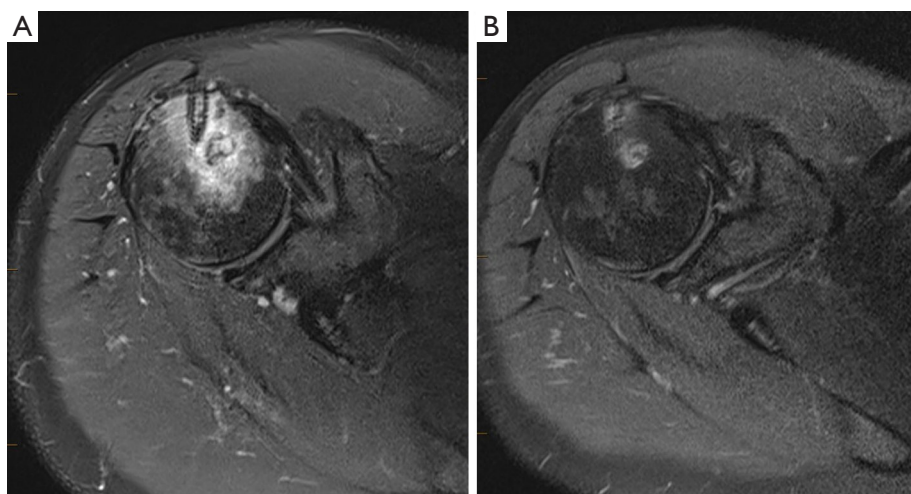


Figure 8 Perianchor cyst in a 46-year-old man following rotator cuff tendon repair in May 2020. An axial PDFS sequence shoulder MRI, performed 10 months later for adhesive capsulitis, showed a perianchor cyst with surrounding marrow oedema signal (A). Routine follow-up 4 months after the initial examination in roughly comparable slice (B) showed spontaneous resolution of the cyst. PDFS, proton density fat saturated; MRI, magnetic resonance imaging.

crystals in and around tendons as a result of trauma, hypoxia and metabolic derangement (4). The shoulder is the most commonly affected site and symptoms include pain, swelling and erythema. Osseous involvement is uncommon and may result from periosteal reactivity in response to crystal-induced tendon inflammation (4). The mechanism of cystic change in calcific tendinosis is unclear; it may be due to calcium accumulation on pre-existing tuberosity cysts, or it may develop as a reactive response to intramedullary crystal deposition (4). It is important to differentiate the osseous changes of calcific tendinitis from neoplastic lesions to avoid more invasive investigation or unnecessary biopsies. The former is easily managed with cortisone injection and anti-inflammatories (4).

On MRI, deposits of calcific tendinitis are observed as T1 and T2 hypointensities within the cystic lesions, with inflammatory oedema manifesting as T2 hyperintensity around tendons (4). Cortical bone erosion and marrow extension, evidenced by heterogenous marrow signal intensity adjacent to tendon calcification, are supporting features (4). Prior or ancillary imaging demonstrating calcium deposit in adjacent tendons, such as on X-ray, may help support the diagnosis.

Iatrogenic lesions

The perianchor cyst (shown in *Figure 8*) is an osteolytic lesion which may be found incidentally in patients following

rotator cuff repairs using suture anchors (18). Perianchor cysts are more common with the use of bioabsorbable suture anchors and 100 patients treated with non-absorbable anchors, Micic *et al.* reported a 12-month incidence of 39% and 6%, respectively (18). They may arise due to synovial fluid entering the bone through cracks produced by the surgeon drilling a hole for anchor insertion (18). Their association with bioabsorbable anchors may be related to the design of these anchors allowing fluid infiltration more easily along the sutures and through the central hole of the anchor (18). These are not associated with impaired postoperative outcomes, do not increase the incidence of rotator cuff retear or shoulder instability and the majority self-resolve by 18 months post-surgery (3,18). These can be mistaken as post-operative infection and the lack of clinical features such as fever may be a useful distinguishing feature.

On MRI, perianchor cysts are seen as collections near the anchor which are hyperintense on fluid-sensitive sequences. They may be graded by size in relation to the anchor (3).

Technical artefacts

Susceptibility artefacts may mimic humeral cysts, as shown in *Figure 9*. They occur due to the hardware used and associated paramagnetic effects. Magnetic field distortion can be observed to differentiate this artefact from true pathology.

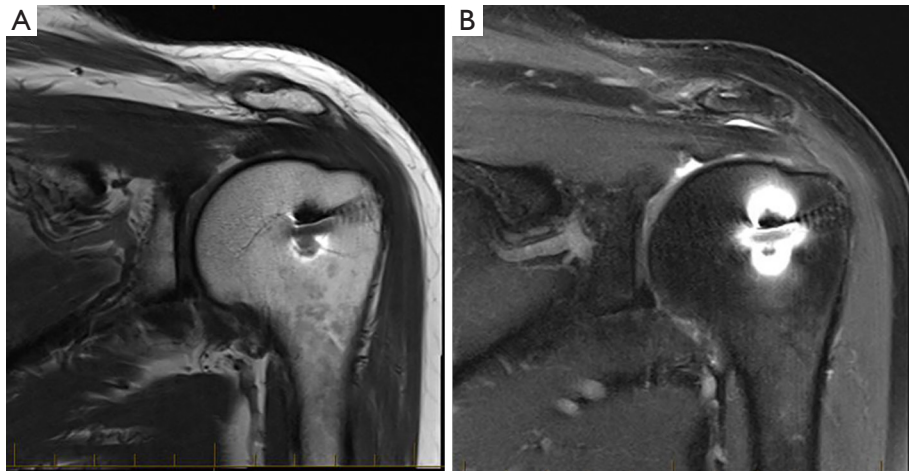


Figure 9 Susceptibility artefact from a biceps tendinosis screw in a 75-year-old, mimicking a perianchor cyst. The changes are more apparent on a fluid-sensitive sequence (B) compared to PD (A), but can be distinguished from a cyst given the adjacent field distortion. PD, proton density.

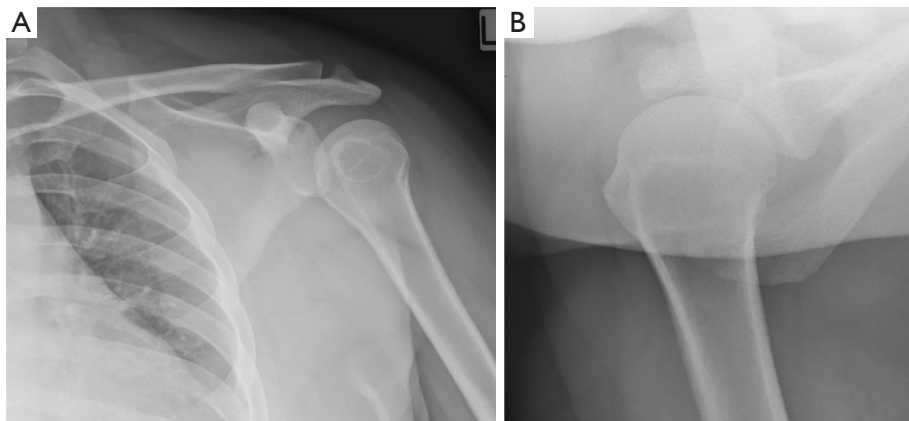


Figure 10 Internally rotated frontal view (A) and axillary view (B) of a 30-year-old female with shoulder pain secondary to bursal impingement. The pseudolesion in the humeral neck seen on the internally rotated view is not apparent on other views.

Infectious lesions

Infectious cystic lesions must be considered in the context of pain, swelling and fever (19). When considering Brodie's abscess as a differential for the cystic lesion, it is important to look for the penumbra sign, which describes four layers of the abscess: a core of T1 hypointensity and T2 hyperintensity, an inner ring of T1 intermediate signal and T2 hypointensity, an outer ring of T1 and T2 hypointensity and surrounding bone marrow oedema (19,20). The abscess enhances peripherally with contrast (19,20). These lesions are managed with antibiotics and may need surgical drainage (20).

Pseudolesions on X-ray that may masquerade as cystic lesions

Pseudolesions of the humerus can appear as cysts, but do not represent a true pathological process. They are commonly seen on internal rotation shoulder radiographs as a radiolucent lesion with a sclerotic border in the humeral head (21). These pseudolesions can be differentiated from true osteolytic lesions as they are absent on externally rotated and other shoulder views (21). An example is shown in *Figure 10*.

Another type of pseudolesion occurs in the superolateral humeral head as a result of normal anatomical variation

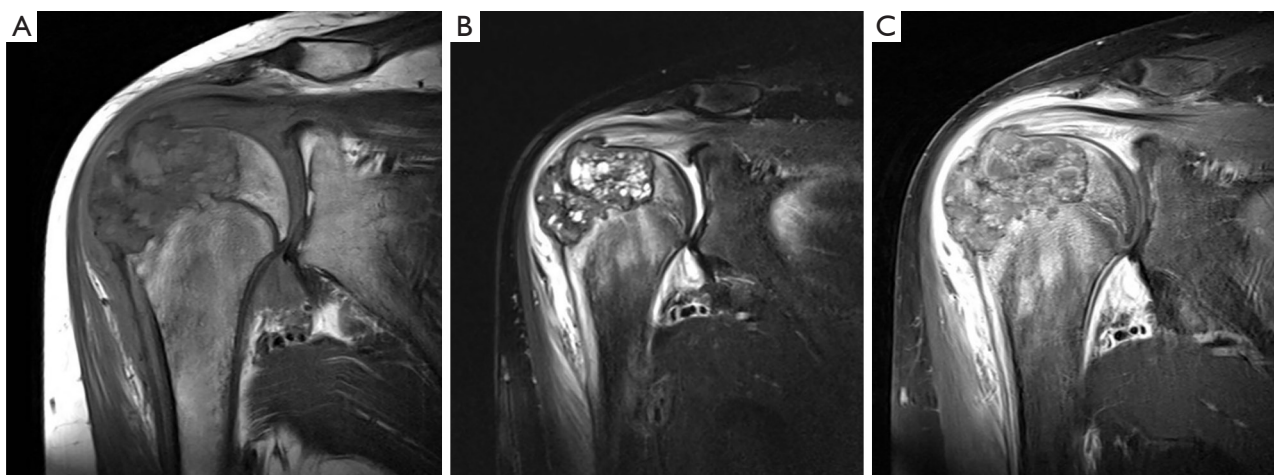


Figure 11 Coronal T1 (A), T2FS (B) and post-gadolinium T1FS (C) imaging of chondroblastoma in a 14-year-old who presented with persistent shoulder pain that was inconsistent with the minor trauma sustained. Note that the lesion with lobulated chondroid signal is centred in the humeral epiphysis, with surrounding florid marrow oedema signal. There is cortical breach and extraosseous extension of tumour superolaterally.



Figure 12 Atypical cartilaginous tumour in a 45-year-old male with a 6-week history of shoulder pain. MRI left shoulder PD sequence in coronal projection (A) shows a rounded lesion in the humeral head extending to the proximal shaft, with adjacent marrow oedema signal. The lesion is hyperintense on the fluid-sensitive sequence. Axial T1 (B) shows circumferential, extraosseous extension of the intramedullary lesion indicating an aggressive process. Frontal projection shoulder X-ray (C) confirms that the lesion is predominantly lucent, with scant areas of rings and arcs calcification, consistent with chondroid matrix. MRI, magnetic resonance imaging; PD, proton density.

with trabecular bone loss and increased fat (21). This radiolucency is seen best on externally rotated radiographs and appears as a region of increased fat-signal on MRI (21).

Tumours

Tumours (shown in *Figures 11-14*) should always be considered in the differential diagnoses of cysts. These

include benign and malignant primary tumours and those secondary to a metastatic aetiology. An example of a tumour which can sometimes be mistaken for a cystic lesion is the chondroid tumour, given its intrinsically hyperintense signal on fluid-sensitive sequences. A useful distinguishing feature is its lobulated contour. Other imaging characteristics that can help separate a neoplastic process from a cystic lesion of the humeral head is the internal architecture of the lesion;

if a lesion has an internal solid component or septation, it is more likely to be neoplastic. Surrounding marrow oedema signal or extraosseous breach would also be more supportive of a malignant process. Occasionally, it can be challenging to differentiate soft tissue tumours or juxtacortical lesions with bone invasion from primary bone tumours with extraosseous extension (22). Using the epicentre of a lesion can help localise its origin.

The details of specific neoplasms are beyond the scope of

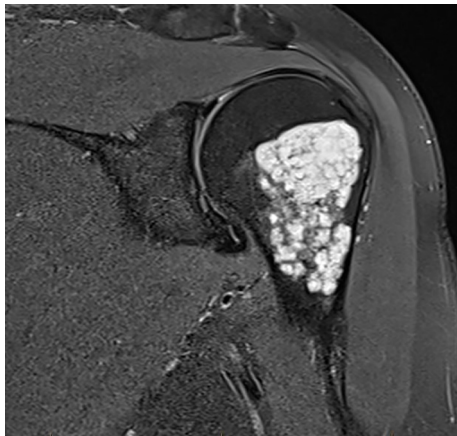


Figure 13 Coronal PDFS sequence of a 41-year-old's shoulder demonstrating an incidental lobulated lesion which is hyperintense on the fluid-sensitive sequence and centred in the humeral metaphysis. This was stable on a subsequent study and is consistent with an enchondroma. PDFS, proton density fat saturated.

this manuscript.

The simple (unicameral) humeral bone cyst is a non-neoplastic bone tumour which may be considered in the differential diagnosis of cystic change in the humeral head, although this lesion usually occurs in the metaphysis and diaphysis rather than the humeral head (23).

Summary and approach to cystic lesions of the humeral head

Once a cystic lesion is identified in the humeral head, characterised by T1 hypointensity and T2, PD, PDFS or STIR hyperintensity, the most useful step in determining its aetiology and associations is noting its location. A summary of this approach is provided in *Figure 15*. The patient's clinical presentation should be considered, for example posterior shoulder pain and instability in a throwing-athlete will support the diagnosis of posterosuperior impingement. Prior imaging is also useful, particularly in cases of calcific tendinosis with osseous involvement.

Contrast-enhanced MRI (CE-MRI) is useful in differentiating the non-enhancing necrotic and enhancing vascularised areas of bone tumours. This can help avoid sampling necrotic areas during biopsy (19). CE-MRI also highlights the changes of osteomyelitis, such as peripheral enhancement of abscesses (part of the penumbra sign) and sinus tracts (20).

Advanced MRI techniques are not routinely needed to

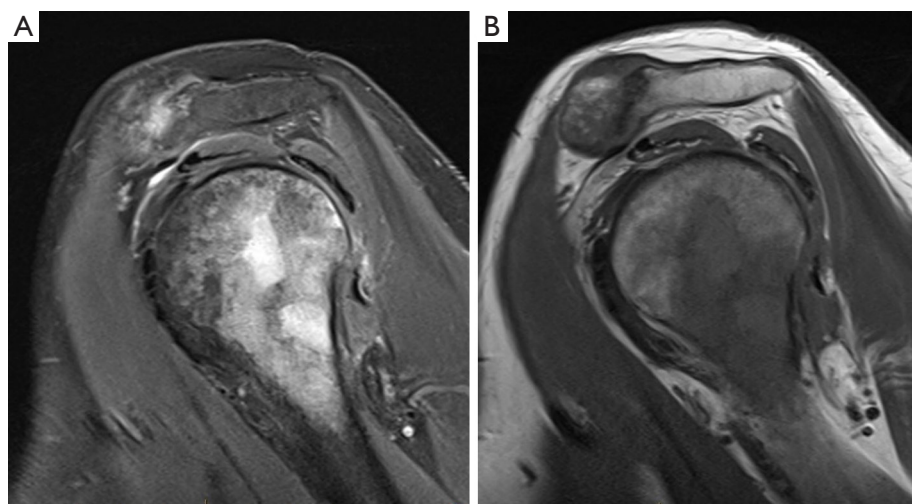


Figure 14 Sagittal PDFS (A) and T1 (B) sequences of a 70-year-old man with a background of known metastatic oesophageal and lung cancer. There is a lesion in the proximal humerus which is heterogeneously hyperintense on the fluid-sensitive sequence with adjacent patchy marrow oedema signal. This is consistent with the presence of metastatic deposits. PDFS, proton density fat saturated.

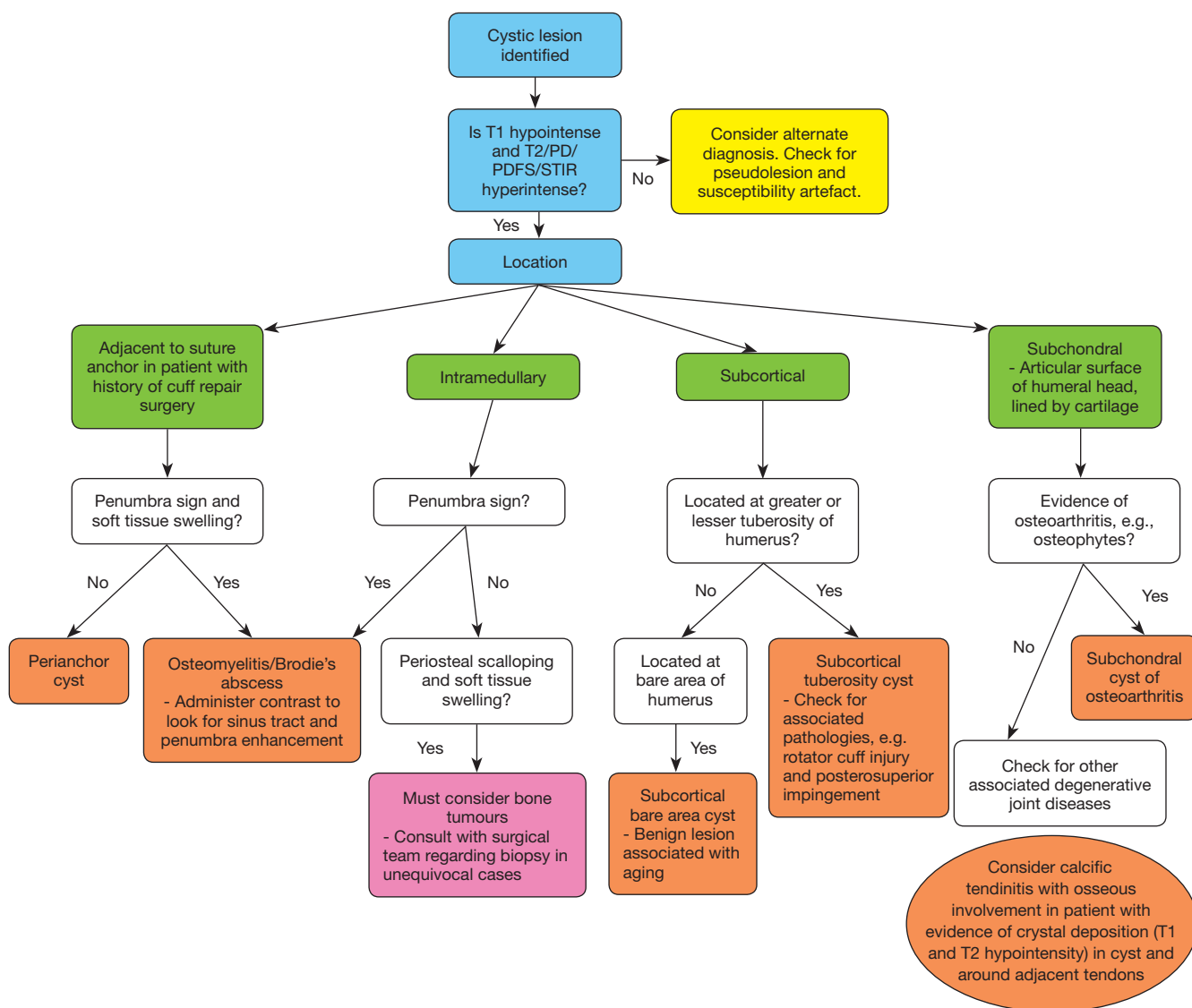


Figure 15 A potential approach to identifying the cause of a cystic lesion of the humeral head. PD, proton density; PDFS, proton density fat saturated; STIR, short tau inversion recovery.

help characterise cystic lesions in the humeral head, although they can be useful in the workup of neoplastic lesions.

For instance, diffusion weighted imaging (DWI) is valuable in differentiating benign and malignant bone lesions. As a lower apparent diffusion coefficient (ADC) can reflect increased cell number and size, malignant tumours tend to have lower ADC values than benign tumours. An ADC of 0.67 and above suggests a benign process. This has a sensitivity of 94%, specificity of 79% and accuracy of 87% (24).

Dynamic CE-MRI can help differentiate tumours from surrounding inflammatory change or post-therapeutic

change such as haematoma or seroma, as tumours will show earlier enhancement (19). The details of these techniques are beyond the scope of the manuscript.

Conclusions

This manuscript provides a basic framework to approaching cystic lesions in shoulder imaging, with specific focus on MRI. With the increased utilisation of shoulder MRI, it is useful to be able to differentiate cystic changes which are benign in nature from those that carry clinical implications

or point to underlying pathology.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://qims.amegroups.com/article/view/10.21037/qims-22-108/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Ethics was waived for this pictorial essay.

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