3 CT and CT Arthrography

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3.1 Introduction

In recent years the advent of MR imaging has reduced the utilisation of computed tomography (CT) in the assessment of shoulder diseases. Magnetic resonance imaging (MRI) has multiplanar capability and excellent tissue contrast that are helpful in the assessment of complex anatomic areas such as the shoulder region. CT, however, still remains useful in the evaluation of a variety of shoulder disorders.

In trauma, standard radiography is the first modality to be performed, but often superimposition of different bone structures compromises ability to evaluate the anatomic details. Although specialised projections can be obtained to accurately assess fractures and dislocations, these views can be difficult to achieve in traumatised patients due to movement limitation and pain. CT can be performed on patients in almost every clinical condition and enables an accurate evaluation of fracture fragments, subluxations, dislocations and loose bodies. Moreover, coronal and sagittal reformatted images as well as three-dimensional (3D) reconstructions ease interpretation of the CT images, especially to the referring clinicians. As a general rule, shoulder arthropathies, tumours and infections are best evaluated with MRI. Possible exceptions are osteoid osteoma, in which thin-slice thickness is necessary to demonstrate the nidus, and the assessment of sequestra in osteomyelitis. With the advent of spiral equipment, shoulder CT arthrography has regained popularity as a valuable and accurate modality to investigate rotator cuff tendons, joint capsule, ligaments and glenoid labrum as well as intraarticular loose bodies. Reformatted images can be obtained in any required plane and allow accurate evaluation of size and location of tendon tears as well as dislocation of biceps tendon. The use of thin collimation thickness yields an assessment of the details of capsuloligamentous lesions secondary to shoulder instability.

The aim of this chapter is to present the technical aspects and normal findings of CT and CT arthrography of the shoulder.

3.2 CT

3.2.1 Technique

The patient is examined in the supine position with the shoulder as close to the gantry centre as possible. The upper arm is positioned closely to the body and immobilised in neutral rotation by an elastic bandage. A small pad placed below the elbow and a pillow placed beneath the knees afford a more comfortable position for the patient. To minimise artefacts the opposite arm is abducted and rests above the patient’s head. Anteroposterior scanning radiograph is used to plan
the level of axial slices. In most patients a traditional acquisition is performed. Depending on the clinical history and on the goal of the examination, slice thickness can vary from 1 to 6 mm. For most patients 2–4 mm thick, contiguous sections reconstructed with bone or soft tissue algorithms are appropriate. If two-dimensional (2D) and 3D reconstructions are needed, a spiral acquisition with small thickness acquisition (1–2 mm), pitch of 1, and reconstruction thickness permitting overlapping is performed. Slices from the acromioclavicular joint to 1 cm below the glenoid are obtained. A 25-cm field of view can usually image the scapula, proximal humerus and the lateral two thirds of the clavicle and permits satisfactory image resolution. Routine comparison images of the contra-lateral shoulder are not obtained.

For the evaluation of the sternoclavicular joint the patient is supine with both arms resting at the side of the trunk. Care must be taken to correctly position the patient inside the gantry to allow symmetrical images of the joints. On an anteroposterior scout view 1 mm axial slices are centred from 1 cm cranial to 1 cm caudal to the medial epiphysis of the clavicle. A 15 cm field of view centred on the midline allows good evaluation of both joints. Coronal reconstructions are obtained to show displacements in the frontal plane.

### 3.2.2 Results

CT can demonstrate the normal bone anatomy of the shoulder region. Cranially the lateral portion of the clavicle and anterior portion of the scapular spine, the acromion, constitute the AC joint. CT can readily diagnose an os acromiale, that results from a non-union of the distal ossification centre of the acromion with the posterior main centre, and evaluate its size. When present the os acromiale articulates with both the clavicle and the acromion and can be implicated in the pathogenesis of anterior impingement syndrome (Granieri and Bacarini 1998). More caudally the spine of the scapula and the coracoid process, respectively anterior and posterior to the glenohumeral joint, are imaged. The round surface of the humeral head and the oval and slightly concave glenoid cavity form the joint surfaces of the glenohumeral joint. The humeral surface is about twice the glenoid surface. The humeral head presents two lateral projections, the anteromedial lesser tuberosity (LT) and the posterolateral greater tuberosity (GT). Humeral torsion can be measured with CT by comparing an image obtained just below the coracoid process with an image obtained about 2.5 cm proximal to the interepicondylar line. Increased humeral torsion may predispose to recurrent glenohumeral joint dislocation (Dias et al. 1993). Between the two tuberosities the bicipes groove or sulcus is found.

The glenoid cavity is perpendicular to the body of the scapula. Glenoid retroversion can be associated with recurrent posterior glenohumeral instability. CT demonstration of retroversion can be useful in operative treatment (Wirth et al. 1994). The posterior glenoid rim appears rounded while the anterior one is pointed and thinner. Intraarticular structures can be hardly imaged by CT. The lax and redundant fibrous capsule is reinforced by the glenohumeral ligaments which insert into the humerus and into the fibrocartilaginous glenoid labrum. The labrum, which is attached at the edge of the glenoid fossa, is thought to increase joint stability. The anatomy of muscles and tendons surrounding the shoulder are easily assessed by CT. The rotator cuff is composed of four muscles which surround the glenohumeral joint. Anteriorly the subscapularis muscle is found between the anterior face of the scapula and the chest wall. Its tendon inserts into the internal aspect of the LT. The main function of the subscapularis muscle is adduction and internal rotation of the arm. The supraspinatus muscle, the main abductor of the arm, is located in the homologous bone fossa, delimited posteriorly by the spine of the scapula and anteriorly by the upper third of the body. The muscle continues in a tendon which inserts into the anterior portion of the GT. Posteriorly, inside the infraspinatus fossa, the infraspinatus and teres minor muscles are found. Both allow external rotation of the humerus. Their tendons insert into the middle and posterior facets of the GT respectively. Muscle fatty degeneration can be assessed by CT in the preoperative evaluation of rotator cuff tears. Five degrees of fatty degeneration were described depending on the amount of adipose infiltration of the muscle (Goutallier et al. 1994). A better patient outcome can be expected if surgical treatment of wide tears is made before irreversible muscular damage takes place. Although the degree of fatty degeneration was significantly related to the amount of atrophy of the respective muscles, CT degree of fatty degeneration correlate poorly with MRI findings (Fuchs et al. 1999). The long head of the biceps tendon originates from the muscle in the anterior aspect of the arm, lies inside the biceps groove and enters into the joint between the supraspinatus and subscapularis tendons (interval of the rotator cuff) to insert into the superior edge of the glenoid fossa. The deltoid muscle is separated from