CHAPTER 6

Humerus and Shoulder Girdle

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CONTENTS

Radiographic Anatomy
Humerus, 172
Shoulder girdle, 173
Clavicle, 173
Scapula, 174
Anatomy review with radiographs, 175
Classification of joints, 176

Radiographic Positioning
Proximal humerus rotation, 177
Positioning and exposure considerations, 178
Alternative modalities or procedures, 178
Pathologic indications, 179
Basic and special projections, 180
Humerus (nontrauma and trauma routines)
  • AP, 181
  • Rotational lateral, 182
  • Horizontal beam lateral, 183
  • Transthoracic lateral, 184
Shoulder (nontrauma routine)
  • AP (external rotation), 185
  • AP (internal rotation), 186
  • Inferosuperior axial (Lawrence method), 187
  • Superoinferior PA (transaxillary), 188
  • Superoinferior PA (Hobbs modification), 188
  • Inferosuperior axial (Clements modification), 189
  • Posterior oblique—glenoid cavity (Grashey method), 190
  • Intertubercular (bicipital) groove (Fisk modification), 191

Radiographic Positioning—cont’d
Shoulder (trauma routine)
  • AP (neutral rotation), 192
  • Transthoracic lateral (Lawrence method), 193
  • Scapular Y lateral, 194
  • Tangential projection—supraspinatus outlet (Neer method), 195
  • AP apical oblique axial projection (Garth method), 196
Clavicle
  • AP and AP axial, 197
Acromioclavicular (AC) joints
  • AP bilateral with and without weights, 198
Sternoclavicular joints (see Chapter 11)
Scapula
  • AP, 200
  • Lateral erect, 201
  • Lateral recumbent, 202

Radiographs for Critique, 203
Upper Limb (Extremity)
The hand, wrist, and elbow of the upper limb were described in Chapter 5. The humerus is covered in this chapter, along with the shoulder girdle, which includes the clavicle and scapula.

HUMERUS
The humerus is the largest and longest bone of the upper limb. Its length on an adult equals approximately one-fifth of body height. The humerus articulates with the scapula (shoulder blade) at the shoulder joint. The anatomy of the distal humerus and of the elbow joint was covered in Chapter 5.

Proximal Humerus
The proximal humerus is the part of the upper arm that articulates with the scapula, making up the shoulder joint. The most proximal part is the rounded head of the humerus. The slightly constricted area directly below and lateral to the head is the anatomic neck, which appears as a line of demarcation between the rounded head and the adjoining greater and lesser tubercles.

The process directly below the anatomic neck on the anterior surface is the lesser tubercle (tu-ber-k’l). The larger lateral process is the greater tubercle, to which the pectoralis major and supraspinatus muscles attach. The deep groove between these two tubercles is the intertubercular (in-ter-tu-ber-k’-lu-lar) groove (bicipital groove). The tapered area below the head and tubercles is the surgical neck, and distal to the surgical neck is the long body (shaft) of the humerus.

The surgical neck is so named because it is the site of frequent fractures requiring surgery. Fractures at the thick anatomic neck are rarer.

The deltoid tuberosity is the roughened raised triangular elevation along the anterolateral surface of the body (shaft) to which the deltoid muscle is attached.

Anatomy of Proximal Humerus on Radiograph
Fig. 6-3 is an AP radiograph of the shoulder taken with external rotation, which places the humerus in a true AP or frontal position. Fig. 6-2 represents a neutral rotation (natural position of the arm without internal or external rotation). This places the humerus in an oblique position midway between an AP (external rotation) and a lateral (internal rotation).

Some anatomic parts are more difficult to visualize on radiographs than on drawings. However, a good understanding of the location and relationship between various parts helps in this identification. The following parts are shown in Fig. 6-3.
A. Head of humerus
B. Greater tubercle
C. Intertubercular groove
D. Lesser tubercle
E. Anatomic neck
F. Surgical neck
G. Body

The relative location of the greater and lesser tubercles is significant in determining a true frontal view or a true AP projection of the proximal humerus. Note that the lesser tubercle is located anteriorly and the greater tubercle is located laterally in a true AP projection.
SHOULDER GIRDLE

The shoulder girdle consists of two bones: the clavicle and the scapula. The function of the clavicle and scapula is to connect each upper limb to the trunk or axial skeleton. Anteriorly, the shoulder girdle connects to the trunk at the upper sternum, but posteriorly, the connection to the trunk is incomplete because the scapula is connected to the trunk by muscles only.

Each shoulder girdle and each upper limb connects at the shoulder joint between the scapula and the humerus. Each clavicle is located over the upper anterior rib cage. Each scapula is situated over the upper posterior rib cage.

The upper margin of the scapula is at the level of the second posterior rib, and the lower margin is at the level of the seventh posterior rib (T7). Note that the lower margin of the scapula corresponds to T7, also used as a landmark for location of the central ray for chest positioning (see Chapter 3).

Clavicle

The clavicle (collarbone) is a long bone with a double curvature that has three main parts: the two ends and the long central portion. The lateral or acromial (ah-kro′-me-al) extremity (end) of the clavicle articulates with the acromion of the scapula. This joint or articulation is called the acromioclavicular (ah-kro′-me-o-klah-vik′-u-lar) joint and generally can be readily palpated.

The medial or sternal extremity (end) articulates with the manubrium, which is the upper part of the sternum. This articulation is called the sternoclavicular (ster′-no-klah-vik′-u-lar) joint. This joint also is easily palpated, and the combination of the sternoclavicular joints on either side of the manubrium helps to form an important positioning landmark called the jugular (jug′-u-lar) notch.

The body (shaft) of the clavicle is the elongated portion between the two extremities.

The acromial end of the clavicle is flattened and has a downward curvature at its attachment with the acromion. The sternal end is more triangular in shape and also is directed downward to articulate with the sternum.

In general, a difference in size and shape of the clavicle exists between males and females. The female clavicle is usually shorter and less curved than the male clavicle. The clavicle in the male tends to be thicker and more curved, usually being most curved in heavily muscled males.

Radiograph of the clavicle

The AP radiograph of the clavicle in Fig. 6-5 reveals the two joints and the three parts of the clavicle as follows:

A. Sternoclavicular joint
B. Sternal extremity
C. Body
D. Acromial extremity
E. Acromioclavicular joint

Fig. 6-5. Radiograph of AP clavicle.
Scapula

The scapula (shoulder blade), which forms the posterior part of the shoulder girdle, is a flat triangular bone with three borders, three angles, and two surfaces. The three borders include the medial (vertebral) border, which is the long edge or border near the vertebrae; the superior border, or the uppermost margin of the scapula; and the lateral (axillary) border, or the border nearest the axilla (ak-sil’ah) (Fig. 6-6). Axilla is the medical term for the armpit.

Anterior view

The three corners of the triangular scapula are called angles (Fig. 6-7). The lateral angle, sometimes called the head of the scapula, is the thickest part and ends laterally in a shallow depression called the glenoid cavity (fossa).

The humeral head articulates with the glenoid cavity of the scapula to form the scapulohumeral (skap’u-lo-hu’mer-al) joint, also known as the glenohumeral joint, or shoulder joint.

The constricted area between the head and the body of the scapula is the neck. The superior and inferior angles refer to the upper and lower ends of the medial or vertebral border. The body (blade) of the scapula is arched for greater strength. The thin, flat, lower part of the body sometimes is referred to as the wing or ala of the scapula, although these are not preferred anatomic terms.

The anterior surface of the scapula is termed the costal (kos’-tal) surface because of its proximity to the ribs (costa, literally meaning ÒribÓ). The mid area of the costal surface presents a large concavity or depression, the subscapular fossa.

The acromion is a long, curved process that extends laterally over the head of the humerus. The coracoid process is a thick, beaklike process that projects anteriorly beneath the clavicle. The scapular notch is a notch on the superior border that is partially formed by the base of the coracoid process.

Posterior view

Fig. 6-8 shows a prominent structure on the dorsal or posterior surface of the scapula, called the spine. The elevated spine of the scapula starts at the vertebral border as a smooth triangular area and continues laterally to end at the acromion. The acromion overhangs the shoulder joint posteriorly.

The posterior border or ridge of the spine is somewhat thickened and is termed the crest of the spine. The spine separates the posterior surface into an infraspinous (in’-frah-spî’-nus) fossa and a supraspinous fossa. Both of these fossae serve as surfaces of attachment for shoulder muscles. The names of these muscles are associated with their respective fossae.

Lateral view

The lateral view of the scapula demonstrates relative positions of the various parts of the scapula (Fig. 6-9). The thin scapula looks like the letter ÒYÓ in this position. The upper parts of the ÒYÓ are the acromion and the coracoid process. The acromion is the expanded distal end of the spine that extends superiorly and posteriorly to the glenoid cavity (fossa). The coracoid process is located more anteriorly in relationship to the glenoid cavity or shoulder joint.

The bottom leg of the ÒYÓ is the body of the scapula. The posterior surface or back portion of the thin body portion of the scapula is the dorsal surface. The spine extends from the dorsal surface at its upper margin. The anterior surface of the body is the ventral (costal) surface. The lateral (axillary) border is a thicker edge or border that extends from the glenoid cavity to the inferior angle, as shown on this lateral view.
REVIEW EXERCISE WITH RADIOGRAPHS OF SCAPULA

AP Projection: Fig. 6-10 is an AP projection of the scapula taken with the arm abducted so as not to superimpose the scapula. Knowing shapes and relationships of anatomic parts should help one to identify each of the following parts:
A. Acromion
B. Neck of scapula (about 1 inch below the coracoid process)
C. Scapular notch
D. Superior angle
E. Medial (vertebral) border
F. Inferior angle
G. Lateral (axillary) border
H. Glenoid cavity (fossa) or scapulohumeral joint

Lateral Projection: This scapular Y lateral projection of the scapula is taken with the patient in an anterior oblique position and with the upper body rotated until the scapula is separated from the rib cage in a true end-on or lateral projection (Fig. 6-11).

Note that this lateral view of the scapula presents a Y shape, wherein the acromion and the coracoid process make up the upper legs of the Y and the body makes up the long lower leg.

The scapular Y position gets its name from this Y shape, resulting from a true lateral view of the scapula. The labeled parts as seen on this view are as follows:
A. Acromion
B. Coracoid process
C. Inferior angle
D. Spine of scapula
E. Body of scapula

Proximal Humerus and Scapula

Inferosuperior (axiolateral) projection
This projection (as illustrated in Fig. 6-13) results in a lateral view of the head and neck of the humerus. It also demonstrates the relationship of the humerus to the glenoid cavity, which makes up the scapulohumeral (shoulder) joint.

Anatomy of the scapula may appear confusing in this position, but understanding relationships between the various parts will facilitate identification.

Part A of Fig. 6-12 is the tip of the coracoid process, which is located anterior to the shoulder joint and therefore would be seen superiorly with the patient lying on her back, as shown in Fig. 6-13.

Part B is the glenoid cavity, which is the articulating surface of the lateral angle or head of the scapula.

Part C is the spine of the scapula, which is located posteriorly with the patient lying on her back, as shown in Fig. 6-13.

Part D is the acromion, which is the extended portion of the spine that is superimposed over the humerus in this position.
CHAPTER 6  HUMERUS AND SHOULD GIRDLE

CLASSIFICATION OF JOINTS

Three joints or articulations are involved in the shoulder girdle: the sternoclavicular joint, the acromioclavicular joint, and the scapulohumeral joint (glenohumeral or shoulder joint, Fig. 6-14).

Classification

The three shoulder girdle joints (articulations) classified as synovial joints are characterized by a fibrous capsule that contains synovial fluid.

Mobility Type

The mobility type of all three of these joints is freely movable, or diarthrodial. All synovial joints are by nature of their structure freely movable. Therefore, the only difference between these three joints is their movement type.

Movement Type

The scapulohumeral (glenohumeral) or shoulder joint involves articulation between the head of the humerus and the glenoid cavity of the scapula. The movement type is a spheroidal (or ball and socket) joint, which allows great freedom of movement. These movements include flexion, extension, abduction, adduction, circumduction, and medial (internal) and lateral (external) rotation.

The glenoid cavity is very shallow, allowing the greatest freedom in mobility of any joint in the human body, but at some expense to its strength and stability. Strong ligaments, tendons, and muscles surround the joint, providing stability. However, stretching of the muscles and tendons can cause separation or dislocation of the humeral head from the glenoid cavity. Dislocations at the shoulder joint occur more frequently than at any other joint in the body, requiring the need for frequent radiographic shoulder exams to evaluate for structural damage. The shoulder girdle also includes two joints involving both ends of the clavicle, called the sternoclavicular and acromioclavicular joints.

The sternoclavicular joint is a double plane, or gliding, joint because the sternal end of the clavicle articulates with the manubrium or upper portion of the sternum and the cartilage of the 1st rib. This allows a limited amount of gliding motion in nearly every direction.

The acromioclavicular joint is also a small synovial joint of the plane, or gliding, movement type between the acromial end of the clavicle and the medial aspect of the acromion of the scapula. Two types of movement occur at this joint. The primary movement is a gliding action between the end of the clavicle and the acromion. Some secondary rotary movement also occurs as the scapula moves forward and backward with the clavicle. This allows the scapula to adjust its position as it remains in close contact with the posterior chest wall. The rotary type of movement, however, is limited, and this joint generally is referred to as a plane, or gliding-type, joint.

SUMMARY OF SHOULDER GIRDLE JOINTS

<table>
<thead>
<tr>
<th>Classification:</th>
<th>Synovial (articular capsule containing synovial fluid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility Type:</td>
<td>Diarthrodial (freely movable)</td>
</tr>
<tr>
<td>Movement Types:</td>
<td>Spheroidal or ball and socket</td>
</tr>
<tr>
<td>1. Scapulohumeral joint (glenohumeral)</td>
<td>Plane or gliding</td>
</tr>
<tr>
<td>2. Sternoclavicular joint</td>
<td>Plane or gliding</td>
</tr>
<tr>
<td>3. Acromioclavicular joint</td>
<td>Plane or gliding</td>
</tr>
</tbody>
</table>

Fig. 6-14. Joints of shoulder girdle.
Proximal Humerus Rotation  
**RADIOGRAPHS OF PROXIMAL HUMERUS**

Rotational views of the proximal humerus or shoulder girdle are commonly taken on nontrauma patients when gross fractures or dislocations of the humerus have been ruled out. These AP rotational projections delineate well the scapulohumeral joint (shoulder joint), revealing possible calcium deposits or other pathology. Note specifically the location and shapes of the greater tubercle (A) and the lesser tubercle (B) on these external, internal, and neutral rotation radiographs (Figs. 6-16, 6-18, and 6-20).

By studying the position and relationships of the greater and lesser tubercles on a radiograph of the shoulder, you can determine the rotational position of the arm. This understanding enables you to know which rotational view is necessary for visualization of specific parts of the proximal humerus.

**External Rotation:** The external rotation position represents a true AP projection of the humerus in the anatomic position, as determined by the epicondyles of the distal humerus. Positioning requires supination of the hand and external rotation of the elbow so that the interepicondylar line is parallel to the image receptor (IR) (Fig. 6-15).

*Note:* You can check this on yourself by dropping your arm at your side and externally rotating your hand and arm while palpating the epicondyles of your distal humerus.

On the external rotation radiograph (Fig. 6-16), the greater tubercle (A), which is located anteriorly in a neutral position, is now seen laterally in profile. The lesser tubercle (B) now is located anteriorly, just medial to the greater tubercle.

**Internal Rotation:** For the internal rotation position, the hand and arm are rotated internally until the epicondyles of the distal humerus are perpendicular to the IR, thus placing the humerus in a true lateral position. The hand must be pronated and the elbow adjusted to place the epicondyles perpendicular to the IR (Fig. 6-17).

The AP projection of the shoulder taken in the internal rotation position is therefore a lateral position of the proximal humerus in which the greater tubercle (A) now is rotated around to the anterior and medial aspect of the proximal humerus. The lesser tubercle (B) is seen in profile medially.

**Neutral Rotation:** Neutral rotation is appropriate for a trauma patient when rotation of the part is unacceptable. The epicondyles of the distal humerus will appear at an approximate 45° angle to the IR. This results in a 45° oblique position of the humerus when the palm of the hand is facing inward against the thigh. The neutral position then is about midway between the external and internal positions and places the greater tubercle anteriorly but still lateral to the lesser tubercle, as can be seen on the radiograph in Fig. 6-20.
**CHAPTER 6 HUMERUS AND SHOULDER GIRDLE**

**Positioning and Exposure Considerations**

General positioning considerations for the humerus and shoulder girdle (clavicle and scapula) are similar to other upper and lower limb procedures.

**Technique Considerations**

Depending on part thickness, the humerus can be exposed with or without a grid. Grids generally are used when the humerus is performed erect with the use of a bucky. However, adult shoulders generally measure from 10 to 15 cm; therefore, the use of a grid is required, and other technical considerations are listed below. Children and thin, asthenic adults may measure less than 10 cm, requiring exposure factor adjustments without the use of grids. Acromioclavicular (AC) joints generally also measure less than 10 cm, thus requiring less kV (65-70) without grids. However, this can vary depending on department protocol, and grids are often used for AC joints because they provide the dual purpose of holding the imaging receptor and eliminating scatter radiation. The use of a grid does result in added dose to the patient caused by the required increase in exposure factors.

**AVERAGE ADULT HUMERUS AND SHOULDER**

1. Medium kV, 70-80 with grids if larger than 10 cm (if smaller than 10 cm, 65-70 kV without grids)
2. Higher mA with short exposure times
3. Small focal spot
4. Center cell for AEC if used for the shoulder (manual techniques may be recommended with certain projections, such as the humerus and AC joints)
5. Adequate mAs for sufficient density (for visualization of soft tissues, bone margins, and trabecular markings of all bones)
6. 400 speed (or higher) Hm-screen combination recommended with grid techniques
7. 40 to 44 inch (100 to 110 cm) SID, except for AC joints, which require a 72 inch (180 cm) SID for less beam divergence

**Shielding**

**GONADS**

Generally, gonadal shielding is important for upper limb radiography because of the proximity of parts of the upper limb, such as the hands or wrists, to the gonads when radiography is performed with the patient in a supine position. The relationship of the divergent x-ray beam to the pelvic region when a patient is in an erect seated position also necessitates gonadal protection. Of course, covering the pelvic region whenever possible for all procedures is good practice and reassures the patient.

**THYROID, LUNGS, AND BREASTS**

Radiography of the shoulder region may provide potentially significant doses to the thyroid and lung regions and to the breasts, all of which are weighted radiosensitive organs that have a relative risk of becoming cancerous, as compared with whole-body effective doses (see Chapter 2, p. 61). Therefore, close collimation to the area of interest is very important, as is providing contact shields over those portions of the lungs, breast, and thyroid regions that do not obscure the area of interest.

**Pediatric Applications**

In general, the routines used for radiographic examinations of the humerus and shoulder girdle do not vary significantly from adult to pediatric patients, although it is essential that exposure technique be decreased to compensate for the decrease in tissue quantity and density. Patient motion plays an important role in pediatric radiography. Immobilization often is necessary to assist the child in maintaining the proper position. Sponges and tape are very useful, but caution is necessary when sandbags are used, because of their weight.

Parents frequently are asked to assist with the radiographic examination of their child. If parents are permitted in the radiography room during the exposure, proper shielding must be provided.

To ensure maximum cooperation, the technologist should speak to the child in a soothing manner and should use words that the child can easily understand.

**Geriatric Applications**

It is essential to provide clear and complete instructions so that the older patient understands. Routine humerus and shoulder girdle examinations may have to be altered to accommodate the older patient’s physical condition. Reduction in radiographic technique may be necessary as a result of destructive pathologies commonly seen in geriatric patients.

**Digital Imaging Considerations**

The following guidelines should be followed when digital imaging systems (computed radiography [CR] or digital radiography [DR]) are used for imaging the humerus and shoulder girdle. These were described in greater detail in Chapter 5 for the upper limb and are summarized here as follows:

1. **Collimation:** Close collimation is important for ensuring that the final image after processing is of optimal quality.
2. **Accurate centering:** Because of the way the digital image plate reader scans the exposure imaging plate, it is important that the body part and the central ray be accurately centered to the IR.
3. **Exposure factors:** It is important that the ALARA principle (exposure to patient As Low As Reasonably Achievable) be followed: that is, the lowest exposure factors required to obtain a diagnostic image should be used. This involves using the highest kV and the lowest mAs that still will result in a final image of diagnostic quality.
4. **Post-processing evaluation of exposure index:** After the image has been processed and is ready for viewing, it must be checked for an acceptable exposure index, to verify that the exposure factors used were in the correct range to ensure an optimum quality image with the least possible radiation dose to the patient.

**Alternative Modalities or Procedures**

**ARTHROGRAPHY**

Arthrography sometimes is used to image soft tissue pathologies such as rotator cuff tears associated with the shoulder girdle. This procedure, which is described in greater detail in Chapter 22, requires the use of a radiographic contrast medium injected into the joint capsule under fluoroscopy and sterile conditions.

**COMPUTED TOMOGRAPHY AND MAGNETIC RESONANCE IMAGING**

Computed tomography (CT) and magnetic resonance imaging (MRI) often are used on the shoulder to evaluate soft tissue and skeletal involvement of lesions and soft tissue injuries. Sectional CT images also are excellent for determining the extent of fracture. MRI, with or without the use of a contrast agent, is useful in the diagnosis of rotator cuff injuries. CT arthrography, as described in Chapter 21, can be performed following conventional arthrography.

**NUCLEAR MEDICINE**

Nuclear medicine bone scans are useful in demonstrating osteomyelitis, metastatic bone lesions, and cellulitis. Nuclear medicine scans will demonstrate pathology within 24 hours of onset. Nuclear medicine is more sensitive than radiography because it assesses the physiologic aspect instead of the anatomic aspect.

**SONOGRAPHY (ULTRASOUND)**

Ultrasound is useful for musculoskeletal imaging of joints such as the shoulder to evaluate soft tissues within the joint for possible rotator cuff tears, bursa injuries, or disruption and damage to nerves, tendons, or ligaments. These studies can be used as an adjunct to more expensive MRI studies. Ultrasound also allows for dynamic evaluation during joint movement.
**Pathologic Indications**

Pathologic indications involving the shoulder girdle that all technologists should be familiar with include the following:

**AC joint separation:** Trauma to the upper shoulder region resulting in a partial or complete tear of the AC and/or coracoclavicular (CC) ligaments.

**Acromioclavicular (AC) dislocation:** The clavicle usually is displaced superiorly. This injury most commonly is caused by a fall.

**Bankart lesion:** An injury of the anteroinferior aspect of the glenoid labrum. This type of injury often is caused by anterior dislocation of the proximal humerus. Repeated dislocation may result in a small avulsion fracture in the anteroinferior region of the glenoid rim.

**Bursitis:** An inflammation of the bursae, or fluid-filled sacs enclosing the joints. It generally involves the formation of calcification in associated tendons, causing pain and limitation of joint movement.

**Hill-Sachs defect:** A compression fracture of the articular surface of the posterolateral aspect of the humeral head that often is associated with an anterior dislocation of the humeral head.

**Idiopathic chronic adhesive capsulitis** (frozen shoulder) is a disability of the shoulder joint that is caused by chronic inflammation in and around the joint. It is characterized by pain and limitation of motion. (Idiopathic means of unknown cause.)

**Impingement syndrome** is impingement of the greater tuberosity and soft tissues on the coracoacromial ligamentous and osseous arch, generally during abduction of the arm.*

**Osteoarthrosis:** As described in Chapter 4, osteoarthritis is also known as degenerative joint disease (DID), a noninflammatory joint disease characterized by gradual deterioration of the articular cartilage with hypertrophic bone formation. DID is the most common type of arthritis and is considered to be part of the normal aging process. It generally occurs in persons older than 50 years, chronically obese persons, and athletes.

**Osteoporosis** is a reduction in the quantity of bone or atrophy of skeletal tissue. Osteoporosis occurs in postmenopausal women and elderly men, resulting in bony trabeculae that are scanty and thin. Most fractures sustained by women over the age of 50 are related to osteoporosis.

**Rheumatoid arthritis** is a chronic systemic disease characterized by inflammatory changes that occur throughout the body’s connective tissues.

**Rotator cuff:** Rotator cuff pathology can occur as acute or chronic and traumatic injury to one or more of the muscles that make up the rotator cuff—teres minor, supraspinatus, infraspinatus, and subscapularis. Rotator cuff injuries limit the range of motion of the shoulder. The most common injury of the rotator cuff is impingement of the supraspinatus muscle as it passes beneath the acromion caused by a subacromial bone spur. Repeated irritation due to the bone spur can lead to a partial or complete tear of the supraspinatus tendon as evident on this ultrasound examination of the shoulder (Fig. 6-21).

**Shoulder dislocation:** This occurs as traumatic removal of humeral head from the glenoid cavity. In all, 95% of shoulder dislocations are anterior, in which the humeral head is projected anterior to the glenoid cavity.

**Tendonitis** is an inflammatory condition of the tendon that usually results from a strain.

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**Summary of Pathologic Indications**

<table>
<thead>
<tr>
<th>Condition or Disease</th>
<th>Most Common Radiographic Examination</th>
<th>Possible Radiographic Appearance</th>
<th>Manual Exposure Factor Adjustment*</th>
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</thead>
<tbody>
<tr>
<td>AC dislocation</td>
<td>Bilateral erect AC joints</td>
<td>Widening of the AC joint space</td>
<td>None</td>
</tr>
<tr>
<td>AC joint separation</td>
<td>Bilateral, erect AC joints (with and</td>
<td>Asymmetric widening of AC joint</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>without weights)</td>
<td>compared with opposite side (3 mm)</td>
<td></td>
</tr>
<tr>
<td>Bankart lesion</td>
<td>AP internal rotation, scapular Y, or</td>
<td>Possible small avulsion fracture</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Grashey</td>
<td>of anteroinferior aspect of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>glenoid rim</td>
<td></td>
</tr>
<tr>
<td>Bursitis</td>
<td>AP and lateral shoulder</td>
<td>Fluid-filled joint space with</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>possible calcification</td>
<td></td>
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<tr>
<td>Hill-Sachs defect</td>
<td>AP internal rotation, exaggerated</td>
<td>Compression fracture and possible</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>external rotation, or axillary lateral</td>
<td>anterior dislocation of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>humeral head</td>
<td></td>
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<td>Idiopathic chronic</td>
<td>AP and lateral shoulder</td>
<td>Possible calcification or other</td>
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<td>adhesive capsulitis</td>
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<td>joint space abnormalities</td>
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<td>(frozen shoulder)</td>
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<td>Impingement syndrome</td>
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<td>Subacromial spurs</td>
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<td>Osteoarthrosis</td>
<td>AP and lateral shoulder</td>
<td>Narrowing of the joint space</td>
<td>Decrease (–)</td>
</tr>
<tr>
<td>Osteoporosis (resultant fractures)</td>
<td>AP and lateral shoulder</td>
<td>Thin bony cortex</td>
<td>Decrease (–)</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>AP and lateral shoulder</td>
<td>Closed joint space</td>
<td>Decrease (–)</td>
</tr>
<tr>
<td>Rotator cuff injury</td>
<td>Arthrogram and/or MRI</td>
<td>Partial or complete tear in the</td>
<td>None</td>
</tr>
<tr>
<td>Shoulder dislocation</td>
<td>Scapular Y, transchondral lateral or</td>
<td>Separation between humeral and</td>
<td>None</td>
</tr>
<tr>
<td>Tendonitis</td>
<td>Garth method</td>
<td>glenoid cavity</td>
<td></td>
</tr>
</tbody>
</table>

*Depends on stage or severity of disease or condition.

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**Fig. 6-21.** Ultrasound demonstration of normal (A) and tear (B) of supraspinatus tendon. (From Drake R, Vogl W, Mitchell A: Gray’s anatomy for students, New York, 2005, Churchill Livingstone.)
Basic and Special Projections

Certain basic and special projections for the humerus, shoulder, clavicle, AC joints, and scapula are demonstrated and described on the following pages as suggested standard basic and special departmental routines or procedures.

BASIC PROJECTIONS

Standard or basic projections, also sometimes referred to as routine projections or departmental routines, are those projections that commonly are taken on average patients who are helpful and can cooperate in performing the procedure.

SPECIAL PROJECTIONS

Special projections are those more common projections that are taken as extra or additional projections to better demonstrate certain pathologic conditions or specific body parts.

BASIC AND SPECIAL PROJECTIONS

<table>
<thead>
<tr>
<th>Humerus (nontrauma and trauma routine)</th>
<th>Shoulder (nontrauma routine)</th>
<th>Shoulder (trauma routine)</th>
<th>Clavicle</th>
<th>Scapula</th>
<th>AC Joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASIC</td>
<td>BASIC</td>
<td>BASIC</td>
<td>BASIC</td>
<td>BASIC</td>
<td>BASIC</td>
</tr>
<tr>
<td>• AP, 181</td>
<td>• AP external rotation (AP), 185</td>
<td>• AP neutral rotation (AP), 192</td>
<td>• AP and AP axial, 197</td>
<td>• AP, 200</td>
<td></td>
</tr>
<tr>
<td>• AP rotational lateral, 182</td>
<td>• AP internal rotation (lateral), 186</td>
<td>• Transthoracic lateral (Lawrence method), 193</td>
<td></td>
<td>• Lateral</td>
<td></td>
</tr>
<tr>
<td>• Horizontal beam lateral, 183</td>
<td>• Inferosuperior axial (Lawrence method), 187</td>
<td>• Scapular Y lateral, 194</td>
<td></td>
<td>• Erect, 201</td>
<td></td>
</tr>
<tr>
<td>SPECIAL</td>
<td>SPECIAL</td>
<td>SPECIAL</td>
<td>SPECIAL</td>
<td></td>
<td>SPECIAL</td>
</tr>
<tr>
<td>• Transthoracic lateral, 184</td>
<td>• Superoinferior axial (Hobbs modification), 189</td>
<td>• Tangential projection—supraspinatus outlet (Neer method), 195</td>
<td></td>
<td></td>
<td>• AP bilateral with weights and AP bilateral without weights, 196–199</td>
</tr>
<tr>
<td></td>
<td>• Inferosuperior axial (Clements modification), 189</td>
<td>• Apical oblique (Garth method), 196</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Posterior oblique—glenoid cavity (Grashey method), 190</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tangential projection—intertubercular groove (Fisk modification), 191</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Warning:** Do not attempt to rotate arm if fracture or dislocation is suspected.

**Pathology Demonstrated**
Fracture and dislocation of the humerus, as well as other pathologic processes such as osteoporosis and arthritis, are demonstrated.

**Technical Factors**
- IR size: lengthwise (large enough to include entire humerus)
  - For larger patient, 35 × 43 cm (14 × 17 inches) may be needed to place cassette diagonally to include both joints
  - For smaller patient, 30 × 35 cm (11 × 14 inches)
- Moving or stationary grid (non-grid, detail screen for smaller patient)
- 70 ± 6 kV range
- Technique and dose:

**Shielding**
Secure or place lead shield over pelvic area.

**Patient Position**
Position patient erect or supine. Adjust height of cassette so that shoulder and elbow joints are equidistant from ends of IR.

**Part Position**
Rotate body toward affected side as needed to bring shoulder and proximal humerus in contact with cassette.
- Align humerus with long axis of IR, unless diagonal placement is needed to include both shoulder and elbow joints.
- Extend hand and forearm as far as patient can tolerate.
- Abduct arm slightly and gently supinate hand so that epicondyles of elbow are equidistant from IR.

**Central Ray**
- CR perpendicular to IR, directed to midpoint of humerus
- Minimum SID of 40 inches (100 cm)

**Collimation**
Collimate on sides to soft tissue borders of humerus and shoulder. (Lower margin of collimation field should include the elbow joint and about 2.5 cm [1 inch] minimum of proximal forearm.)

**Respiration**
Suspend respiration during exposure.

**Radiographic Criteria**

**Structures Shown:** AP projection of the entire humerus, including the shoulder and elbow joints, is visible.

**Position:** Long axis of humerus should be aligned with long axis of IR. **True AP** projection is evidenced at proximal humerus by the following: Greater tubercle is seen in profile laterally; humeral head is partially seen in profile medially, with minimal superimposition of the glenoid cavity. Distal humerus: Lateral and medial epicondyles both are visualized in profile.

**Collimation and CR:** Collimation borders are visible at the skin margins along the length of the humerus, with minimal collimation at both ends to ensure that essential joint anatomy is included. **CR** and center of the collimation field should be to the approximate midpoint of the humerus.

**Exposure Criteria:** Optimal density and contrast with no motion visualize sharp cortical margins and clear, bony trabecular markings at both proximal and distal portions of the humerus.
Warning: Do not attempt to rotate arm if fracture or dislocation is suspected (see Trauma Horizontal Beam Lateral on p. 183).

Pathology Demonstrated
Fracture and dislocation of the humerus, as well as pathologic processes such as osteoporosis and arthritis, are demonstrated.

Technical Factors
- IR size: lengthwise (large enough to include entire humerus)
  - For larger patient, $35 \times 43$ cm ($14 \times 17$ inches)
  - For smaller patient, $30 \times 35$ cm ($11 \times 14$ inches)
- Moving or stationary grid (non-grid, detail screen for smaller patient)
- $70 \pm 6$ kV range
- Technique and dose:
  - Shielding: Secure or place lead shield over pelvic area.
  - Patient and Part Position:
    - Lateromedial: Position patient erect with back to IR and elbow partially flexed, with body rotated toward affected side as needed to bring humerus and shoulder in contact with cassette. **Internally rotate arm as needed for lateral position; epicondyles are perpendicular to IR.**
    - Mediolateral: Face patient toward IR (Fig. 6-27) and oblique as needed (20¡ to 30¡ from PA) to allow close contact of humerus with IR; flex elbow 90¡ as shown.
    - Adjust cassette height so that shoulders and elbow joints are equidistant from ends of cassette.
- Central Ray
  - CR perpendicular to IR, centered to midpoint of humerus
  - Minimum SID of 40 inches (100 cm)
- Collimation: Collimate on four sides to soft tissue border of humerus, ensuring that all of shoulder and elbow joints are included.
- Respiration: Suspend respiration during exposure.

Radiographic Criteria
- Structures Shown: A lateral projection of the entire humerus, including elbow and shoulder joints, is visible.
- Position: True lateral projection is evidenced by the following: Epicondyles are directly superimposed; lesser tubercle is shown in profile medially, partially superimposed by lower portion of glenoid cavity.
- Collimation and CR: Collimation borders should be visible at the skin margins along the length of the humerus, with minimal collimation at both ends to ensure that essential joint anatomy is included. CR and center of collimation field should be to the approximate midpoint of the humerus.
- Exposure Criteria: Optimal density and contrast with no motion visualize clear, sharp bony trabecular markings of entire humerus.
TRAUMA HORIZONTAL BEAM LATERAL—LATEROMEDIAL PROJECTION: HUMERUS

**Warning:** Do not attempt to rotate arm if fracture or dislocation is suspected.

**Proximal Humerus**
See Transthoracic Lateral.

**Pathology Demonstrated**
Fractures and dislocations of the mid- and distal humerus, as well as other pathologic processes such as osteoporosis and arthritis, are demonstrated.

**Technical Factors**
- IR size 30 x 35 cm (11 x 14 inches); for smaller patient, 24 x 30 cm (10 x 12 inches)
- Detail screen, non-grid with film-screen imaging
- 64 ± 6 kV range
- Technique and dose:

**Shielding** Place lead shield over thorax and pelvis, between the cassette and the patient.

**Patient and Part Position**
- With patient recumbent, perform image as a horizontal beam lateral, placing support under the arm.
- Flex elbow if possible, but do not attempt to rotate arm; projection should be 90° from AP.
- Gently place cassette between arm and thorax (top of IR to axilla).

**Central Ray**
- CR perpendicular to midpoint of distal two-thirds of humerus
- Minimum SID of 40 inches (100 cm)

**Collimation** Collimate to soft tissue margins.

**Respiration** Suspend respiration during exposure. (This step is important in preventing movement of the cassette during the exposure.)

**Radiographic Criteria**

**Structures Shown:** A lateral projection of the mid- and distal humerus, including the elbow joint, is visible. The distal two-thirds of the humerus should be well visualized.

**Position:** The long axis of the humerus should be aligned with the long axis of the IR. The elbow is flexed 90°.

**Collimation and CR:** Collimation borders should be visible at the skin margins along the length of the humerus. CR and center of the collimation field should be to the approximate midpoint of the distal two-thirds of the humerus.

**Exposure Criteria:** Optimal density and contrast with no motion should visualize sharp cortical borders and clear, sharp bony trabecular markings.
TRANSTHORACIC LATERAL PROJECTION: HUMERUS (TRAUMA)

**Pathology Demonstrated**
Fractures of the diaphysis of the humerus are demonstrated. An AP with neutral rotation (Fig. 6-35) is required in addition to the transthoracic lateral projection.

**Technical Factors**
- IR size: 35 × 43 cm (14 × 17 inches), lengthwise
- Moving or stationary grid, vertical, CR to centerline
- 75 ± 5 kV range
- Minimum of 2 seconds exposure time with breathing technique (between 2 and 4 seconds is desirable)
- Technique and dose:
  - CM
  - kV: 54
  - mA: 75
  - mAs: 600
  - ML: 158
  - Thyroid: 86
  - Breast: 238

**Shielding**
Shield pelvic area.

**Patient Position**
Perform radiograph with the patient in an erect or supine position. (The erect position, which also may be more comfortable for patient, is preferred.) Place patient in lateral position with side of interest closest to IR (Fig. 6-34). With patient supine, place portable grid lines horizontally and center CR to centerline to prevent grid cutoff (Insert).

**Part Position**
- Place affected arm at patient’s side in neutral rotation; drop shoulder if possible.
- Raise opposite arm and place hand over top of head; elevate shoulder as much as possible to prevent superimposition of affected shoulder.
- Center mid-diaphysis of affected humerus and center of IR to CR as projected through thorax.
- Ensure that thorax is in a true lateral position or has slight anterior rotation of unaffected shoulder to minimize superimposition of humerus by thoracic vertebrae.

**Central Ray**
- CR perpendicular to IR, directed through thorax to mid-diaphysis (see Note below)
- Minimum SID of 40 inches (100 cm)

**Collimation**
Collimate on four sides to area of interest.

**Respiration**
Breathing technique is preferred if patient can cooperate. Patient should be asked to gently breathe short, shallow breaths without moving affected arm or shoulder. (This will allow best visualization of humerus by blurring out ribs and lung structures.)

**Note:** If patient is in too much pain to drop injured shoulder and elevate uninjured arm and shoulder high enough to prevent superimposition of shoulders, angle CR 10° to 15° cephalad.

**Radiographic Criteria (Transthoracic Lateral)**
- **Structures Shown:** Lateral view of the entire humerus and glenohumeral joint should be visualized through the thorax without superimposition of the opposite humerus.
- **Position:** The outline of the shaft of the humerus should be clearly visualized anterior to the thoracic vertebrae. The relationship of the humeral head and the glenoid cavity should be demonstrated.
- **Collimation and CR:** Collimation should be visible on four sides to area of affected humerus. CR and center of collimation field should be at the mid-diaphysis of the affected humerus.
- **Exposure Criteria:** Optimal density and contrast will demonstrate the entire outline of the humerus. Overlying ribs and lung markings should appear blurred because of breathing technique, but bony outlines of the humerus should appear sharp, indicating no motion of the arm during the exposure.
**Warning:** Do NOT attempt to rotate arm if fracture or dislocation is suspected (see trauma routine).

**Pathology Demonstrated**
Fractures and/or dislocations of the proximal humerus and shoulder girdle are demonstrated. This projection may demonstrate calcium deposits in the muscles, tendons, or bursal structures. Some pathologies, such as osteoporosis and osteoarthritis, also may be demonstrated.

**Technical Factors**
- IR size: 24 × 30 cm (10 × 12 inches), crosswise (or lengthwise to show more of humerus if injury includes proximal half of humerus)
- Moving or stationary grid
- 70 ± 5 kV range
- Technique and dose: Shield pelvic area.

**Patient Position**
Perform radiograph with the patient in an erect or supine position. (The erect position is usually less painful for patient, if condition allows.) Rotate body slightly toward affected side if necessary to place shoulder in contact with IR or tabletop.

**Part Position**
- Position patient to center scapulohumeral joint to center of IR.
- Abduct extended arm slightly; then **externally rotate arm** (supinate hand) until epicondyles of distal humerus are parallel to IR.

**Central Ray**
- CR perpendicular to IR, directed to 1 inch (2.5 cm) inferior to coracoid process (see Note below)
- Minimum SID of 40 inches (100 cm)

**Collimation** Collimate on four sides, with lateral and upper borders adjusted to soft tissue margins.

**Respiration** Suspend respiration during exposure.

**Note:** The coracoid process may be difficult to palpate directly on most patients, but it can be approximated; it is about ¾ inch (2 cm) inferior to the lateral portion of the more readily palpated clavicle.

**Radiographic Criteria**

- **Structures Shown:** AP projection of proximal humerus and lateral two-thirds of the clavicle and upper scapula, including relationship of the humeral head to the glenoid cavity.
- **Position:** Full external rotation is evidenced by the greater tubercle visualized in full profile on the lateral aspect of the proximal humerus. Lesser tubercle is superimposed over humeral head.
- **Collimation and CR:** Collimation should be visible on four sides to the area of the affected shoulder. CR and center of the collimation field should be at scapulohumeral joint.
- **Exposure Criteria:** Optimum density and contrast with no motion will demonstrate clear, sharp bony trabecular markings with soft tissue detail visible for possible calcium deposits.
**Warning:** Do NOT attempt to rotate arm if fracture or dislocation is suspected (see trauma routine).

**Pathology Demonstrated**
Fractures and/or dislocations of the proximal humerus and the shoulder girdle may demonstrate calcium deposits in the muscles, tendons, or bursal structures. Some pathology, such as osteoporosis, osteoarthritis, and bony tumors, also may be evident.

**Technical Factors**
- IR size: 24 × 30 cm (10 × 12 inches), crosswise (or lengthwise to demonstrate entire humerus if injury includes proximal half of humerus)
- Moving or stationary grid
- 70 ± 5 kV range
- Technique and dose: Shield pelvic area.

**Patient Position**
Perform radiograph with the patient in an erect or supine position. (The erect position is usually less painful for patient, if condition allows.) Rotate body slightly toward affected side, if necessary, to place shoulder in contact with IR or tabletop.

**Part Position**
- Position patient to center scapulohumeral joint to center of IR.
- Abduct extended arm slightly; then **internally rotate arm** (pronate hand) until epicondyles of distal humerus are perpendicular to IR.

**Central Ray**
- CR perpendicular to IR, directed to 1 inch (2.5 cm) inferior to coracoid process (see Note on preceding page)
- Minimum SID of 40 inches (100 cm)

**Collimation**
Collimate on four sides, with lateral and upper borders adjusted to soft tissue margins.

**Respiration**
Suspend respiration during exposure.

**Radiographic Criteria**
- **Structures Shown:** Lateral view of proximal humerus and lateral two-thirds of the clavicle and upper scapula are demonstrated, including the relationship of the humeral head to the glenoid cavity.
- **Position:** Full internal rotation position is evidenced by the lesser tubercle **visualized in full profile** on the medial aspect of the humeral head. An outline of the greater tubercle should be visualized superimposed over the humeral head.
- **Collimation and CR:** Collimation should be visible on four sides to area of affected shoulder. CR and center of the collimation field should be at scapulohumeral joint.
- **Exposure Criteria:** Optimal density and contrast with no motion will demonstrate clear, sharp bony trabecular markings with soft tissue detail visible for possible calcium deposits.
**Warning:** Do NOT attempt to rotate arm or force abduction if fracture or dislocation is suspected.

**Pathology Demonstrated**
Osteoporosis, osteoarthritis, and the Hill-Sachs defect with exaggerated rotation may be demonstrated.

**Technical Factors**
- IR size: 18 × 24 cm (8 × 10 inches), crosswise
- Stationary grid (CR to centerline of grid, crosswise to prevent grid cutoff caused by CR angle)
- 70 ± 5 kV range
- Technique and dose: 15 70 10 65 17 Thyroid 0 Breast 0 mrad

**Shielding** Place lead shield over pelvis and radiosensitive regions.

**Patient Position** Position patient supine with shoulder raised about 2 inches (5 cm) from tabletop by placing support under arm and shoulder to place body part near center of IR.

**Part Position**
- Move patient toward the front edge of tabletop and place a cart or other arm support against front edge of table to support abducted arm.
- Rotate head toward opposite side, place vertical cassette on table as close to neck as possible, and support with sandbags.
- Abduct arm 90° from body if possible; keep in external rotation, palm up, with support under arm and hand.

**Central Ray**
- Direct CR medially 25° to 30°, centered horizontally to axilla and humeral head. If abduction of arm is less than 90°, the CR medial angle also should be decreased to 15° to 20° if possible.
- Minimum SID is 40 inches (100 cm).

**Collimation** Collimate closely on four sides.

**Respiration** Suspend respiration during exposure.

An alternative position is exaggerated external rotation.* An anterior dislocation of the humeral head may result in a compression fracture of the articular surface of the humeral head, called the Hill-Sachs defect. This is best demonstrated by exaggerated external rotation, wherein the thumb is pointed down and posteriorly about 45°.

**Radiographic Criteria**

**Structures Shown:**
- Lateral view of proximal humerus in relationship to the scapulohumeral cavity is shown.
- Coracoid process of scapula and lesser tubercle of humerus will be seen in profile.
- The spine of the scapula will be seen on edge below the scapulohumeral joint.

**Position:**
- Arm is seen to be abducted about 90° from the body.
- The superior and inferior borders of the glenoid cavity should be directly superimposed, indicating correct CR angle.

**Collimation and CR:** Collimation should be visible on four sides to the affected shoulder. CR and center of the collimation field should be at the axilla and the humeral head.

**Exposure Criteria:** Optimal density and contrast with no motion will demonstrate clear, sharp bony trabecular markings. The bony margins of the acromion and distal clavicle will be visible through the humeral head.

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**CHAPTER 6  HUMERUS AND SHOULDER GIRDLE**

**SUPEROINFERIOR PA TRANSAXILLARY PROJECTION: SHOULDER (NONTRAUMA)**

**Hobbs Modification**

**Warning:** Do NOT attempt to rotate, force extension, or abduct arm if fracture or dislocation is suspected.

**Pathology Demonstrated**

Fractures and/or dislocations of the proximal humerus are shown. Bursitis, shoulder impingement, osteoporosis, osteoarthritis, and tendonitis may be demonstrated.

**Technical Factors**

- IR size $18 \times 24$ cm ($8 \times 10$ inches), lengthwise
- Bucky or stationary grid (CR to centerline of grid)
- $70 \pm 5$ kV range
- Technique and dose:

<table>
<thead>
<tr>
<th>cm</th>
<th>kV</th>
<th>mA</th>
<th>kJ</th>
<th>ml</th>
<th>Thyroid</th>
<th>Breast</th>
<th>MRd</th>
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<tbody>
<tr>
<td>11</td>
<td>75</td>
<td>62</td>
<td>13</td>
<td>75</td>
<td>7</td>
<td>20</td>
<td>25</td>
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</table>

**Shielding**

Place lead shield over pelvis and radiosensitive regions.

**Patient Position**

Take radiograph with the patient in an erect position (Fig. 6-47) or by leaning the patient over the end of the x-ray table (Fig. 6-48). The patient is positioned in a slight 5º to 10º anterior oblique.*

**Part Position**

- The arm is raised superiorly as much as the patient can tolerate.
- The head is turned away from the affected arm.

**Central Ray**

- CR is directed perpendicular to the axilla and the humeral head to pass through the glenohumeral joint.
- Minimum SID is 40 inches (100 cm).

**Collimation**

Collimate closely on four sides.

**Respiration**

Suspend respiration during exposure.

**Radiographic Criteria**

**Structures Shown:**

- Lateral view of proximal humerus in relationship to the glenohumeral articulation is visualized.
- Coracoid process of scapula is seen on end.

**Position:**

Arm is seen to be raised superiorly above the body.

**Collimation and CR:**

Collimation should be visible on four sides to the affected shoulder. CR and center of the collimation field should be at the axilla and humeral head.

**Exposure Criteria:**

Optimal density and contrast with no motion will demonstrate clear, sharp bony trabecular markings. The bony margins of the acromion and coracoid process will be visible through the humeral head.

---

**Warning:** Do NOT attempt to rotate arm or force abduction if fracture or dislocation is suspected.

**Pathology Demonstrated**
Osteoporosis, osteoarthritis, and the Hill-Sachs defect may be demonstrated.

**Technical Factors**
- IR size: 18 × 24 cm (8 × 10 inches), lengthwise
- 70 ± 5 kV range
- Technique and dose:

**Shielding**
Place lead shield over pelvis and radiosensitive regions.

**Patient Position**
Position patient in the lateral recumbent position with the affected arm up.

**Part Position**
- Abduct arm 90° from body if possible.

**Central Ray**
- Direct horizontal CR perpendicular to the IR.
- If the patient cannot abduct the arm 90°, then angle the tube 5° to 15° toward the axilla.
- Minimum SID is 40 inches (100 cm).

**Collimation**
Collimate closely on four sides.

**Respiration**
Suspend respiration during exposure.

**Radiographic Criteria**
- **Structures Shown:** Lateral view of proximal humerus in relationship to the scapulohumeral cavity is shown.
- **Position:** Arm is seen to be abducted about 90° from the body. The relationship of the humeral head and glenoid cavity should be evident.
- **Collimation and CR:** Collimation should be visible on four sides to the affected shoulder. CR and center of the collimation field should be at the axilla and humeral head.
- **Exposure Criteria:** Optimal density and contrast with no motion will demonstrate clear, sharp bony trabecular markings. The bony margins of the acromion and distal clavicle will be visible through the humeral head.

Pathology Demonstrated
Fractures and/or dislocations of the proximal humerus and fractures of the glenoid labrum or rim are demonstrated; may demonstrate a Bankart lesion, erosion of glenoid rim, and the integrity of the scapulohumeral joint; also may demonstrate certain pathologies, such as osteoporosis and osteoarthritis.

Technical Factors
- IR size: 18 × 24 cm (8 × 10 inches), crosswise
- Moving or stationary grid
- 75 ± 5 kV range
- Technique and dose:
  - Technique
  - Dose

Shielding Place gonadal shielding over pelvic area.

Patient Position Perform radiograph with the patient in an erect or supine position. (The erect position is usually less painful for patient, if condition allows.)

Part Position
- Rotate body 35° to 45° toward affected side (see Note below).
  - If the radiograph is performed with the patient in the supine position, place supports under elevated shoulder and hip to maintain this position.
- Center mid-scapulohumeral joint to CR and to center of IR.
- Adjust cassette so that top of IR is about 2 inches (5 cm) above shoulder and side of IR is about 2 inches (5 cm) from lateral border of humerus.
- Abduct arm slightly with arm in neutral rotation.

Central Ray
- CR perpendicular to IR, centered to scapulohumeral joint, which is approximately 2 inches (5 cm) inferior and medial from the superolateral border of shoulder
- Minimum SID of 40 inches (100 cm)

Collimation Collimate so upper and lateral borders of the field are to the soft tissue margins.

Respiration Suspend respiration during exposure.

Note: The degree of rotation varies depending on how flat or round the shoulders of the patient are. Having a rounded or curved shoulder and back requires more rotation to place the body of the scapula parallel to the IR.

Radiographic Criteria
- Structures Shown: Glenoid cavity should be seen in profile without superimposition of humeral head.
- Position: The scapulohumeral joint space should be open. Anterior and posterior rims of glenoid cavity are superimposed.
- Collimation and CR: Collimation should be visible on four sides to area of affected shoulder. CR and center of the collimation field should be at the mid-glenohumeral joint.
- Exposure Criteria: Optimal density and contrast with no motion will visualize soft tissue margins and clear, sharp bony trabecular markings. Soft tissue detail of the joint space and axilla should be visualized.
Pathology Demonstrated
Pathologies of the intertubercular groove, such as bony projections of the humeral tubercles, are demonstrated.

Technical Factors
- IR size: 18 × 24 cm (8 × 10 inches), crosswise
- Detail screen cassette, non-grid
- 60 ± 5 kV range
- Technique and dose:
  - **Erect**
    - CR perpendicular to IR, directed to groove area at mid-anterior margin of humeral head (groove can be located by careful palpation)
  - **Supine**
    - CR 10° to 15° posterior from horizontal, directed to groove at mid-anterior margin of humeral head
- Minimum SID of 40 inches (100 cm)

Collimation
- Collimate closely on four sides to area of affected shoulder.
- CR and center of the collimation field should be at the intertubercular groove.

Radiographic Criteria
- **Structures Shown:** The anterior margin of the humeral head is seen in profile. The humeral tubercles and the intertubercular groove are seen in profile.
- **Position:** A correct CR angle of 10° to 15° to the long axis of the humerus will demonstrate the intertubercular groove and the tubercles in profile without superimposition of the acromion process.
- **Collimation and CR:** Collimation should be visible on four sides to area of affected shoulder. CR and center of the collimation field should be at the intertubercular groove.
- **Exposure Criteria:** Optimal density and contrast with no motion will visualize sharp borders and sharp bony trabecular markings and will demonstrate the complete intertubercular groove seen through soft tissue without excessive density or burnout.
**Warning:** Do NOT attempt to rotate arm if fracture or dislocation is suspected; perform in neutral rotation, which generally places humerus in an oblique position.

**Pathology Demonstrated**
Fractures and/or dislocations of the proximal humerus and the shoulder girdle are demonstrated. Calcium deposits in the muscles, tendons, or bursal structures may be evident. Some pathologies, such as osteoporosis and osteoarthritis, also may be apparent.

**Technical Factors**
- IR size 24 × 30 cm (10 × 12 inches), crosswise (or lengthwise to show more of humerus if injury includes proximal half of humerus)
- Moving or stationary grid
- 70 ± 5 kV range
- Technique and dose:

> **Shielding**
Shield pelvic area.

**Patient Position** Perform radiograph with the patient in an erect or supine position. (The erect position is usually less painful for patient if condition allows.) Rotate body slightly toward affected side if necessary to place shoulder in contact with IR or tabletop.

**Part Position**
- Position patient to center scapulohumeral joint to IR.
- Place patient’s arm at side in “as is” neutral rotation. (Epicondyles generally are approximately 45° to plane of IR.)

**Central Ray**
- CR perpendicular to IR, directed to mid-scapulohumeral joint, which is approximately ¾ inch (2 cm) inferior and slightly lateral to the coracoid process (see Note below).
- Minimum SID of 40 inches (100 cm)

**Collimation** Collimate on four sides, with lateral and upper borders adjusted to soft tissue margins.

**Respiration** Suspend respiration during exposure.

**Note:** The coracoid process may be difficult to palpate directly on most patients, but it can be approximated if it is known that it is about ¾ inch (2 cm) inferior to the lateral portion of the readily palpated clavicle. Also, the scapulohumeral joint generally is found at the base or pit of the concave-like depression just medial to the humeral head.

**Radiographic Criteria**
**Structures Shown:**
- The proximal one-third of the humerus and upper scapula and the lateral two-thirds of the clavicle are shown, including the relationship of the humeral head to the glenoid cavity.

**Position:**
- With neutral rotation, both the greater and lesser tubercles most often will be superimposed by the humeral head.

**Collimation and CR:**
- Collimation should be visible on four sides to the affected shoulder. CR and center of the collimation field should be at the mid-scapulohumeral joint.

**Exposure Criteria:**
- Optimal density and contrast with no motion will visualize sharp bony trabecular markings. The outline of the medial aspect of the humeral head will be visible through the glenoid cavity, and soft tissue detail should be visible to demonstrate possible calcium deposits.
Pathology Demonstrated
Fractures and/or dislocations of the proximal humerus are demonstrated.

Technical Factors
- IR size: 24 x 30 cm (10 x 12 inches), lengthwise
- Moving or stationary grid, vertical, CR to centerline
- 75 ± 5 kV range
- Minimum of 3 seconds exposure time with breathing technique (4 or 5 seconds is desirable)
- Technique and dose:

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Shielding Shield pelvic area.

Patient Position Perform radiograph with the patient in an erect or supine position. (The erect position is preferred and also may be more comfortable for the patient.) Place patient in lateral position with side of interest against IR. With patient supine, place grid lines vertically and center CR to centerline to prevent grid cutoff.

Part Position
- Place affected arm at patient’s side in neutral rotation; drop shoulder if possible.
- Raise opposite arm and place hand over top of head; elevate shoulder as much as possible to prevent superimposition of affected shoulder.
- Center surgical neck and center of IR to CR as projected through thorax.
- Ensure that thorax is in a true lateral position or has slight anterior rotation of unaffected shoulder to minimize superimposition of humerus by thoracic vertebrae.

Central Ray
- CR perpendicular to IR, directed through thorax to surgical neck (see Note below)
- Minimum SID of 40 inches (100 cm)

Collimation Collimate on four sides to area of interest.

Respiration Breathing technique is preferred if patient can cooperate. Patient should be asked to gently breathe short, shallow breaths without moving affected arm or shoulder. (This will best visualize proximal humerus by blurring out ribs and lung structures.)

Note: If patient is in too much pain to drop injured shoulder and elevate uninjured arm and shoulder high enough to prevent superimposition of shoulders, angle CR 10° to 15° cephalad.

Radiographic Criteria
- Structures Shown: Lateral view of the proximal half of the humerus and the glenohumeral joint should be visualized through the thorax without superimposition of the opposite shoulder.
- Position: The outline of the shaft of the proximal humerus should be clearly visualized anterior to the thoracic vertebrae. The relationship of the humeral head and the glenoid cavity should be demonstrated.
- Collimation and CR: Collimation should be visible on four sides to area of affected shoulder. CR and center of collimation field should be at the surgical neck of the affected humerus.
- Exposure Criteria: Optimal density and contrast will demonstrate the entire outline of the humeral head and the proximal half of the humerus. Overlying ribs and lung markings should appear blurred because of breathing technique, but bony outlines of the humerus should appear sharp, indicating no motion of the arm during the exposure.
CHAPTER 6  HUMERUS AND SHOULD GIRDLE

SCAPULAR Y LATERAL—ANTERIOR OBLIQUE POSITION: SHOULDER (TRAUMA)

Warning: Do NOT attempt to rotate arm if fracture or dislocation is suspected.

Pathology Demonstrated
Fractures and/or dislocations of the proximal humerus and scapula are demonstrated. The humeral head will be demonstrated inferior to the coracoid process with anterior dislocations, and for less common posterior dislocations, the humeral head will be demonstrated inferior to the acromion process. Excellent projection to demonstrate profile of coracoid process and scapular spine.

Technical Factors
- IR size: 24 × 30 cm (10 × 12 inches), lengthwise
- Moving or stationary grid
- Digital IR: very close collimation required
- 75 ± 5 kV range
- Technique and dose:

Shielding
Shield pelvic area.

Patient Position
Perform radiograph with the patient in an erect or recumbent position. (The erect position is usually more comfortable for the patient.)

Part Position
- Rotate into an anterior oblique position as for a lateral scapula with patient facing the IR. Average patient will be in a 45° to 60° anterior oblique position. Palpate scapular borders to determine correct rotation for a true lateral position of scapula.
- Center scapulohumeral joint to CR and to center of IR.
- Abduct arm slightly if possible so as to not superimpose proximal humerus over ribs; do not attempt to rotate arm.

Central Ray
- CR perpendicular to IR, directed to the scapulohumeral joint (2 or 21/2 inches [5 or 6 cm] below top of shoulder) (see Note below)
- Minimum SID of 40 inches (100 cm)

Collimation
Collimate on four sides to area of interest.

Respiration
Suspend respiration during exposure.

Note: If necessary, because of patient condition, this scapular Y lateral may be taken recumbent in the opposite posterior oblique position with injured shoulder elevated (see p. 201, for lateral scapula, recumbent).

Radiographic Criteria
- Structures Shown: A true lateral view of the scapula, proximal humerus, and scapulohumeral joint.
- Position: The thin body of the scapula should be seen on end without rib superimposition. The acromion and coracoid processes should appear as nearly symmetric upper limbs of the Y. The humeral head should appear superimposed over the base of the Y if the humerus is not dislocated.
- Collimation and CR: Collimation is visible on four sides to area of affected shoulder. CR and center of the collimation field should be at the humeral head and surgical neck region.
- Exposure Criteria: Optimal density and contrast with no motion will visualize sharp bony borders and the outline of the body of the scapula through the proximal humerus.
Warning: Do NOT attempt to rotate arm if fracture or dislocation is suspected.

Pathology Demonstrated
Fractures and/or dislocations of the proximal humerus and scapula are visualized. Specifically demonstrates the coracoacromial arch for the supraspinatus outlet region for possible shoulder impingement.*

Technical Factors
- IR size: 24 × 30 cm (10 × 12 inches), lengthwise
- Moving or stationary grid
- 75 ± 5 kV range
- AEC not recommended
- Technique and dose: 16/75/13/56/30 mAs Sk. ML

Shielding
Shield pelvic area.

Patient Position
Take radiograph with the patient in an erect or recumbent position. (The erect position is usually more comfortable for the patient.)

Part Position
- With patient facing the IR, rotate into an anterior oblique position as for a lateral scapula.
- Average patient will be in a 45° to 60° anterior oblique position. Palpate scapular borders to determine correct rotation.
- Center scapulohumeral joint to CR and to center of IR.
- Abduct arm slightly so as not to superimpose proximal humerus over ribs; do not attempt to rotate arm.

Central Ray
- Requires a 10° to 15° CR caudal angle, centered posteriorly to pass through the superior margin of humeral head
- Minimum SID of 40 inches (100 cm)

Collimation
Collimate on four sides to area of interest.

Respiration
Suspend respiration during exposure.

Radiographic Criteria
- Structures Shown: • Proximal humerus will be superimposed over thin body of the scapula, which should be seen on end without rib superimposition
- Position: • The acromion and coracoid processes should appear as nearly symmetric upper limbs of the Y. • The humeral head should appear superimposed and centered to the glenoid fossa just below the supraspinatus outlet region. • The supraspinatus outlet region will appear open, free of superimposition by the humeral head (see small arrow in Fig. 6-73).
- Collimation and CR: • Collimation is visible on four sides to area of affected shoulder. • CR and center of collimation field to supraspinatus outlet region.
- Exposure Criteria: • Optimal density and contrast will demonstrate the Y appearance of the upper lateral scapula superimposed by humeral head with outline of body of scapula visible through humerus. • Bony margins will appear clear and sharp, indicating no motion.

CHAPTER 6  HUMERUS AND SHOULDER GIRDLE

AP APICAL OBLIQUE AXIAL PROJECTION: SHOULDER (TRAUMA)

Garth Method

Pathology Demonstrated
An optimal trauma projection for possible scapulohumeral dislocations (especially posterior dislocations), glenoid fractures, Hill-Sachs lesions, and soft tissue calcifications.*

Technical Factors
¥ IR size: 18 x 24 cm (8 x 10 inches), lengthwise
¥ Moving or stationary grid
¥ Digital IR: very close collimation required
¥ 75 ± 5 kV range
¥ Technique and dose:

Shielding
Shield pelvic area.

Patient Position
Perform radiograph with the patient in an erect or supine position. (The erect position is usually less painful, if patient’s condition allows.) Rotate body 45° toward affected side (posterior surface of affected shoulder against IR).

Part Position
¥ Center scapulohumeral joint to CR and mid-IR.
¥ Adjust IR so that the 45°-angled CR will project the scapulohumeral joint to the center of the IR.
¥ Flex elbow and place arm across chest, or with trauma, place arm at side as is.

Central Ray
¥ CR 45° caudad, centered to the scapulohumeral joint
¥ Minimum SID of 40 inches (100 cm)

Collimation
Collimate closely to area of interest.

Respiration
Suspend respiration during exposure.

Radiographic Criteria
Structures Shown:
¥ The humeral head, glenoid cavity, and neck and head of the scapula are well demonstrated free of superimposition.

Position:
¥ The coracoid process is projected over part of the humeral head, which appears elongated. ¥ The acromion and AC joint are projected superior to the humeral head.

Collimation and CR:
¥ Collimation should be visible on four sides to area of affected shoulder. ¥ CR and center of collimation field should be at the scapulohumeral joint.

Exposure Criteria:
¥ Optimal density and contrast with no motion will demonstrate clear, sharp bony trabecular markings and soft tissue detail for possible calcifications.

Pathology Demonstrated
Fractures and/or dislocations of the clavicle are demonstrated. Departmental routines commonly include both AP and AP axial projections.

Technical Factors
- IR size: 24 × 30 cm (10 × 12 inches), crosswise
- Moving or stationary grid
- AEC not recommended
- Digital IR requires very close collimation
- 70 ± 5 kV range
- Technique and dose: 24 cm, 70 mAs, 150 kV

Shielding
Shield pelvic area.

Patient Position
Perform radiograph with the patient in an erect or supine position with arms at sides, chin raised, and looking straight ahead. Posterior shoulder should be in contact with IR or tabletop, without rotation of body.

Part Position
- Center clavicle and IR to CR. (Clavicle can be readily palpated with medial aspect at jugular notch and lateral portion at AC joint above shoulder.)

Central Ray

AP
- CR perpendicular to midclavicle

AP Axial
- CR 15° to 30° cephalad to midclavicle (see Note below)
- Minimum SID of 40 inches (100 cm)

Collimation
Collimate to area of clavicle. (Ensure that both AC and sternoclavicular joints are included.)

Respiration
Suspend respiration at end of inhalation (helps to elevate clavicles).

Alternate PA: The radiograph also may be taken as a PA projection and/or a PA axial with a 15° to 30° caudal angle.

Note: Thin (asthenic) patients require 10° to 15° more angle than do patients with thick shoulders and chest (hypersthenic).

Radiographic Criteria

AP 0°: Collimation borders should be visible with entire clavicle visualized, including both AC and sternoclavicular joints.

AP Axial: Correct angulation of CR will project most of the clavicle above the scapula and ribs. Only the medial portion of the clavicle will be superimposed by the first and second ribs. Optimal exposure will demonstrate the distal clavicle and AC joint without excessive density. The bony margins and trabecular markings should appear sharp, indicating no motion, and the medial clavicle and sternoclavicular joint also should be visualized through the thorax.
Warning: Shoulder and/or clavicle projections should be completed first to rule out fracture, or this radiograph may be taken without weights first and checked before it is taken with weights.

Pathology Demonstrated
AC joint separation is demonstrated. Widening of one joint space, as compared with the other view with weights, usually indicates an AC joint separation.

Technical Factors
- IR size: 35 x 43 cm (14 x 17 inches), crosswise, or 7 x 17 inches (14 x 43 cm), if available
- With weight and without weight markers
- Bucky or non-grid (depending on size of shoulder)
- AEC not recommended
- 65 ± 5 kV with screen; 65-70 kV with grid on larger patients
- For broad-shouldered patients, two 18 x 24-cm (8 x 10-inch) cassettes crosswise, placed side by side and exposed simultaneously to include both AC joints on a single exposure
- Technique and dose:

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<td>20</td>
<td>65</td>
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<td>Breast 50</td>
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Shielding Secure gonadal shield around waist.

Patient Position Perform radiograph with the patient in an erect position, posterior shoulders against cassette with equal weight on both feet; arms at side; no rotation of shoulders or pelvis; and looking straight ahead. (May be taken seated if patient’s condition requires.) Two sets of bilateral AC joints are taken in the same position, one without weights and one stress view with weights.

Part Position
- Position patient to direct CR to midpoint between AC joints.
- Center midline of IR(s) to CR (top of IR should be <2 inch [5 cm] above shoulders).

Central Ray
- CR perpendicular to a midpoint between AC joints, 1 inch (2.5 cm) above jugular notch (see Note below)
- Minimum SID of 72 inches (180 cm)

Collimation Collimate with a long, narrow light field to area of interest; upper light border should be to upper shoulder soft tissue margins.

Respiration Suspend respiration during exposure.

Weights After the first exposure is made without weights and the cassette(s) has (have) been changed, for large adult patients, strap 8 to 10 pound minimum weights to each wrist, and, with shoulders relaxed, gently allow weights to hang from wrists while pulling down on each arm and shoulder. The same amount of weight must be used on each wrist. Less weight (5 to 8 pounds per limb) may be used for smaller or asthenic patients and more weight for larger or hypersthenic patients. (Check department protocol for the quantity of applied weights.)

Note: Patients should NOT be asked to hold onto the weights with their hands; rather, the weights should be attached to the wrists so that the hands, arms, and shoulders are relaxed and possible AC joint separation can be determined. Holding onto weights may result in false-negative radiographs because they tend to pull on the weights, resulting in contraction rather than relaxation of the shoulder muscles.
Alternate AP axial projection (Alexander method): A 15° cephalic angle centered at the level of the AC joints projects the AC joint superior to the acromion, providing optimal visualization.

Alternate supine position: If patient’s condition requires, the radiograph may be taken supine by tying both ends of a long strip of gauze to patient’s wrists and placing around patient’s feet with knees partially flexed, then slowly and gently straightening legs and pulling down on shoulders. Also may be performed by an assistant who gently pulls down on arms and shoulders.

Warning: This method should be used only by experienced and qualified personnel to prevent additional injury.

Radiographic Criteria
Structures Shown: ¥ Both AC joints, as well as the entire clavicles and SC joints, are demonstrated.
Position: ¥ Both AC joints are on the same horizontal plane. ¥ No rotation occurred, as is evidenced by symmetric appearance of the SC joints on each side of the vertebral column.
Collimation and CR: ¥ Collimation should be visible on four sides, remembering to include both AC joints. ¥ CR and center of the collimation field should be at the midpoint between the AC joints.
Exposure Criteria and Markers: ¥ Optimal density and contrast will clearly demonstrate the AC joints and soft tissue without excessive density. Bony margins and trabecular markings will appear sharp, indicating no motion. ¥ Right and left markers, as well as markers indicating with and without weights, should be visible without superimposing essential anatomy.

Fig. 6-84. Alternate supine position.

Fig. 6-85. AP acromioclavicular joints with and without weights.
Pathology Demonstrated
Fractures of the scapula are demonstrated.

Technical Factors
- IR size: 24 × 30 cm (10 × 12 inches), lengthwise
- Moving or stationary grid
- 75 ± 5 kV range
- Minimum of 3 seconds exposure time with breathing technique (3 to 4 seconds is desirable)
- Manual exposure factors (AEC is not recommended)
- Technique and dose:
  - Technique and dose:

Shielding
Place gonadal shield over pelvic area.

Patient Position
Perform radiograph with the patient in an erect or supine position. (The erect position may be more comfortable for the patient.) Posterior surface of shoulder is in direct contact with tabletop or IR without rotation of thorax. (Rotation toward affected side would place scapula into a truer posterior position, but this also would result in greater superimposition of the rib cage.)

Part Position
- Position patient so midscapula area is centered to CR.
- Adjust cassette to center to CR. Top of IR should be about 2 inches (5 cm) above shoulder, and lateral border of IR should be about 2 inches (5 cm) from lateral margin of rib cage.
- Gently abduct arm 90° and supinate hand. (Abduction will move scapula laterally to clear more of the thoracic structures.)

Central Ray
- CR perpendicular to midscapula, 2 inches (5 cm) inferior to coracoid process, or to level of axilla, and approximately 2 inches (5 cm) medial from lateral border of patient
- Minimum SID of 40 inches (100 cm)

Collimation
Collimate on four sides to area of scapula.

Respiration
Breathing technique is preferred if patient can cooperate. Ask patient to breathe gently without moving affected shoulder or arm.

Radiographic Criteria
Structures Shown:
- The lateral portion of the scapula is free of superimposition.
- The medial portion of the scapula is seen through the thoracic structures.

Position:
- Affected arm seen to be abducted 90° and hand supinated, as evidenced by the lateral border of the scapula free of superimposition.

Collimation and CR:
- Collimation should be visible on four sides to the area of the affected scapula. CR and center of the collimation field should be at midscapular area.

Exposure Criteria:
- Optimal density and contrast with no motion will demonstrate clear, sharp bony trabecular markings of the lateral portion of the scapula. Ribs and lung structures will appear blurred with proper breathing technique.
**LATERAL PROJECTION—RAO OR LAO: SCAPULA**

**Pathology Demonstrated**
Horizontal fractures of the scapula are demonstrated. Arm placement should be determined by scapular area of interest.

**Technical Factors**
- **IR size**: 24 × 30 cm (10 × 12 inches), lengthwise
- **Moving or stationary grid**
- **Manual exposure factors** (AEC is not recommended)
- **Digital IR**: Requires very close collimation
- **75 ± 5 kV range**
- **Technique and dose**: Shielding

**Shielding**
Secure gonadal shield around waist.

**Patient Position**
Perform radiograph with the patient in an erect or recumbent position. (The erect position is preferred if patient’s condition allows.) Face patient toward IR in an anterior oblique position.

**Part Position (Erect)**
- Have patient reach across front of chest and grasp opposite shoulder. This best demonstrates body of scapula (Figs. 6-90 and 6-91).
- Have patient drop affected arm, flex elbow, and place arm behind lower back with arm partially abducted, or just let arm hang down at patient's side. This best demonstrates acromion and coracoid processes (Figs. 6-92 and 6-93).
- Palpate borders of scapula and rotate patient until the scapula is in a true lateral position. The average patient will be rotated 30° to 45° from the lateral position, which results in a 45° to 60° anterior oblique position. The position of the humerus (down at side or up across anterior chest) has an effect on the amount of body rotation required. Less rotation is required with arm up across anterior chest. (The flat posterior surface of body of scapula should be perpendicular to the IR.)
- Align patient to center midvertebral border to CR and to IR.

**Central Ray**
- CR to mid-vertebral border of scapula
- Minimum 40 inches (100 cm) SID

**Collimation**
Collimate to area of scapula.

**Respiration**
Suspend respiration during exposure.

**Radiographic Criteria**
**Structures Shown and Position:** Entire scapula should be visualized in a lateral position, as evidenced by direct superimposition of vertebral and lateral borders. **True lateral** is shown by direct superimposition of vertebral and lateral borders. **Body of scapula** should be in profile, free of superimposition by ribs. **As much as possible**, the humerus should not superimpose area of interest of the scapula.

**Collimation and CR:** Collimation should be visualized on four sides to area of scapula. **CR** and center of collimation held to lateral border of midscapula.

**Exposure Criteria:** Optimal exposure with no motion will demonstrate sharp bony borders and trabecular markings without excessive density in area of inferior angle. **Bony borders** of both the acromion and coracoid processes should be seen through the head of the humerus.
LATERAL PROJECTION—LPO OR RPO: SCAPULA
Patient Recumbent—See p. 201 for Patient Erect

Pathology Demonstrated
Fractures of the scapula are demonstrated.

Note: This position results in a magnified image because of increased OID.

Technical Factors
¥ IR size 24 × 30 cm (10 × 12 inches), lengthwise
¥ Moving or stationary grid
¥ Manual exposure factors (AEC is not recommended)
¥ Digital IR requires very close collimation
¥ 75 ± 5 kV range
¥ Technique and dose:

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Shielding
Place lead shield over pelvic area.

Patient Position
Perform radiograph with the patient in a supine position, and place affected arm across chest. Then rotate entire body approximately 30° or as needed to elevate affected shoulder until body of scapula is in a true lateral position. Flex knee of affected side to help patient maintain this oblique body position.

Part Position
¥ Palpate borders of scapula by grasping medial and lateral borders of body of scapula with fingers and thumb (Fig. 6-94, inset). Carefully adjust body rotation as needed to bring the plane of the scapular body perpendicular to the IR.
¥ Align patient on tabletop so that the center of the midlateral (axillary) border of scapula is centered to the CR and IR.

Central Ray
¥ CR to midscapula lateral border
¥ Minimum 40 inches (100 cm) SID

Collimation
Collimate to area of scapula.

Respiration
Suspend respiration during exposure.

Radiographic Criteria
Structures Shown:
¥ Entire scapula should be visualized in a lateral position.

Position:
¥ True lateral is shown by direct superimposition of vertebral and lateral borders. ¥ Body of scapula should be seen in profile, free of superimposition by ribs. ¥ As much as possible, the humerus should not superimpose area of interest of the scapula.

Collimation and CR:
¥ Collimation should be visualized on four sides to area of scapula. ¥ CR and center of collimation field to lateral border of midscapula.

Exposure Criteria:
¥ Optimal exposure with no motion will demonstrate sharp bony borders and trabecular markings. ¥ Entire scapula should be visualized without excessive density in area of inferior angle. ¥ Bony borders of both the acromion and coracoid processes should be seen through the head of the humerus.
Students should determine whether they can critique each of the radiographs based on the categories as described in the textbook and as outlined on the right. As a starting critique exercise, place a check in each category that demonstrates a repeatable error for that radiograph.

Answers to repeatable errors are provided in Appendix B (at the end of this textbook).

**Fig. C6-96.** AP clavicle.

**Fig. C6-97.** AP shoulder—external rotation.

**Fig. C6-98.** AP scapula.

**Fig. C6-99.** AP humerus.