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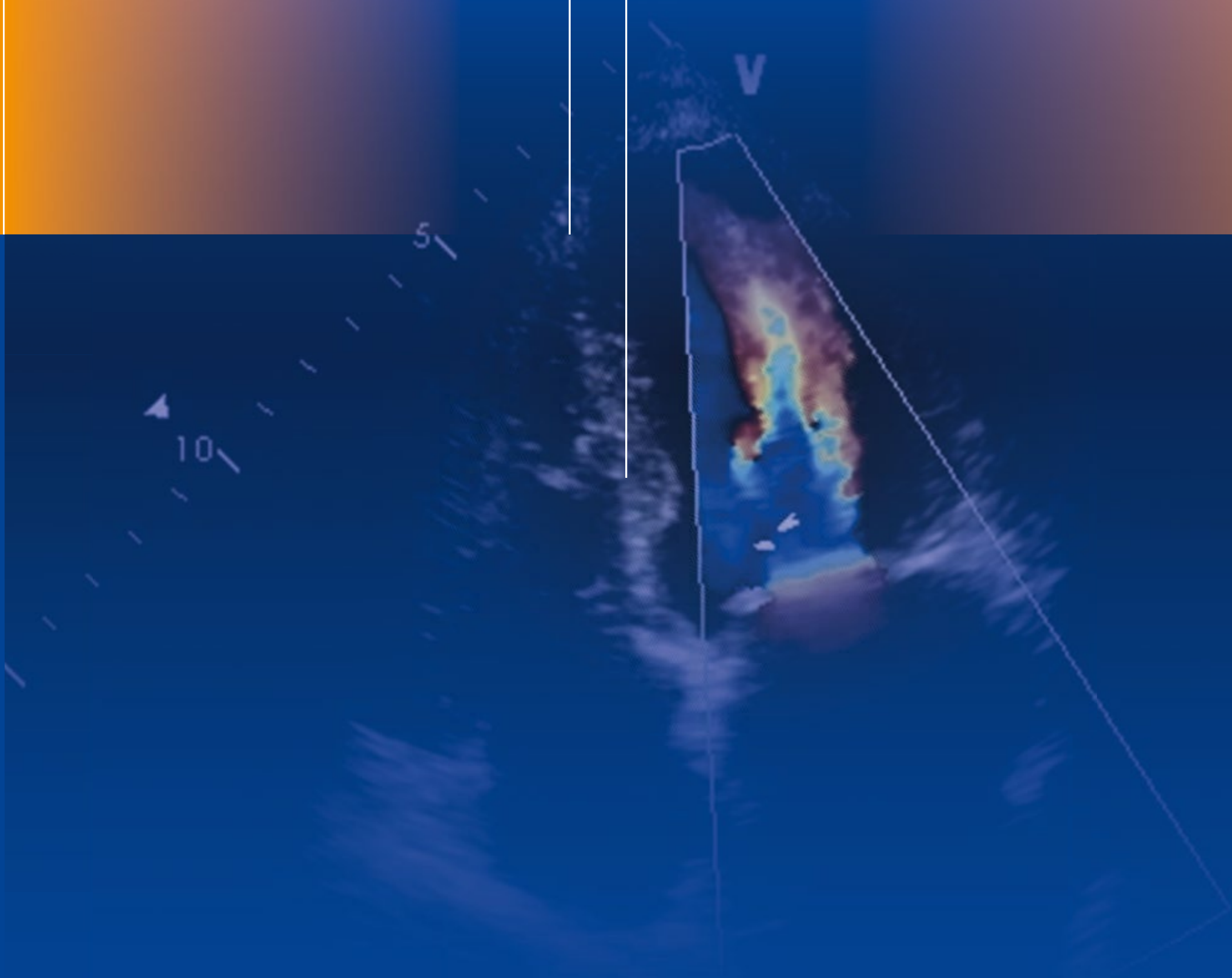
Atlas of Handheld Ultrasound



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Dedicated to the stethoscope on its retirement after 200 years of excellent service to the bedside cardiovascular examination

Preface

Tremendous strides in noninvasive diagnostic imaging have been made over decades in radiology, obstetrics, and cardiology. More recently, a revolution in bedside diagnosis has begun with the advent of point-of-care ultrasound. Now, clinicians can apply imaging to their own patients, in real time, to answer focused questions that will immediately impact their care.

The most recent generation of inexpensive, handheld ultrasound devices has taken this a step further—we are now firmly within the era of ultrasound availability for providers of all specialties. Thus, we have created this *Atlas of Handheld Ultrasound* to demonstrate the power of even basic organ assessments across the entire body.

Ultrasound is a force multiplier for the clinical assessment of patients, adding vital information to the history, physical examination, and other diagnostic testing available at the bedside. We hope the basic scan techniques and recognition of normal and pathologic states described here will inspire deliberate practice in improving the skill set of image acquisition and interpretation for an ever-growing number of providers.

We believe that it is time to add ultrasound imaging as a fifth vital pillar to the bedside examination. From now on it must be Inspection, Palpation, Percussion, Auscultation and INSONATION.

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Soft-Tissue Complaints

1

Errel Khordipour and Ee Tay

Soft-tissue complaints are common presentations in acute care environments. Ultrasound may assist in the diagnosis of soft-tissue findings, such as identifying cellulitis [1, 2], abscesses [3, 4], and foreign bodies [5, 6]. Most soft-tissue structures are readily visible on ultrasound, as they conduct sound waves well and are superficial. Ultrasound may guide procedures involving the skin and joints, such as incision and drainage, foreign body removals, and joint aspirations [7, 8]. While the use of bedside ultrasound for soft tissue is operator-dependent [9], it is easy to learn, readily available, affordable, and decreases overall time to diagnosis. In many cases it is an excellent alternative to X-ray, CT scan, or MRI (Figs. 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, and 1.10; Videos 1.1, 1.2, and 1.3).

Electronic Supplementary Material The online version of this chapter (https://doi.org/10.1007/978-3-319-73855-0_1) contains supplementary material, which is available to authorized users.

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Fig. 1.1 Select a high frequency (linear) probe for the evaluation of skin, subcutaneous tissue, fascia, muscle, and bone. Image courtesy of Errel Khordipour

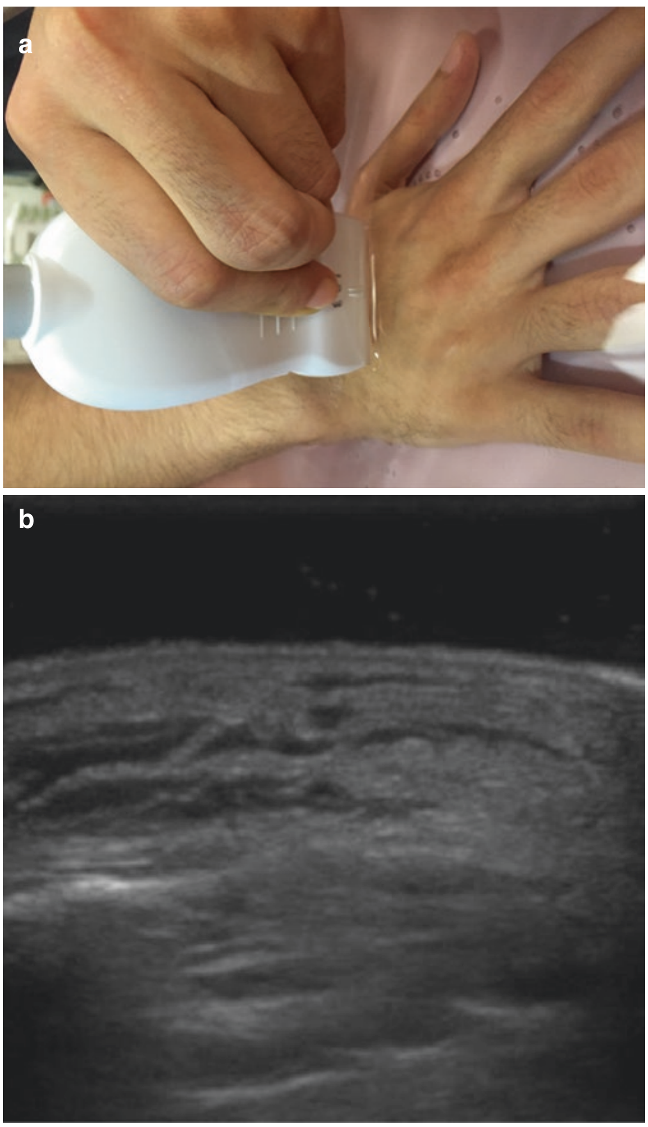

Fig. 1.2 (**a**, **b**) The water bath technique uses water as a medium to conduct sounds waves, similar to using gel during an examination. This is performed by immersing the extremity to be ultrasound under water. Consider using a water bath particularly when looking at hands and feet for abscess, cellulitis, foreign body, fracture, and evaluation of muscles and tendons. (**a**) Image courtesy of Errel Khordipour, (**b**) Image courtesy of Ee Tay

Fig. 1.3 A 100 mL saline bag may also be placed on top of the hand with gel on stop to be used an aqueous medium. Image courtesy of Errel Khordipour

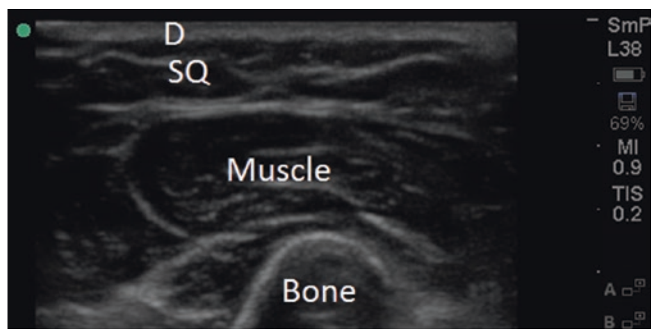

Fig. 1.4 The skin (D), both epidermis and dermis, will appear as a hyperechoic thin layer. The subcutaneous (SQ) layer has hypoechoic fat interspersed with hyperechoic linear echoes running parallel to the skin, which represent connective tissue septa. Veins and nerves may also be seen within this layer. Image courtesy of Errel Khordipour

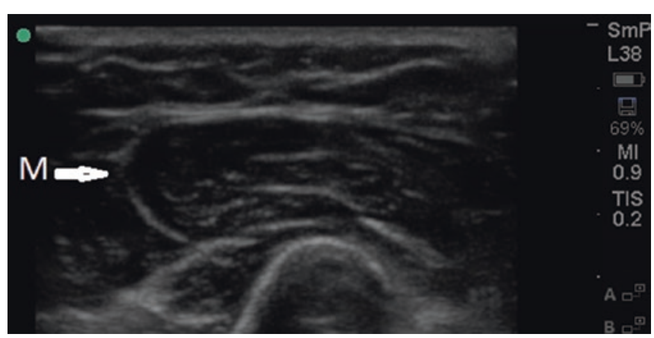

Fig. 1.5 Muscle fascicles can be visualized as hypoechoic cylindrical structures with hyperechoic connective tissue surrounding them. Image courtesy of Errel Khordipour

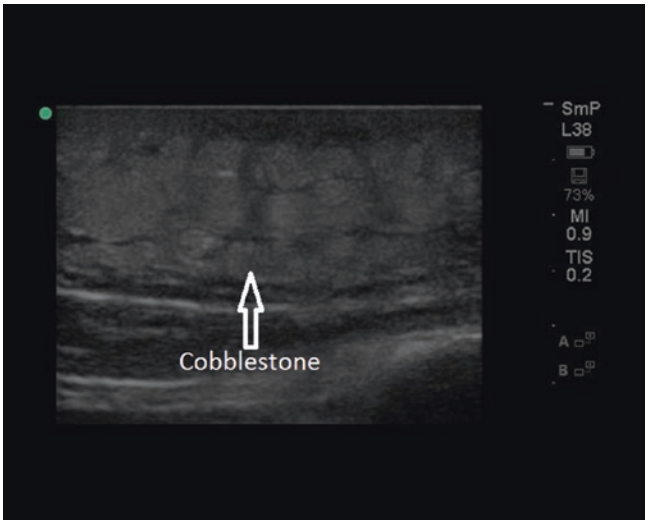

Fig. 1.6 Cellulitis can be differentiated form abscess by soft tissue ultrasound. Interstitial edema surrounding subcutaneous adipose is a hallmark of this disease and it is referred to as "cobblestoning." Although cobblestone appearance is common in cellulitis, it is advanced finding. Early cellulitis may appear as generalized swelling with increased echogenicity of the skin and subcutaneous tissues. Image courtesy of Ee Tay

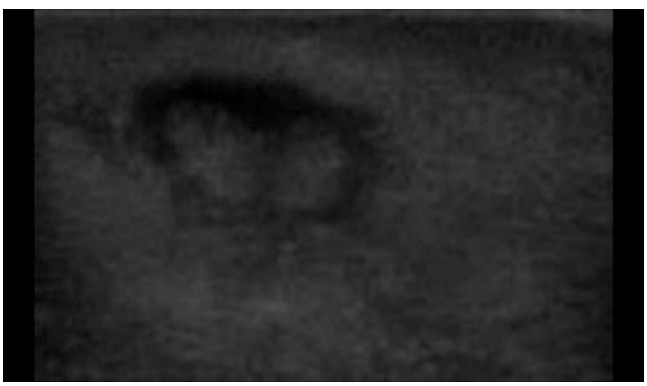

Fig. 1.7 Abscess has a characteristic spherical or elliptical shape with loosely defined margins. Within the abscess cavity, there may be a mixture of anechoic, hypoechoic and/or hyperechoic ultrasound findings. The abscess cavity can be compressed with the probe which may produce a swirling of the contents. It should be noted that absence of swirling does not rule out abscess (*see* Video 1.1). Images courtesy of Ee Tay

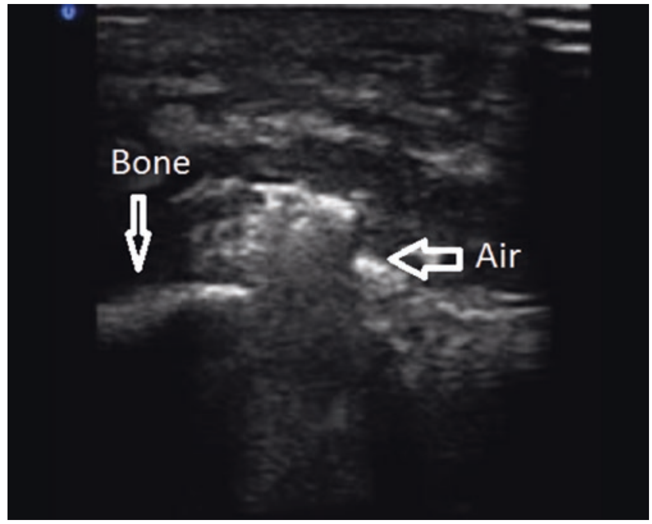

Fig. 1.8 Necrotizing fasciitis will appear as a thickened and distorted fascia with adjacent hypoechoic fluid colleting along the subcutaneous tissues of muscle. Small foci of gas can appear as well. A mixture of abscess, cellulitis and gas should strongly suggest this disease. Image courtesy of Jim Tsung (YouTube.com/Pocus4Geri)

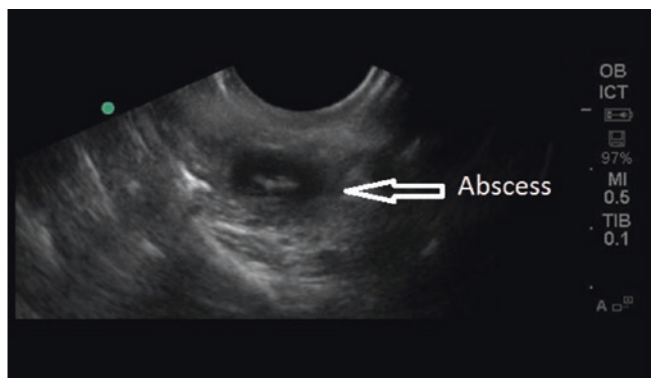

Fig. 1.9 For the evaluation of peritonsillar abscess you may decide to use the endocavitary probe. Place the probe inside the patient's mouth on top of the enlarged tonsil and fan toward the patient's head or cephalad with the head rotated to the opposite side. A linear probe may also be used to detect peritonsillar abscess in patients who have trismus and are unable to tolerate the probe inside the mouth. Look for similar findings as described above to distinguish abscess from cellulitis. Image courtesy of Ee Tay

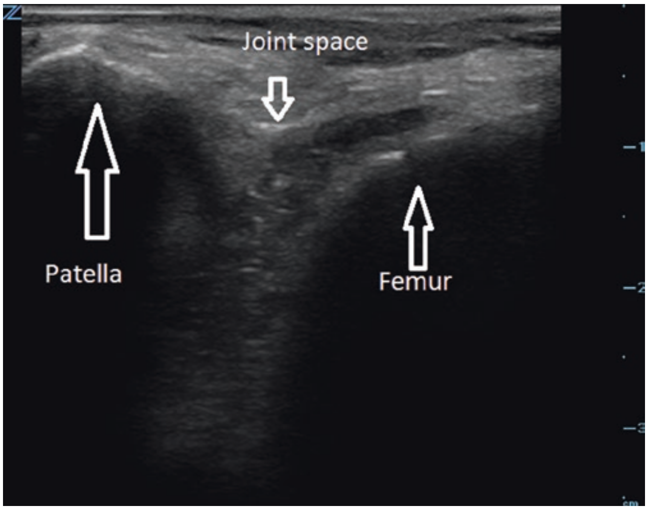

Fig. 1.10 In evaluating a knee or joint effusion, place the linear probe over the area of fluctuance. Ultrasound the contralateral side of the same area for comparison. Image courtesy of Errel Khordipour

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Shoulder

2

Laura S. Greenlund

The shoulder is a common site of pain, and point-of-care ultrasound is a very useful tool for examining the soft tissues surrounding the shoulder to determine its cause. Used along with physical examination, it compares well with more expensive and resource-intensive imaging [1, 2]. Typically, a linear mid-frequency (3–16 Hz) probe or curvilinear (1–7 Hz) probe is used. Depending on the site of pain and the mechanism of injury, different scanning techniques may be utilized. Ultrasound examination of the anterior, lateral, superior, or posterior shoulder will be used to visualize specific structures that are suspected to be injured, torn, arthritic, or inflamed (Figs. 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, and 2.12; Videos 2.1 and 2.2).

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Fig. 2.1 An anterior shoulder examination is performed using a linear probe with the patient in a seated position. The patient's hand is placed palm up in his or her lap, on the lateral thigh. The probe marker is directed toward the patient's body and the probe is moved from a position on the proximal shoulder at the top of the humeral head downward toward the biceps muscle while imaging

Fig. 2.2 Structures that are frequently painful or injured include the long head of the biceps tendon (B), which is visualized in the biceps groove between the greater tuberosity (GT) and lesser tuberosity (LT) of the humerus, and the subscapularis (Sb) tendon of the rotator cuff, which can be seen to the medial side. These are first examined in transverse view

Fig. 2.3 The long head of the biceps tendon (B) is then examined in the longitudinal view with the probe marker pointing upward, moving the probe from a superior to inferior position. The deltoid muscle (DL) is seen overlying the biceps tendon, and the humerus (H) is seen below

Fig. 2.4 A superior scan of the shoulder is performed if injury or arthritis of the acromioclavicular joint is suspected as the cause of pain. The linear probe is placed over the joint with the probe marker medial toward the clavicle (C) and the acromion (A) toward the lateral portion of the image. The coracoid process (CP) is palpable just below

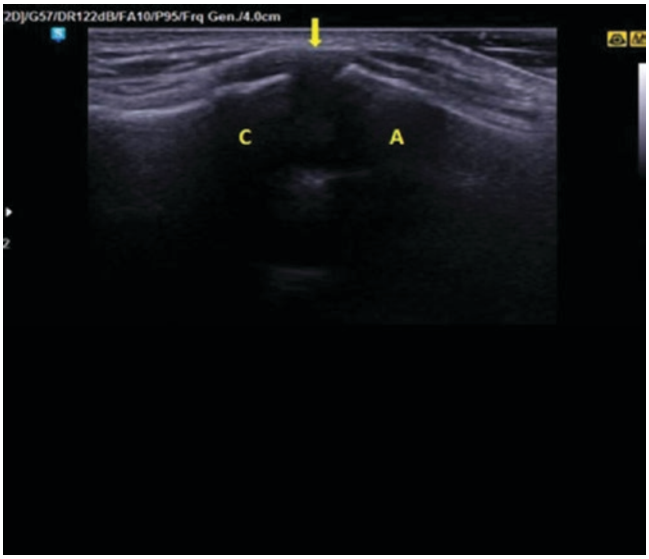

Fig. 2.5 The acromioclavicular joint capsule and overlying acromioclavicular ligament are indicated by the *arrow*. A tear of the ligament can result in shoulder separation and displacement or hypermobility of the clavicle (C) relative to the acromion (A)

Fig. 2.6 The posterior shoulder is examined with a low- to mid-frequency curvilinear probe (1–7 Hz) to evaluate the posterior portion of the glenohumeral joint. The probe is placed just below the scapular spine (S), with the probe marker pointing toward the medial side

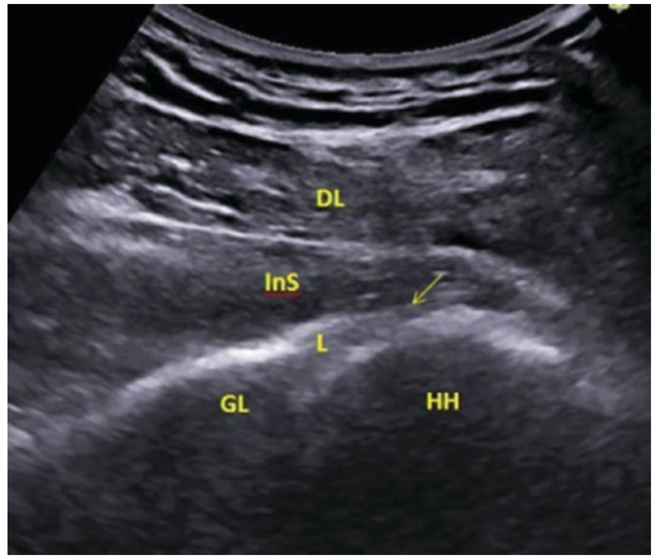

Fig. 2.7 The glenoid (GL), humeral head (HH), and glenoid labrum (L) are visualized deep to the infraspinatus muscle (InS). The deltoid muscle (DL) overlies the infraspinatus. The joint capsule is indicated by the *arrow*

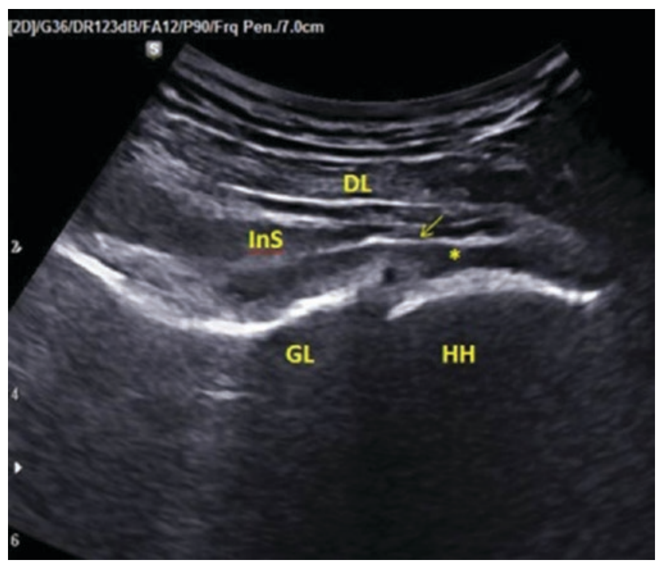

Fig. 2.8 A glenohumeral joint effusion is evidenced by hypoechoic fluid (*asterisk*) distending the joint capsule (*arrow*); it will lie beneath the infraspinatus muscle (InS) and above the glenoid (GL) and humeral head (HH). Movement of the glenohumeral joint can be assessed by ultrasound, as shown in Video 2.1

Fig. 2.9 The lateral shoulder is examined using a linear probe with the marker facing upward. The top of the probe is at the level of the acromion. The lateral shoulder exam is useful for visualizing the subacromial bursa and supraspinatus tendon. The patient's hand is in a position with the palm over the gluteus maximus as if placing it over a rear pants pocket. This view is in the long axis relative to the supraspinatus tendon

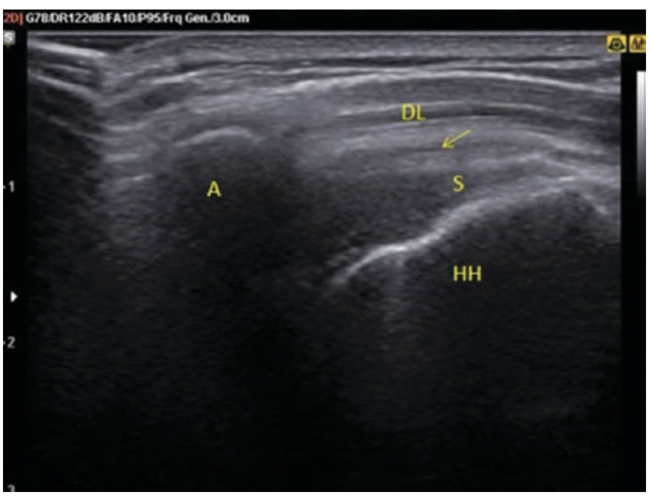

Fig. 2.10 With the probe in the long axis relative to the supraspinatus tendon (S), the acromion (A) is viewed on the left of the image. The deltoid muscle (DL) lies above the supraspinatus tendon, and the humeral head (HH) is deep to the tendon. The subacromial bursa is indicated by the *arrow*. In this normal patient, no fluid is visualized in the bursa, which appears very thin

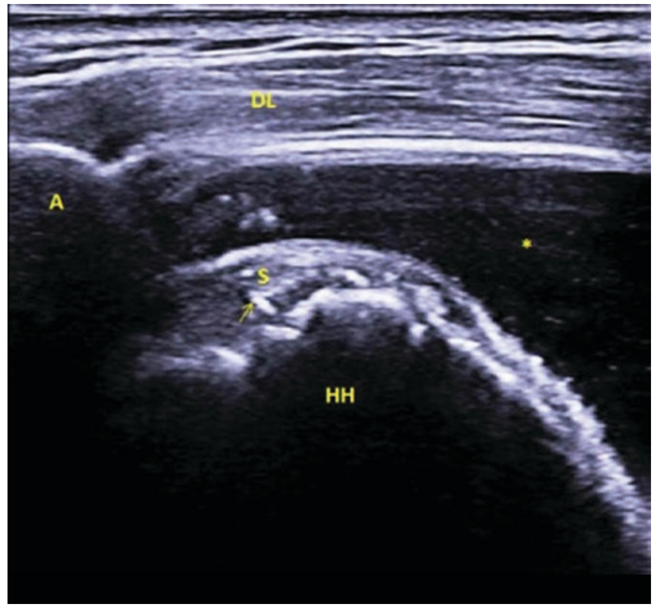

Fig. 2.11 In this patient with subacromial bursitis, fluid is visualized within the bursa. The acromion (A) is to the left, with the deltoid (DL) on top of the bursa and the supraspinatus tendon (S) below. Dark, hypoechoic fluid (*asterisk*) is seen within the subacromial bursa. The humeral head (HH) is deep to the overlying structures. Small, bright, hyperechoic calcifications are visible in the supraspinatus tendon (*arrow*)

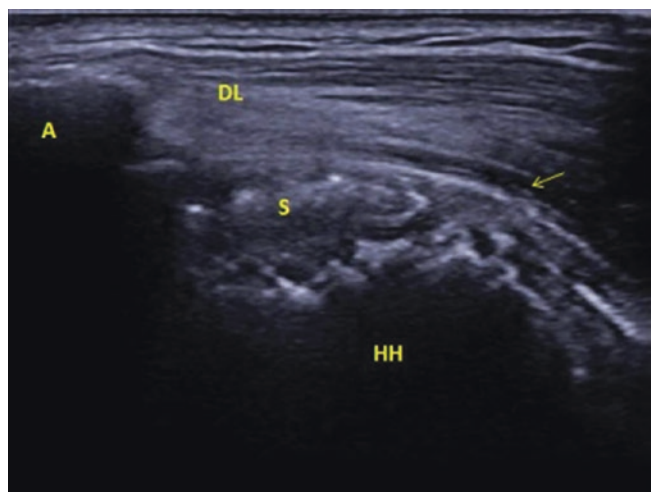

Fig. 2.12 If fluid is present within the bursa, it can be aspirated. This image shows the same patient as Fig. 2.11 after aspiration of the subacromial bursa fluid. The acromion (A) is to the left, with the deltoid (DL) on top of the bursa and the supraspinatus tendon (S) below. The *arrow* indicates the subacromial bursa. The humeral head (HH) is deep to the overlying structures. Video 2.2 shows dynamic ultrasound imaging used to assess for subacromial impingement of the supraspinatus tendon

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