Pitfalls in the Diagnosis of Infection Around the Shoulder Joint
Report of Three Cases


Abstract
Infection around the shoulder joint is rare. Clinical suspicion and diagnostic imaging are required for accurate diagnosis. We present three cases that emphasise particular diagnostic challenges when dealing with infection around the shoulder joint. Discussion includes the role of ultrasound as a screening tool and the importance of magnetic resonance imaging (MRI) in the accurate diagnosis and localisation of infections around the shoulder.

The differential diagnosis of an atraumatic, acutely painful, swollen shoulder with reduced range of motion includes calcific tendonitis, frozen shoulder, glenohumeral septic arthritis, acromioclavicular septic arthritis, osteomyelitis, subacromial-subdeltoid abscess, and inflammatory arthropathy. Distinguishing between these pathologies requires clinical suspicion and radiological investigation. Glenohumeral septic arthritis accounts for 4% to 14% of all cases of septic arthritis. It is considerably more common than the other infective differentials of an acutely painful shoulder. Despite this, infection must be accurately localized in order to appropriately plan the necessary surgical intervention. We present three cases of infection in or around the shoulder joint, highlighting some of the diagnostic challenges.

Case History 1
A 56-year-old female was referred to the trauma clinic with a 10-day history of insidious onset left shoulder pain, swelling, and reduced range of movement. The pain was not made worse by neck movements and was not associated with any neurological symptoms. There was no history of trauma and no significant past medical history, though she was a current smoker.

Physical examination showed the patient to be hemodynamically stable and apyrexial. The left shoulder was obviously swollen and with a decreased range of motion. There was no overlying skin erythema. The remainder of the physical examination was unremarkable.

Initial relevant laboratory results were C-reactive protein, 300 mg/l; white blood cell count, 13 x 10^9/l; and neutrophil count, 10.2 x 10^9/l. Radiographs of the shoulder were normal. Ultrasound examination of the shoulder, performed by a consultant musculoskeletal radiologist, demonstrated a large echogenic collection in the shoulder joint, with gross distension of the capsule and extension into the subdeltoid bursa.

A presumptive diagnosis of septic glenohumeral arthritis was made. She, therefore, underwent prompt, open washout of the left shoulder, via a deltopectoral approach. The glenohumeral capsule was opened, but there was no evidence of a glenohumeral collection and no evidence of rotator cuff tear. A large subdeltoid-subacromial collection was encountered and washed out with 6 litres of normal saline. The false impression of septic glenohumeral arthritis diagnosis is discussed further below and in the literature. The glenohumeral capsule was closed, and a drain was placed into the subacromial-subdeltoid space. Postoperatively, she received intravenous flucloxacillin and oral fusidic acid for 1 week and orally for 5 weeks. Samples obtained intraoperatively

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cultured *Staphylococcus aureus*, sensitive to flucloxacillin and fusidic acid. Following surgery, pain improved but shoulder movements have remained limited despite physiotherapy. The C-reactive protein rapidly declined to 19 mg/l on day 13 postoperatively.

**Case History 2**

A 50-year-old male presented to the on-call medical team with a 2-week history of painless progressive jaundice. He admitted to alcohol dependence of approximately 20 units daily. His past medical history included hypercholesterolemia. On admission, his vital signs were stable. Physical examination revealed him to be deeply jaundiced, with peripheral stigmata of chronic liver disease, and, afterwards, a clinical examination consistent with a diagnosis of acute alcoholic hepatitis.

Two days into his hospital admission, he complained of left shoulder pain, with limited movement. He gave a history of a previously dislocated left shoulder as a teenager; conservative treatment was applied and left him with no ongoing complaints. There was no history of recent trauma or other musculoskeletal problems. At this point, *S. aureus* sensitive to flucloxacillin was cultured from his blood and urine, which had been obtained 48 hours previously. He was referred to the rheumatology team for review and commenced on intravenous flucloxacillin and oral fusidic acid. The rheumatologists then referred him to the on-call orthopaedic team.

Clinical examination at the time of referral to the orthopaedic team revealed a swollen, warm, and erythematous left shoulder. The point of maximal tenderness was over the acromioclavicular joint. He had been febrile (38.4° C) for the preceding 48 hours. Laboratory investigations at the time were CRP, 170 mg/l; erythrocyte sedimentation rate (ESR), 125 mm/hr; and white blood cell count, 7.8 x 10^9/l.

A shoulder radiograph demonstrated minor degenerative changes in the shoulder joint. An attempted diagnostic glenohumeral aspiration revealed no fluid within the joint. This raised the suspicion of infection elsewhere around the shoulder joint and, consequently, the patient underwent an ultrasound examination of the shoulder. The procedure, performed by a consultant musculoskeletal radiologist, showed fluid and inflammatory change in and around the acromioclavicular joint and extensive hypervascular tissue deep to the deltoid anteriorly. There was subacromial inflammatory change but no significant shoulder joint effusion and an intact rotator cuff. The shoulder was further imaged with magnetic resonance imaging (MRI) (Fig. 1). The image demonstrated inflammation in the subacromial-subdeltoid bursa, with a collection extending into the supraspinous fossa, as well as inferiorly between the muscle plane of infraspinatus and deltoid. The deltoid was edematous. The acromioclavicular joint was inflamed but with no significant destruction or edema of the juxta-articular bone. The glenohumeral joint and rotator cuff appeared normal. He was then referred to the orthopaedic team for review.

On the day of referral, he underwent an urgent open washout of the left shoulder, via a deltopectoral approach. The glenohumeral joint was not opened, as MRI clearly demonstrated no intra-articular involvement. There was no evidence of acromioclavicular joint involvement intraoperatively. A large subacromial-subdeltoid collection was washed out, with 6 litres of normal saline and a drain placed in the subacromial-subdeltoid space. Samples obtained intraoperatively cultured *S. aureus*, sensitive to flucloxacillin and fusidic acid. Intravenous antibiotic therapy was continued for a further 10 days, followed by 5 weeks of oral therapy. He responded favorably to his course of treatment. He became afebrile on the first postoperative day, and the C-reactive protein promptly decreased to 31 mg/l on postoperative day 12.

**Case History 3**

An 11-year-old male adolescent presented to the Emergency Department with a 4-day history of acute onset right shoulder pain and reduced range of movement. There was no history of trauma and no significant past medical history. On examination, the patient was hemodynamically stable, with a temperature of 37.8° C. There was no obvious effusion in the shoulder joint and no overlying skin erythema. Marked tenderness of the acromioclavicular joint was present. Range of movement was limited by pain. Cardiovascular and respiratory examinations were unremarkable, and a urine dipstick was negative.

Laboratory investigations were as follows: C-reactive protein...
protein, 166 mg/l; white blood cell count, 7.50 x 10^9/l; and neutrophil count, 5.36 4 x 10^9/l. Plain radiographs of the shoulder and acromioclavicular joint showed no abnormality. Ultrasound examination was performed on admission by a senior specialist registrar, showing no glenohumeral or acromioclavicular joint effusion (Fig. 2). The images were reviewed by a musculoskeletal consultant radiologist the following morning and deemed normal. A provisional diagnosis of osteomyelitis of the distal clavicle was made. Blood cultures were taken and empirical broad spectrum antibiotics were commenced.

The following morning, there had been no clinical improvement despite broad spectrum antibiotics. Therefore, the shoulder was further imaged with MRI and demonstrated an effusion in the glenohumeral joint, with abnormal signal in the subscapularis and infraspinatus consistent with reactive inflammatory changes (Fig. 3). Simultaneously, blood samples cultured S. aureus, sensitive to flucloxacillin and fusidic acid. The intravenous antibiotic regimen was altered accordingly, and the patient underwent urgent arthroscopic washout of the glenohumeral joint.

Intraoperatively, the joint contained pus, with no evidence of chondrolysis. The joint was washed out with 5 litres of normal saline. Postoperatively, the patient remained afebrile, and, by day 4, had regained full functional use of the shoulder. His C-reactive protein had dropped to 26 mg/l. Intravenous antibiotics were continued for 1 week and orally for a further 5 weeks. The patient made an uneventful recovery.

### Discussion

Localizing infections around the shoulder is challenging. A good history and accurate clinical examination, along with hematological and biochemical inflammatory markers, will produce a differential diagnosis of infection. This clinical suspicion should then be confirmed with further investigation.

Plain radiographs will rule out most bony traumatic causes of acute shoulder pain. Ultrasound is a useful tool, as it is noninvasive, inexpensive, and widely available. There are no contraindications to diagnostic ultrasound. Ultrasound can localize the site and extent of a collection, give information about the nature of contents of the collection and guide aspiration, drainage, or biopsy. A normal ultrasound examination normally has a strong negative predictive value.
for septic arthritis.4

However, ultrasonography can be technically difficult in both obese patients and the very young. It is highly operator-dependent and challenging to even an experienced radiologist.5 Additionally, the painful shoulder poses further technical difficulties, as the range of movement of the joint required to obtain optimal images is usually severely restricted. Ultrasound does not give information about bony involvement and can underestimate the extent of spread of collections along tissue planes.5 Therefore, it follows that preoperative planning based solely on ultrasound findings may be suboptimal.

In Case 1, a subacromial-subdeltoid abscess gave a false impression of intra-articular glenohumeral septic arthritis, due to extension anteriorly into the plane between the subscapularis and pectoralis minor (subacromial-subdeltoid abscess can also extend posteriorly into the supraspinous fossa).3 As a result, the uninvolved glenohumeral joint was surgically opened, placing the patient at risk of iatrogenic septic arthritis and its potential complications. If the images obtained by ultrasonography are suboptimal, without the whole shoulder girdle being fully assessed, confirmatory investigations should be performed. In the adult or anaesthetized child, we recommend glenohumeral needle aspiration. This will confirm the presence and nature of any joint effusion while minimizing the risk of iatrogenic septic arthritis.

Case 2 highlights the importance of MRI in the undifferentiated “shoulder” infection following ultrasound identification of pathology. MRI provides excellent anatomic detail and has a 100% negative predictive value for excluding osteomyelitis.5 MRI can demonstrate the precise location and extent of a collection, particularly in areas inaccessible to ultrasound, such as the subacapular space.

Finally, Case 3 draws attention to the key role that clinical suspicion has in the diagnosis of infection around the shoulder joint. A surgeon must not rely on a negative ultrasound when dealing with a clinical picture that is failing to improve with conservative management. While ultrasound is a readily available and, thus, a useful screening tool, the advantages of MRI are undisputable. Therefore, we recommend ultrasound scanning as a first line imaging investigation for the acutely painful shoulder. Positive evidence of infection or inflammation on ultrasound, with confidently localized collections, may suffice in making the decision to operate as well as planning surgery. However, in those instances where ultrasound is negative but clinical suspicion remains high, or where the ultrasound findings are nonspecific but suggestive of regional inflammation or infection, MRI or joint aspiration should be considered. This would ensure accurate diagnosis and localization of infection, aid preoperative planning, prevent unnecessary surgical exposure of the glenohumeral joint, and avoid inappropriate arthroscopic approaches in instances where the subacromial-subdeltoid space is involved. Our algorithm for investigation of sepsis around the shoulder is shown in Figure 4.

Despite these recommendations, we appreciate that there are very few departments that offer a true 24/7 MRI service for such cases and, consequently, a high index of clinical suspicion must justify operative management over delayed imaging in some instances.

Disclosure Statement
None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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