Chapter 4
Radiological Investigations

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Radiological studies of the shoulder can assist in the diagnostic pathway in a wide variety of conditions. The appropriate imaging studies will depend on the nature of the suspected pathology, and the correct radiological investigation should be guided by accurate clinical history and examination. Plain X-ray is frequently the initial imaging investigation of choice, with more advanced imaging techniques e.g. ultrasound, MRI and CT selected, dependent upon the clinical and plain X-ray findings. This chapter aims to highlight and review the imaging modalities available to assess the various shoulder pathologies, describing their common indications as well as their clinical applications.

Plain X-ray

Plain film X-ray of the shoulder is the most commonly performed initial imaging investigation in patients presenting with shoulder trauma or chronic symptoms including pain, weakness and instability. It is useful to diagnose or exclude common shoulder pathologies, including fractures and dislocations in the context of acute trauma, or arthritic and degenerative changes in the context of patients presenting with chronic shoulder pain.

There are three commonly acquired X-ray views: anteroposterior (AP), lateral view of the scapula and an axial view (taken from inferior to superior or superior

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and inferior with the arm in an abducted position). Modified views may need to be performed when the patient cannot move the arm particularly in the context of trauma and severe a result of trauma or pain.

Impingement and Rotator Cuff Tears

While plain X-ray cannot diagnose impingement or rotator cuff tears directly, there are useful secondary signs which should be reviewed as an adjunct to the clinical diagnosis.

Morphological changes in the shape of the acromion may have an association with impingement or rotator cuff tears, although such associations are not universally accepted. The most commonly described variations in acromion shape are lateral downsloping of the acromion (seen on the AP view) and variations of the curvature in the undersurface of the acromion as seen on the lateral scapular view or sagittal MRI sequence. Three morphological appearances to the acromion process were described by Bigliani [1]; Type I (flat undersurface), Type II (curved/concave undersurface), and Type III (anterior hook-shaped). Type III is said to have an increased association with impingement and rotator cuff tears, although other authors have not found a clear association. The presence of an unfused os acromiale is also important in the context of impingement and should be identified on imaging which aids the surgeon in operative planning.

Acquired degenerative changes are also important. Acromioclavicular joint (ACJ) osteoarthritis is common and can be a significant additional pain generator as well as associated inferior osteophytes which may be implicated in impingement to the rotator cuff. Degenerative cystic changes in the humeral head give an assessment of overall severity of the disease process.

In cases with advanced rotator cuff tear, the supraspinatus tendon tears and retracts, allowing the humeral head to migrate superiorly, thus narrowing the normal acromio-humeral distance. When this subacromial space is severely narrowed or obliterated, osteoarthritis type change can develop between the superior margins of the humeral head and the undersurface of the acromion. This is often associated with glenohumeral joint (GHJ) osteoarthritis (Fig. 4.1). This condition is known as ‘rotator cuff arthropathy’ and signifies an irreparable rotator cuff [2].

Arthritis

Osteoarthritis

Primary osteoarthritis of the GHJ is less common than secondary degenerative changes associated with rotator cuff disease, or ACJ osteoarthritis. As in other joints, the typical findings of osteoarthritis are osteophyte formation, subarticular

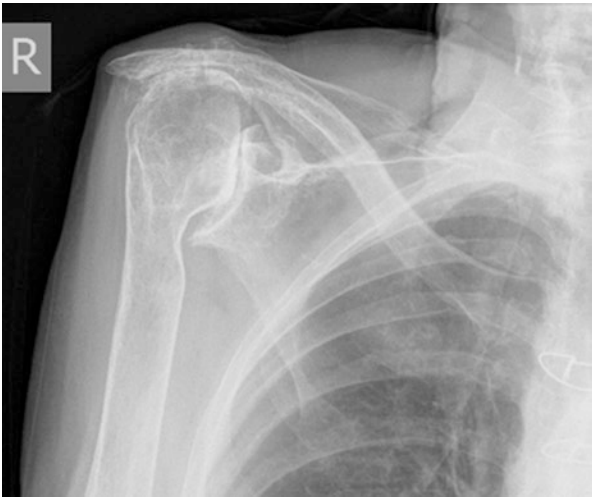

Fig. 4.1 X-ray rotator cuff arthropathy

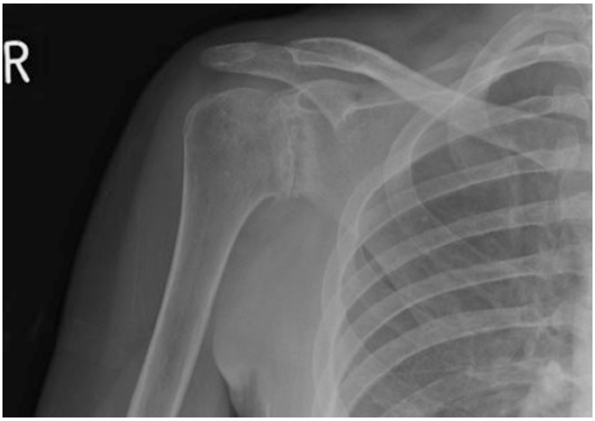

Fig. 4.2 X-ray glenohumeral osteoarthritis

sclerosis and joint space narrowing (Fig. 4.2). Subarticular cysts, or geodes, are often found. These defects, or erosions found in erosive arthritis, may be important quantitatively, as they can reduce the bone stock of the glenoid and it is, therefore, important to recognise in the context of surgical planning for shoulder arthroplasty.

Inflammatory Arthritis

The shoulder joint may be involved in inflammatory arthritides, particularly rheumatoid arthritis. This is a chronic multisystem disease which most commonly involves inflammation of the synovium with consequent bone erosion and cartilage loss. In the shoulder, the most common manifestations are marginal erosions within the humeral head and GHJ space loss. Erosion of the ACJ is common, particularly to the lateral clavicle. Also, there may also be associated rotator cuff tears.

Crystal Arthritis

Deposition of monosodium urate, calcium pyrophosphate or hydroxyapatite crystals may occur in or around the shoulder, although gout of the shoulder is uncommon. Of particular note is the condition Milwaukee shoulder syndrome. This is a condition of rapidly progressive and destructive arthritis, usually found in elderly women. It is uncommon but shows recognisable X-ray features with often gross bony destruction particularly in the humeral head and an effusion containing amorphous calcification. It is associated with hydroxyapatite crystals, although these are not necessarily causative [3].

Septic Arthritis

As with other joints, the X-ray is typically normal in the early stages of septic arthritis apart from possibly showing soft tissue swelling due to effusion. With the progression of any infection, bone demineralization and erosion with a destruction of the joint space can be seen.

Calcific Tendinitis

Calcific tendinitis results from the deposition of calcium hydroxyapatite crystals within the substance of the rotator cuff tendons, most commonly supraspinatus. The condition is typically encountered in the fourth and fifth decades and is usually self-limiting, as the calcification is resorbed spontaneously. However, the condition is often painful and may last for months or even years. X-ray shows a focus of calcification within the rotator cuff tendons, usually supraspinatus (Fig. 4.3). This may be well-defined, but can be ill-defined if there is extravasation into the overlying subacromial bursa.

Other Conditions

Instability

Assessment of instability often requires advanced imaging and in particular MRI or MRI arthrogram investigations. The X-ray should be reviewed for signs of glenoid fracture e.g. bony Bankart lesions, and humeral head fractures, particularly Hill-Sach's defects, which represent the consequence of previous dislocations. An axial

Fig. 4.3 X-ray calcific tendonitis

plain X-ray view of the shoulder can identify subtle displacements in position of the humeral head in relation to the glenoid.

Adhesive Capsulitis (Frozen Shoulder)

Often, a plain X-ray of the shoulder is normal in cases of adhesive capsulitis; the usefulness is to exclude any alternative causes e.g. Osteoarthritis, calcific tendinitis or even tumours.

Ultrasound and MRI may show non-specific features such as thickening of the coracohumeral ligament, and MRI may show besides, thickening to the inferior joint capsule at the inferior axillary recess, pericapsular oedema, and soft tissue thickening/scarring within the rotator interval, but ultimately the diagnosis is often made clinically.

Ultrasound

Musculoskeletal ultrasound is most commonly used to assess tendon pathology and to look for and describe excess fluid or abnormal fluid collections. Its use in the shoulder is no exception; ultrasound is commonly used to evaluate rotator cuff abnormalities and biceps tendon pathology, and fluid collections such as effusions, bursal fluid collections and cysts [4]. It is sensitive in the diagnosis of rotator cuff calcification. Ultrasound can be used to guide injections and other treatments. In the context of the acute presentation, ultrasound can distinguish and guide the aspiration of fluid collections for potential infection.

Ultrasound is less useful in the context of pathology associated with dislocation or instability; labral or SLAP tears will not usually be seen. While abnormalities have been described related to adhesive capsulitis, ultrasound will not typically add to the clinical assessment of this condition [5].

Ultrasound is a rapid examination which is performed with clinical correlation and can be used as an adjunct to clinical examination. Unlike other imaging modalities, a dynamic examination can be performed. While MRI provides a more global assessment of the shoulder and surrounding soft tissues, ultrasound is less time consuming and can give an answer to a focused clinical question which can be as accurate as with MRI.

Indications for Ultrasound

1. Assessment of rotator cuff pathology

   Advantages

   – Accurate assessment of rotator cuff tears
   – Quick examination; can be performed at the time of initial clinical assessment.
   – Dynamic assessment possible (e.g. assessment of impingement)

   Disadvantages

   – ‘Operator dependent’- ultrasound images cannot be optimally reviewed independently afterwards, so the examination is dependent on the operator’s interpretation.
   – Less accurate than MRI in diagnosing and grading muscle atrophy.
   – Cannot assess intra-articular or intrinsic bony pathology.
   – The examination may be limited if patient shoulder range of movement is reduced.

2. Assessment of long head of biceps tendon pathology

   – Can readily diagnose biceps tendon tears and dislocations.
   – The whole biceps tendon and muscle can be assessed if necessary.

3. Assessment of calcific tendinitis.

   – Ultrasound is the most sensitive imaging modality for calcific tendinitis.
   – Can be used to guide therapeutic injections e.g. Barbotage procedures

4. Assessment of instability and labral pathology.

   – Not useful in the intra-articular assessment of ligaments, labrum and articular chondral surfaces.

5. Assessment of fluid collections around the shoulder.
   - Accurate in the diagnosis of effusions, fluid in the subacromial/subdeltoid bursa and other fluid collections around the shoulder.
   - Can be used to guide aspirations.
6. Ultrasound-guided interventional procedures. Common procedures include
   - Injection of subacromial/subdeltoid bursa with steroid and local anaesthetic.
   - ACJ and/or GHJ injections.
   - Suprascapular nerve block or ablation.
   - Injection of calcific tendinitis.
   - Aspiration of collections where infection is suspected

Clinical Uses of Ultrasound

Impingement and Rotator Cuff Tears

Ultrasound of the shoulder in patients presenting with impingement or rotator cuff tears is often undertaken when the patient has failed to respond to initial conservative management including physiotherapy and possibly injections. A high-frequency linear array transducer is used. A full description of the technique of ultrasound is beyond the scope of this book; briefly, the long head of biceps tendon is usually examined first with the arm in a neutral position. The subscapularis tendon is assessed with the arm in external rotation, while the supraspinatus is examined with the humerus in extension and internal rotation. These changes of movement bring the relevant tendon anterior to the humeral head, where they can be examined clear of the acromion and clavicle. The ACJ is examined, and the muscle bellies, particularly supraspinatus, are reviewed to assess for atrophy [6]. Dynamic examination for impingement involves scanning while abducting the arm to assess for thickening or bunching of the subdeltoid bursa as it passes under the coracoacromial ligament.

A full-thickness cuff tear is a defect in the tendon which extends, at least for a small area, across the height of the tendon from the articular side to the bursal aspect of the tendon. Small full-thickness rotator cuff tears are seen as small defects in the rotator cuff tendon or subtle loss of the normal convexity of the bursal surface of the tendon. In large rotator cuff tears with tendon retraction, the supraspinatus tendon may appear absent with the deltoid muscle almost apposing or sagging upon the humeral head. Rotator cuff tears most commonly start in the supraspinatus tendon and may extend into the other rotator cuff muscles particularly infraspinatus and subscapularis. Assessment for subscapularis tears is of particular importance, as this may alter the surgical approach as well as becoming an increasing recognition for morbidity and failed shoulder surgery.

Partial-thickness tears are identified as a defect in the tendon that does not extend across its complete width. In rotator cuff tendinopathy, the tendon will be thickened and amorphous, with loss of the normal low signal and striated tendon pattern. Increased Doppler flow may be seen.

Ultrasound is accurate in the assessment of full-thickness tears, with a sensitivity of 92% and specificity of 93% in a recent meta-analysis [7]. This is compatible to MRI. Ultrasound is less sensitive than MRI in the detection of partial-thickness rotator cuff tears, but with similar specificity. (Ultrasound: Sensitivity 52%, specificity 93%. MRI: Sensitivity 74%, specificity 93%).

Biceps Tendon Pathology

The long head of biceps tendon is easily visualised within the bicipital groove. In a complete tear of the long head of biceps tendon, the tendon will not be seen in the bicipital groove; the retracted end can be identified by scanning inferiorly. High-grade partial-thickness tears may be difficult to distinguish from a complete tear. The long head of biceps may sublux or dislocate from the bicipital groove; in this case, the tendon will be identified medial to its normal site and is classically seen in the context of full-thickness subscapularis tendon tears with disruption to the overlying transverse humeral ligament. Partial-thickness tears will be seen as~~a~~ focal hypoechoic areas within the tendon. Fluid in the biceps tendon sheath may indicate tenosynovitis of the tendon or may be part of generalised GHJ effusion.

Calcific Tendinitis

In calcific tendinitis of the rotator cuff, calcification most commonly occurs within the supraspinatus tendon but may happen in other rotator cuff tendons. The presence of calcification is readily identified on ultrasound scanning, which is more sensitive than X-ray. Calcific tendinitis presents on ultrasound as calcification at any site in the body; usually an echogenic ‘line’ with ~~a~~ posterior acoustic shadowing (ultrasound artefact).

Ultrasound-Guided Injections

Injections can be performed under ultrasound guidance; the transducer is held in one hand while injecting with the other. By scanning in the correct plane, the needle tip can be seen to advance in ‘real-time’ while scanning. Thus the tip of the needle can be placed in a fluid collection or effusion for aspiration for biochemical or microbiological analysis, or an injection of local anaesthetic for diagnosis or of steroid for treatment can be made into the intended site under direct visualisation.

Ultrasound-guided injections are commonly given into the subacromial space, bicipital tendon sheath, GHJ or ACJ. The suprascapular notch can be identified on ultrasound, and the suprascapular nerve can be injected with local anaesthetic and steroid for diagnosis and temporary pain relief (suprascapular nerve block) [8] or permanently ablated using pulsed radiofrequency ablation, particularly in the context of rotator cuff arthropathy.

Ultrasound can be used to guide treatment of calcific tendinitis. An attempt can be made to aspirate the calcified deposits, or the calcification can be ‘dry needled’ by passing a needle through the calcification with several passes. This is to attempt to break up the calcification which may encourage healing by promoting a localised inflammatory/vascular response leading to an earlier reabsorption of the calcification than would spontaneously occur. Ultrasound-guided needling and lavage have been shown to give significantly better results than a subacromial corticosteroid injection only [9].

Magnetic Resonance Imaging (MRI)

Magnetic resonance (MR) imaging provides a comprehensive and accurate assessment of the osseous and soft tissue structures involving the shoulder [10]. Standard radiography is often used as a primary imaging modality to assess the osseous anatomy of the shoulder however its limited capability to evaluate the soft tissues often leads to MR imaging being utilised.

Conventional MR imaging is used to characterise a range of conditions from rotator cuff disease and acromioclavicular (AC) joint pathology in impingement disorders to glenoid labrum pathology and the capsular structures in instability utilising contrast-enhanced MR arthrography.

Protocols for Imaging of the Shoulder

- Patient’s arm should be positioned with patient supine and the arm by the side parallel to the body with the shoulder in neutral to mild external rotation.
- Coronal oblique images are performed parallel to the course of the supraspinatus tendon.
- Coronal oblique Proton Density Fat-Suppressed sequences are sensitive to rotator cuff degeneration although it can be difficult to differentiate between severe cuff tendinosis and partial-thickness tears
- Coronal oblique or sagittal oblique T2 sequences are required to distinguish between severe tendinosis and partial tears with the presence of fluid high signal.
- Axial sequences are used to assess the AC joint, as well as capsular and labral anatomy.

- Sagittal oblique sequences are used to evaluate the acromial anatomy, rotator interval, the cuff muscles and the capsulolabral complex.

MRI Arthrography

The procedure involves the instillation of dilute gadolinium-based para-magnetic contrast agent to distend the glenohumeral joint via needle placement under fluoroscopic or ultrasound guidance.

- Typically T1, proton density or T2 fat-suppressed sequences may then be performed using axial, coronal oblique and sagittal oblique sequences.
- An additional abduction external rotation (ABER) view can be utilised in MR arthrography to evaluate for labral tears or in the integrity of the post-operative labrum.

Indications for MRI

1. Assessment of rotator cuff and long head of biceps pathology and tears.

   Advantages:

   - Accurate assessment of rotator cuff tendinopathy, partial-thickness and full-thickness tears.
   - Accurate assessment of biceps tears and dislocations.
   - Atrophy and fatty infiltration of rotator cuff muscles can be readily viewed and graded.
   - Underlying bone and intra-articular pathology can be assessed.

   Disadvantages:

   - Relatively expensive and time-consuming procedure.
   - Some patients cannot be scanned as a result of claustrophobia.

2. Assessment of instability and labral or articular cartilage defects.

   - Accurate assessment of labral and cartilage defects, including SLAP tears
   - Assessment of underlying bony pathology.

Currently, in most centres, assessment of labral pathology and SLAP tears requires intra-articular contrast injection, turning a non-invasive examination into a minimally invasive study. More powerful magnets (3 T and above) may obviate the need for intra-articular injection in the future.

3. Assessment of bone tumours and infections.

   - The most accurate imaging modality for assessing the extent of the pathology.

Clinical Uses of MRI

Rotator Cuff Tears

MRI offers a detailed, global and accurate assessment of the shoulder in cases of impingement and suspected rotator cuff tears. Full-thickness rotator cuff tears can be accurately diagnosed and characterised, and distinguished from partial-thickness rotator cuff tears and tendinopathy (Fig. 4.4). Rotator cuff muscle atrophy is seen, and its severity can be graded (Fig. 4.5). Causes of impingement can be assessed; the presence of acromion and AC joint osteophytes and the assessment of acromion morphology are useful in the planning of surgery. Tears, tendinopathy and tenosynovitis of the biceps tendon are also well seen. Underlying bone pathology and arthritis will also be visualised to advantage on MRI scanning.

MRI and ultrasound can both be used to assess for rotator cuff tears. Compared with ultrasound, MRI offers an overall view of the shoulder and surrounding soft tissues. MR is also better at evaluating the rotator cuff muscles for atrophy than ultrasound, while ultrasound can be performed alongside clinical assessment, and offers an excellent opportunity for dynamic evaluation of the shoulder.

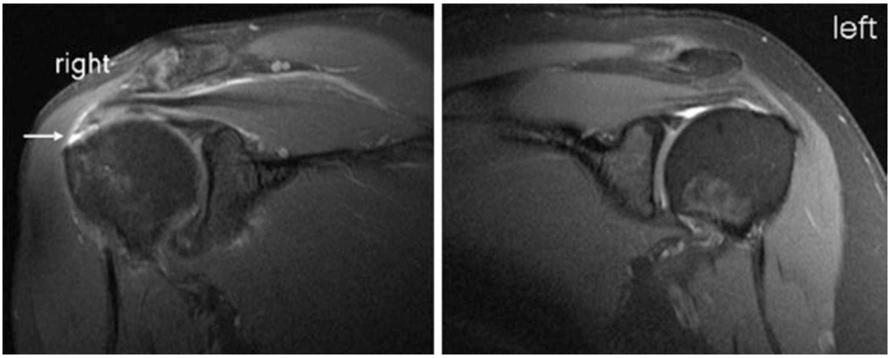

Fig. 4.4 MRI rotator cuff tear

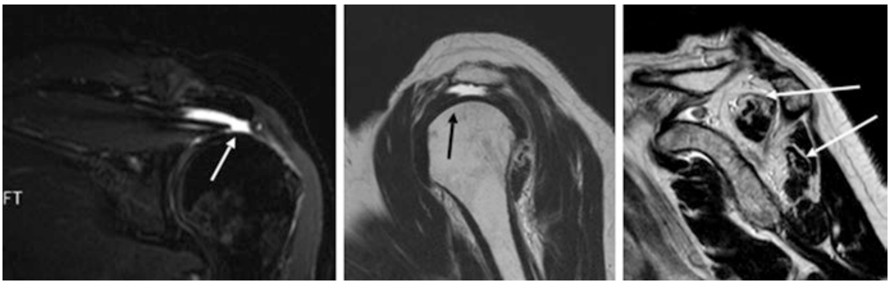

Fig. 4.5 MRI large rotator cuff tear with wasting and atrophy

Cochrane review [7] shows sensitivity and specificity of 94 and 93% respectively for full-thickness tears on MRI. For partial-thickness tears, the sensitivity and specificity values were 74 and 93% respectively. MR arthrography can also be used to assess for rotator cuff tears. While the images may give improved detail compared with plain MRI, the Cochrane review shows no significant advantage in the sensitivity and specificity, and for this reason, plain MRI is usually preferred to assess for rotator cuff pathology.

Instability

Injection of dilute paramagnetic contrast into the shoulder joint before MRI (MR arthrography) distends the shoulder joint and allows clear visualisation of the internal soft tissue structures of the shoulder joint which are sometimes not clearly distinguished on plain MRI [11]. Thus the articular cartilage, glenoid labrum, capsular ligaments and rotator interval are better assessed with MR arthrography.

In patients with instability, tears of the glenoid labrum, articular cartilage and capsular ligaments can be diagnosed and described before consideration of surgery (Fig. 4.6). Studies have shown that MR arthrogram is significantly more accurate in assessment of labral tears than plain MRI. Underlying bony glenoid and humeral head defects can readily be seen. MR arthrogram studies can be used to assess for associated rotator cuff tears, and it has been suggested that partial-thickness rotator cuff tears may be more easily identified in the younger age group with MR arthrograms. Contrast outlines the biceps and bicipital-labral complex to also aid in the detection of superior labral anterior to posterior (SLAP) lesions (Fig. 4.7). MRI arthrography can also be used to assess symptomatic recurrence in the shoulder previously operated for instability.

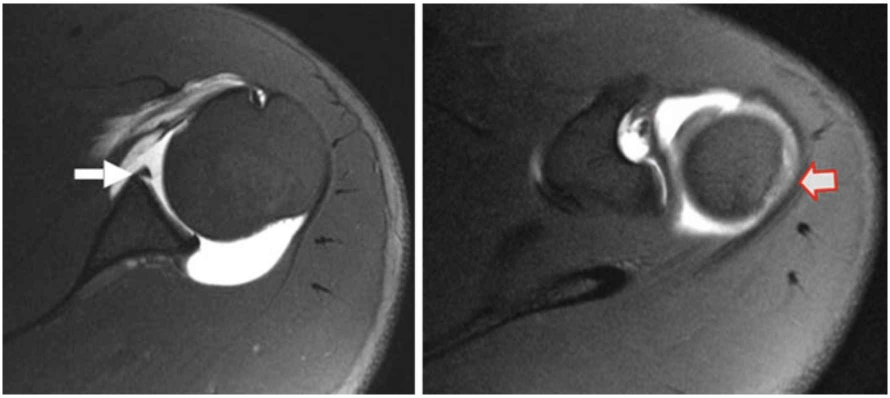

Fig. 4.6 MRA glenoid labral tear and Hill Sachs defect

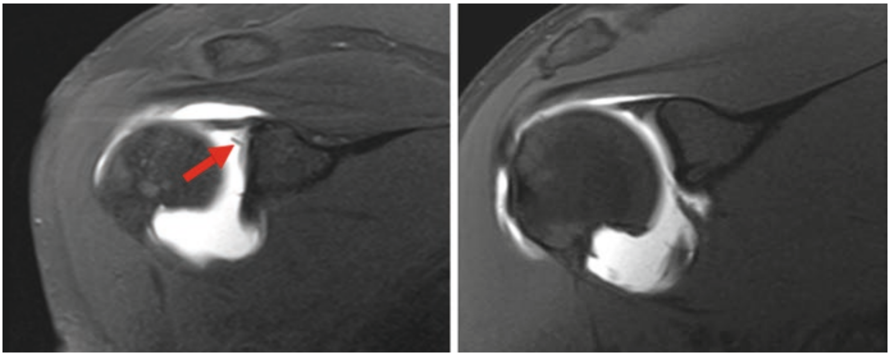

Fig. 4.7 MRA superior labral tear (**a**) compared with normal (**b**)

Other Clinical Indications

- MRI can be used to diagnose, describe and characterise bone and soft tissue tumours around the shoulder.
- The assessment of infections around the shoulder joint; to distinguish fluid collections from inflammation, and to assess for the presence of osteomyelitis
- In cases of complex osteoarthritis or inflammatory arthritis where X-ray does not give sufficient information. MRI is particularly useful in the assessment of effusions, fluid collections and bony involvement.

CT

CT (Computed Tomography, Computerised Tomography) involves passing X-ray beams at different angles through the patient in an axial 'slice'. The X-ray source continually rotates around the patient as the patient is moved through the scanner. X-raying the patient at multiple different angles allows the data to be reconstructed to give a density at each point (pixel) so that a 3-D picture can be obtained.

Images are usually displayed as successive 2-D 'slices' to build up a 3-D image. Modern multislice CT scanners produce images with a very thin (0.5 or 1 mm) slice thickness, enabling coronal, sagittal or oblique reconstructions to be made from the axial data with minimal loss of resolution. 3-D reconstructions can also be obtained, using all the data from the scan to produce a 3-D image which can be rotated to view from any angle.

As CT is an X-ray based imaging modality, the greatest advantage and most common use in orthopaedic imaging is to assess bony pathology. Bone outline, bony trabeculae and joint surfaces are easily visualised with high spatial resolution because of the inherent density difference between bone and other tissues. In general, there is a low difference in density between different soft tissues, and soft tissue pathology is less well visualised than on ultrasound or MRI. However intravenous iodine-based contrast administration can help particularly when MRI is contraindicated, and intra-articular contrast can be used as an alternative to MRI arthrogram to study cartilage defects and labral tears.

Indications for CT

1. Fractures. 3-D assessment of complex fractures and dislocations.
2. Arthritis. Assessment of glenohumeral arthritis and rotator cuff arthropathy preoperatively.
3. Instability. CT arthrogram can be used instead of MRI arthrogram to assess labral and bony defects.
4. Rotator cuff disease. Useful to evaluate the bony anatomy and fatty infiltration/atrophy of the rotator cuff musculature, but not helpful in the diagnosis of rotator cuff tears.

Clinical Uses of CT

Fractures

CT is ideally suited to give precise 3-D representation in cases of complex fractures and dislocations (Fig. 4.8). Healing of fractures can be studied with CT scanning; the degree of callus formation and bone union can be assessed in detail.

Fig. 4.8 CT 3D reconstruction of a scapula fracture

Arthritis

CT gives a detailed image of articular surfaces, showing joint space narrowing and subarticular erosion associated with arthritis. Glenohumeral, A/C joint arthritis and rotator cuff arthropathy can be assessed. CT scanning is most commonly used before shoulder surgery and in particular joint replacement. Review of glenoid bone stock is necessary preoperatively to evaluate the feasibility of glenoid prosthesis implantation and technical planning. This cannot be achieved on plain X-ray but is easily visualised on CT.

Symptomatic shoulder joint replacements can also be assessed with CT. Beam hardening artefact degrades the image a standard CT, but utilisation of extended Hounsfield unit scale and metal artefact reduction post-processing software should be used to give images where, for example, subtle loosening can be seen right up to the edge of the metallic prosthesis [12].

Instability—CT Arthrogram

Contrast medium is injected into the shoulder before a standard CT scan examination. The contrast distends the joint and outlines the articular cartilage, fibrocartilaginous labrum and glenohumeral ligaments. This allows defects in the structures, including labral and SLAP tears to be diagnosed and characterised. CT arthrography can be used as an alternative to MRI arthrography, with CT having the advantage of greater spatial resolution as opposed to the higher contrast resolution of MRI. CT is particularly useful in assessing the postoperative labrum, where MRI might be degraded by metal artefact. CT is also the preferred choice to evaluate the integrity of bone stabilisation procedures.

Rotator Cuff Disease

CT is not accurate in the assessment of rotator cuff tendon tears, and MRI or ultrasound should be used for this purpose. However, CT may be useful, especially when MRI is contraindicated, to assess the rotator cuff muscles for atrophy in cases of rotator cuff tears. The Goutallier classification, commonly used to determine the degree of degeneration and fatty infiltration of rotator cuff muscles in the context of rotator cuff tears, was initially described in shoulder CT but is also applicable to MRI [13].

Other Bony and Soft Tissue Pathology

CT gives explicit detail of bony erosion or destruction in cases of infection or tumour. The glenohumeral joint and scapula can be assessed in cases of dysplasia, particularly to look for the glenoid area, depth and version.

As discussed above, CT of the soft tissues is limited by the inherent lack of contrast, but masses and fluid collections can be assessed with the aid of intravenous iodinated contrast enhancement. However, MRI or ultrasound is preferred.

Nuclear Medicine

Nuclear medicine techniques involve injecting small amounts of radioactive substances, often bound to biologically active molecules. The gamma photons produced by the radioactive isotope are detected in the gamma camera with a crystal constructed of sodium iodide.

Technetium (Tc) 99 m MDP bone scintigraphy is the traditional isotope scanning technique to assess for increased osteoblastic activity and has been in use since the 1960s. Increased activity will be detected in bone tumours, infections, fractures, arthritis and other forms of increased metabolic activity such as Paget's disease. The investigation is, therefore, sensitive, but not specific.

Nuclear medicine imaging with^{111}Indium-Oxide or more recently anti-granulocyte scintigraphy using (99 m)Tc-labeled monoclonal antibodies (MoAb) provide a high degree of specificity in imaging osteomyelitis. In a patient presenting with chronic shoulder symptoms (pain, weakness or instability) nuclear medicine imaging does not have a place on the diagnostic workup unless an infection is suspected.

Conclusion

There is a broad range of imaging techniques available to investigate patients with shoulder pain, weakness and instability. The initial radiological investigation will usually be with a plain X-ray. Further studies—ultrasound, MRI, MRI arthrogram and CT scanning—will be dependent on the clinical presentation and the information required from the scan. This chapter has given an introduction to the different imaging modalities, their indications and the abnormal findings that can be seen with each technique. Specific imaging pathways will be further discussed in the relevant chapters to follow.

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