and to promote healing. However, unlike the situation with other joints, there is a greater priority on maintaining range of motion in the early stages of a shoulder injury because the shoulder is particularly prone to contractures, capsulitis, and severe loss of movement if it is immobilized. Hence, early treatment often involves exercises that are aimed at maintaining range of motion without aggravating the condition, performed several to many times per day.

When symptoms allow, progressive resistance exercises are gradually added. These strengthening exercises should include exercises for (1) the rotator cuff, vital for shoulder stability and the SIT force couple; (2) the scapular muscles, key for restoring an appropriate scapulohumeral rhythm; and (3) the other major glenohumeral muscles, important for shoulder joint stability and movements.

Evaluation and, if necessary, correction of shoulder mechanics are also essential for successful rehabilitation and the prevention of injury recurrence of the shoulder. With many shoulder injuries, the scapulohumeral rhythm tends to become disrupted (scapular dyskinesis), and excessive elevation accompanied by inadequate or delayed upward rotation of the scapula occurs. Use of technique cues and re-education, in conjunction with selective strengthening of necessary muscles such as the serratus anterior and lower trapezius, is often necessary to restore proper mechanics. As with other joints previously discussed, progression to exercises involving support of the bodyweight (closed kinetic chain exercises) and proprioceptive challenges (such as performing exercises with single- or double-arm support on a foam roller, ball, or balance board) is also desired.

**Common Injuries of the Upper Extremity**

A brief discussion of some of the more common injuries that involve the upper extremity follows. Although there is limited research related to upper extremity injuries in dancers, interested readers are referred to the vast number of studies in which upper extremity injuries are common such as swimming, throwing sports, racket sports, and gymnastics.

**Acromioclavicular Sprain**

(Acromioclavicular Separation)

An *acromioclavicular sprain*, acromioclavicular separation, or “shoulder separation” refers to a sprain and often dislocation of the acromioclavicular joint. It involves a tearing of the ligaments and frequently the capsule of the joint. This injury often occurs from a fall on the point of the shoulder or on an outstretched hand (Hall-Craggs, 1985).

An acromioclavicular sprain is characterized by severe pain that is aggravated by movements of the arm and by localized tenderness and swelling directly over the acromioclavicular joint (Roy and Irvin, 1983). Less severe sprains are associated with a subluxation, while more severe sprains are associated with a complete dislocation of the acromioclavicular joint as seen in figure 7.52. With more severe sprains, the ligaments that connect the clavicle to the coracoid process of the scapula (coracoclavicular ligaments: coracoid and trapezoid ligaments) are torn; the distal end of the clavicle is raised relative to the acromion and may even ride above the acromion process (figure 7.52B). The shoulder tends to fall away from the clavicle, due to the weight of the arm, and appears to droop relative to the other shoulder. The acromion of the scapula also appears more prominent on the injured side (Moore and Agur, 1995).

Recommended treatment often involves use of a snug arm sling designed to support the weight of the arm (Yamaguchi, Wolfe, and Bigliani, 1997). Since the stability of this joint is dependent on the ligaments and the surrounding muscles do little for stability, the focus of initial treatment is generally more oriented toward trying to prevent excessive motion of the acromioclavicular joint so that ligamental healing can occur. With severe dislocations it is often difficult to maintain the desired alignment of the acromion and scapula without the clavicle’s overriding the acromion; and for elite athletes, some physicians recommend surgery to stabilize the joint.

**Shoulder Dislocation**

Due to the design of the shoulder for mobility and its inherent instability, the shoulder (glenohumeral joint) is vulnerable to dislocation. Although there are four types of dislocation that can occur, inferior and particularly anterior dislocations occur most frequently in forming athletes (Moore and Agur, 1995). In anterior or subcoracoid dislocations (figure 7.53B), as the head of the humerus moves forward, the joint capsule, inferior glenohumeral ligament, and sometimes the glenoid labrum can be torn from their anterior attachment onto the glenoid cavity. Common mechanisms for this injury include an abduced and externally rotated arm position, or less frequently an arm position involving extreme shoulder extension with external rotation. In contrast, the mechanism of injury for inferior or subglenoid dislocation (figure 7.53C) is a blow or large downward force applied to the arm when it is fully abducted in
FIGURE 7.52  (A) Moderate and (B) severe sprain of the acromioclavicular joint (right shoulder, anterior view).

FIGURE 7.53  Two common types of shoulder dislocations (right shoulder, anterior view). (A) Normal positioning of the head of the humerus, (B) anterior (subcoracoid) dislocation, (C) inferior (subglenoid) dislocation.

an overhead position. In dance, shoulder dislocations occur infrequently. When they do occur, potential mechanisms include falls, mistakes with partnering or contact improvisation, or demanding positions of body support by an arm.

Anterior dislocation of the shoulder is visually apparent, as the rounded appearance of the shoulder due to the greater tubercle of the humerus disappears and a cavity can be felt below the acromion while the acromion appears more prominent (Roy and Irvin, 1983). The initial dislocation of the shoulder is associated with intense pain. Pain with movement is severe, and the dancer may attempt to support the injured arm with the opposite arm. Tingling and numbness may be present down the arm to the hand.

This is a medical emergency, and a qualified medical professional should be summoned or the medical emergency system activated (call 911). In some cases, the humerus will go back into its socket by itself (spontaneous reduction), but in other cases a specific reduction maneuver has to be performed by a qualified physician as nerves and blood vessels can be injured if the procedure is performed incorrectly. Furthermore, additional injury such as fractures and rotator cuff tears can be associated with a dislocation and must be ruled out by a qualified medical professional before reduction is performed.

The arm is often initially placed in a sling (Park, Blaine, and Levine, 2002) as initial symptoms are controlled. When rehabilitation occurs, a particularly strong emphasis is placed on building the strength of the rotator cuff muscles. Emphasis on strengthening the deltoid and scapular muscles, as well as progressing to proprioceptive exercises and functional open and closed kinematic chain movement patterns, is important for restoring correct mechanics and stability (Shea, 2001). Unfortunately, traumatic shoulder dislocations often involve disruption of the glenoid labrum and inferior glenohumeral ligament, as well as deformation of the joint capsule. This damage can readily lead to shoulder instability, and reports
of shoulder dislocation recurrence rates in athletes vary from 50% to 90% (Yamaguchi, Wolfe, and Bigliani, 1997). Hence, corrective surgery may be necessary, often involving the repair of any avulsion of the glenoid labrum, ligaments, or capsule from the rim of the glenoid fossa and “tightening” of the joint capsule (Levine et al., 2000; Nelson and Arciero, 2000; Steinbeck and Jerosch, 1998).

**External Shoulder Impingement Syndrome**

**External shoulder impingement syndrome** (subacromial impingement) is classically used to describe a pinching or impingement of inflamed or tender soft tissues between the head of the humerus and the overlying coracoacromial ligament, acromion process, or both. The space inferior to the coracoacromial arch and superior to the head of the humerus, termed the subacromial space, is only about 0.4 inches (1 centimeter) when the arm is down by the side (Kreighbaum and Barthels, 1996). External impingement syndrome can be further subdivided into primary and secondary impingement.

**Primary impingement** occurs when this subacromial space is mechanically narrowed by factors such as a hooked acromion, bone spurs, a thinned rotator cuff, or fibrotic subacromial bursa (Myers, 1999). In contrast, **secondary impingement** occurs when the subacromial space is functionally narrowed by factors such as scapular or rotator cuff muscle weakness and fatigue, posterior capsule tightness, or glenohumeral instability. These latter factors have the effect of allowing the head of the humerus to migrate upward or not stay centered in the glenoid cavity during shoulder flexion and abduction, producing impingement. Secondary impingement occurs more frequently in individuals under 35 years of age (Cavallo and Speer, 1998), while primary impingement occurs more commonly in older individuals.

Given that the supraspinatus tendon runs right over the top of the humerus to attach onto the upper portion of the greater tubercle (figure 7.54), it is not surprising that the most common inflamed structure “pinched” with external shoulder impingement syndrome is the external surface of the supraspinatus tendon. However, other structures located in this area that can be involved include the tendon of the biceps brachii and the subacromial bursa.

The impingement syndrome is particularly prevalent in sports that utilize repetitive shoulder flexion and abduction, particularly overhead motions such as in baseball, swimming, gymnastics, and weightlifting (Briner and Benjamin, 1999; Cavallo and Speer, 1998; Kammer, Young, and Niedfeldt, 1999; Warner et al., 1990). As many as 50% of competitive swimmers report impingement-type shoulder pain (Nuber et al., 1986). In dance, similar stresses can occur with overhead partnering, choreography that requires very rapid and percussive use of the arms, and movements that require support of the body weight by the arms such as handstands, cartwheels, and handsprings.

---

**FIGURE 7.54** Impingement syndrome (right shoulder). (A) Lateral view of coracoacromial arch. (B) With arm down by side, adequate space is present between the humerus and coracoacromial arch, but (C) with shoulder abduction the space is reduced and impingement can occur.
External impingement syndrome is characterized by pain in the anterior, superior, or lateral shoulder (Wolin and Tarbet, 1997) that is aggravated by overhead movements, particularly between 60° and 120° of shoulder abduction as seen in figure 7.55. Due to the mechanics of the shoulder, the initial range of abduction does not approximate the involved structures sufficiently to produce impingement. However, usually at about 60° (although sometimes as early as 45°) the inflamed tendons or bursa is impinged against the overlying coracoclavicular arch, producing pain. Blood supply to the supraspinatus tendon may also be compromised in this range of motion (Kreighbaum and Barthels, 1996). In some cases, a snapping sensation or crepitus may also accompany the pain occurring in this arc. Sometimes the pain is severe enough to prohibit further raising of the arm, but if not, the pain usually diminishes after about 120° when external rotation of the humerus places the greater tubercle behind the acromion so that impingement no longer occurs. Due to pain, the use of the shoulder joint is often limited, and muscle inhibition, weakness, and atrophy often follow.

During initial phases of treatment, shoulder abduction and overhead movements are often limited or avoided. Dancers can temporarily modify use of the arms to below shoulder height (or whatever range is pain free) or perform some combinations with and without arms so that fatigue and associated pain are avoided. Stretching to maintain normal range of motion is often recommended, as low range of motion in shoulder horizontal abduction (Greipp, 1985), shoulder external rotation, shoulder internal rotation, and shoulder horizontal adduction (Warner et al., 1990) may increase the risk for impingement. The latter decrease in range is often due to tightness in the posterior capsule and is theorized to produce undesired anterior glide and elevation of the head of the humerus during shoulder flexion.

When symptoms allow, strengthening exercises are initiated. Particular emphasis is placed on strengthening the rotator cuff due to its important role in helping prevent excessive upward movement of the head of the humerus (SIT force couple). Furthermore, the impingement syndrome has been shown to be associated with low strength in the external rotators relative to the internal rotators (Warner et al., 1990), suggesting that greater emphasis should be placed on strengthening shoulder external rotation. However, positions for strengthening the rotator cuff often have to be modified to avoid 60° to 120° of abduction, and a position in which the arm is slightly raised (30° of abduction in the scapular plane) so that blood flow is not decreased and impingement risk is low is often recommended. Strengthening of the scapular depressors and upward rotators (lower trapezius and serratus anterior) is also essential for restoring a normal scapulohumeral rhythm when the arm is raised overhead. With normal mechanics, upward rotation of the scapula moves the acromion process out of the way as the humerus approaches it during abduction (Kreighbaum and Barthels, 1996). However, individuals with impingement appear to exhibit inhibition and disrupted recruitment patterns of the serratus anterior and lower trapezius (Cools et al., 2003), with increased activity of the rhomboids (Johnson, Gauvin, and Fredericson, 2003) or upper trapezius (Kibler, McMullen, and Uhl, 2001). This disruption of scapular synergies can lead to excessive scapular elevation, or hiking of the shoulder when raising the arm, perhaps to compensate for decreased glenohumeral motion but tending to drive the humeral head upward and increase impingement risk. Thus, restoration of adequate strength and shoulder mechanics is necessary for avoidance of impingement and resolution of symptoms. Correction of rolled shoulder and kyphosis, when indicated, may also be prudent due to the decrease in subacromial space associated with these postural problems (DePalma and Johnson, 2003).

Rotator Cuff Tear

In some cases, injury to the rotator cuff may not involve only inflammation (tendinitis) but rather an incomplete or complete tear of the rotator cuff. Such
an injury most commonly involves the supraspinatus (figure 7.56) at its musculotendinous junction where blood supply is poor but may also include the infraspinatus tendon. In the younger athlete, this tear is often associated with a traumatic event such as a fall on an outstretched hand or forceful deceleration of internal rotation as in throwing (Duda, 1985; Yamaguchi, Wolfe, and Bigliani, 1997). During the acceleration phase of throwing, shoulder internal rotation can reach velocities of 9,000° per second in male intercollegiate baseball players (Brindle et al., 1999). Following the release of the ball, the rotator cuff works eccentrically to quickly decelerate this high-velocity internal rotation, leaving it vulnerable for injury. A rotator cuff tear can also follow weakening of the tendon from tendinitis and impingement. Millar (1987) states that rotator cuff strains are the most common shoulder injury in dancers and especially in male dancers.

The signs and symptoms of a rotator cuff tear are often very similar to those of the impingement syndrome, with tenderness near the insertion of the supraspinatus and aching pain that is magnified by shoulder abduction, especially between 60° and 120°. Pain is often persistent at rest and even at night (Wolin and Tarbet, 1997) and is often referred to the distal attachment of the deltoid. Furthermore, wasting of the supraspinatus may be present; and with more serious tears there may be the inability to abduct the arm against resistance or hold the arm in abduction (Caillet, 1996), probably due to pain. One test used, the drop arm test (Tests and Measurements 7.3) involves trying to hold the arm in abduction after it has been passively raised to about 90° (Magee, 1997; Mercier, 1995).

Recommended initial treatment may involve use of a sling and limitation of abduction, with additional treatment similar to that used with the shoulder impingement syndrome, including careful strength-training of the rotator cuff, proprioceptive exercises, and restoration of proper shoulder mechanics. However, in cases of a complete tear or when conservative treatment is unsuccessful, surgical repair may be recommended (Mercier, 1995; Yamaguchi, Wolfe, and Bigliani, 1997).

**Bursitis**

*Bursitis* is an inflammation of a bursa, and the subacromial bursa is most commonly involved at the shoulder (figure 7.54). As described with the shoulder impingement syndrome, the subacromial bursa’s location inferior to the coracacromial arch and superior to the supraspinatus tendon allows it to become readily inflamed due to impingement. Bursitis can also result from irritation by calcium deposits in the rotator cuff tendons (Wolf III, 1999) that occur in response to degenerative changes in these tendons or secondary to other injuries of the shoulder or acromioclavicular joint. As with impingement,

**TESTS AND MEASUREMENTS 7.3**

**Drop Arm Test for a Rotator Cuff Tear**

This test is performed by a physician or physical therapist when a tear of the rotator cuff is suspected. The examiner lifts the patient’s arm to 90° abduction and then lets go. The patient attempts to hold the arm in this position and then slowly lower it back down to the side. The inability to hold this position alone or against slight resistance, or the inability to lower the arm in a smooth, controlled manner without extreme pain, is considered a drop sign and suggests that a tear of the rotator cuff is present.
bursitis is particularly common in individuals utilizing repetitive overhead movements.

Bursitis is often associated with a generalized ache around the shoulder that is aggravated by full abduction, as well as external or internal rotation in abduction (Magee, 1997; McCarthy, 1989; Millar, 1987). It is also generally aggravated by sleeping with the arm overhead. Tenderness may also be present over the front and lateral aspect of the shoulder joint.

Recommended treatment often involves modification of activity to avoid lifting or overhead arm movements that aggravate the condition, modalities including ice or heat, anti-inflammatory medications, and, when symptoms allow, rehabilitation emphasizing strengthening the rotator cuff and correcting any technique/training errors (McCarthy, 1989). Careful injection of corticosteroids into the bursa (avoiding the closely aligned tendons) is also recommended by some physicians in cases that do not respond to these former treatments (Mercier, 1995; Millar, 1987).

Frozen Shoulder (Adhesive Capsulitis)

A frozen shoulder, or adhesive capsulitis, involves chronic inflammation and fibrosis of the glenohumeral capsule. In later stages it often involves adhesions between the capsule and articulating surfaces, as well as inflammation of the subacromial bursa and coracohumeral ligament. These changes result in a situation in which shoulder motion is dramatically reduced (e.g., inability to raise the arm overhead), hence the term "frozen shoulder." The etiology is not well understood, but frozen shoulder generally occurs after inactivity of the shoulder consequent to an injury or inflammation of the shoulder complex. Although it is rare in young active individuals, it can occur in older dancers, and particularly in women versus men (Mercier, 1995).

Adhesive capsulitis is generally associated with progressive loss of shoulder motion and an insidious onset of pain, localized to the area of the rotator cuff. This pain often interferes with sleep, prevents lying on the affected shoulder, and is progressive in nature. Tenderness is often present around the rotator cuff and biceps tendon. In terms of range of motion, there tends to be a generalized loss of both passive and active range of motion, and universally a loss of external rotation (Yamaguchi, Wolfe, and Bigliani, 1997). Although the person is often comfortable when moving within the restricted range, severe pain is often experienced with accidental movement beyond this range.

Treatment often involves anti-inflammatory medications and physical therapy that focuses on stretching and restoring range of motion. However, if conservative approaches fail, corticosteroids or more aggressive measures such as breaking of the adhesions under local anesthesia or surgical release of the capsule by an orthopedic surgeon may be required, followed by aggressive rehabilitation to avoid adhesion (Caillet, 1996; Pearsall and Speer, 1998).

**Biceps Tendinitis and Rupture**

The biceps brachii tendon can become inflamed, resulting in tendinitis (figure 7.57). This most commonly involves the tendon of the long head of the biceps brachii and its sheath (tenosynovitis). This tenosynovitis most often occurs in adults over 40 or in younger athletes whose sports demand repetitive arm movements (Mercier, 1995). Factors including a narrow intertubercular groove, repetitive subluxation of the tendon, or impingement under the coracoacromial arch may precipitate this injury.

**Biceps tendonitis** is characterized by pain that extends down the anterior aspect of the upper arm, lower than usually experienced with involvement of the supraspinatus tendon. Tenderness is also generally present over the bicipital groove when palpated. The intertubercular groove and associated biceps tendon can be easily palpated on the anterior shoulder when the arm is abducted 90° and the elbow is flexed 90°. The pain can often be replicated through utilization of maneuvers that place the biceps tendon on a stretch such as shoulder hyperextension with the elbow extended.

Recommended treatment often involves the usual limitation of motion to pain-free ranges, anti-
inflammatory medications, and physical therapy. However, successful treatment also needs to address potential underlying causes such as technique or shoulder impingement syndrome. If inadequately treated, chronic tendinitis, similar to that described at the ankle-foot, can result in an area of degeneration within the tendon that may precipitate complete rupture of the tendon (Mercier, 1995). Rupture usually follows a forceful contraction of the biceps and may be accompanied by the sensation of a “snap” and ensuing pain and weakness of the arm. Increased size and a distorted shape of the retracted biceps are often visible.

**Lateral Epicondylitis or Tennis Elbow**

*Lateral epicondylitis* involves injury in the area of the lateral epicondyle that is thought to entail inflammation and small tears of the proximal tendinous attachments of the extensors of the wrist (Moore and Agur, 1995; Soderberg, 1986). Lateral epicondylitis is an overuse injury that is common in athletes utilizing the wrist extensors repetitively, such as pitchers and tennis players. In fact, this injury is so common in tennis that it is often termed “tennis elbow.” Approximately 45% of tennis players who play daily develop tennis elbow (Weldon, 1988). In dancers, lateral epicondylitis is likely related to partnering and support of the body weight by the arms and has been reported to be the most common injury to the elbow (Millar, 1987).

Lateral epicondylitis is characterized by pain over the lateral aspect of the elbow, usually 0.4 to 0.8 inches (1-2 centimeters) distal to the lateral epicondyle (Goldman and McCann, 1997) as seen in figure 7.58. The pain is initially associated with activity and relieved by rest. Pain can generally be reproduced with passive wrist flexion or by resisting wrist extension (Magee, 1997) and tends to be aggravated by movements involving active wrist extension, rotation of the forearm (such as turning a doorknob or lid of a jar), or grasping of objects. If activity is continued, the pain often radiates down into the forearm and progresses such that it occurs during rather than only after activity.

Initial recommended treatment generally involves cessation or modification of aggravating movements, oral anti-inflammatory medications, and physical therapy modalities such as heat, cold, electric stimulation, and ultrasound (Kulund et al., 1979; Nirschl and Kraushaar, 1996a). Some physicians advocate the injection of corticosteroids in individuals who do not respond to other measures (Giacotti and Charlton, 2001; Roberts, 2000). When symptoms allow, balanced strength and flexibility of the elbow and forearm muscles are developed with emphasis on strength and flexibility of the wrist extensors. Technique should also be evaluated and correction made, if indicated. Some dancers may benefit from wearing a band (counter brace) 1 inch (2.5 centimeters) or more below the elbow (Barclay, 2004; Goldman and McCann, 1997) during rehearsals or classes that involve movements placing repetitive or large stresses on this area. Elbow counterforce braces have been shown to decrease elbow angular acceleration and reduce activity of the wrist extensors (Groppel and Nirschl, 1986), valuable for the treatment of lateral epicondylitis.

**Carpal Tunnel Syndrome**

The carpal tunnel is a narrow tunnel found in the hand. Its floor is formed by selected carpals that create a concave surface, and its roof is formed by a fibrous band formed by the flexor retinaculum or transverse carpal ligament (figure 7.59). Hence, this tunnel is termed a fibro-osseous tunnel (“osseous” meaning bone). The carpal tunnel extends about 1.2 inches (3 centimeters) and is traversed by the nine tendons of the flexors of the fingers and the median nerve (Caillet, 1996; Kreighbaum and Barthels, 1996). Due to the limited space available in this canal, the carpal tunnel becomes a common site for nerve compression, termed *carpal tunnel syndrome* (CTS).

Although the cause of this condition is poorly understood, a higher risk is associated with occupations involving repetitive finger or wrist flexion (such as with computer keyboards), repetitive gripping, or prolonged exposure to vibration. Similarly, athletes engaged in activities with repetitive flexion or gripping such as racquetball players, golfers, and rock climbers tend to sustain CTS (Rosenwasser and

![Lateral epicondyle](image)

**FIGURE 7.58** Lateral epicondylitis (right elbow, lateral view).
Wilson, 1997). In dance, choreography demanding repetitive support of the body by the arms, especially in dancers not accustomed to such activity, may increase the risk for CTS. During pregnancy, the associated fluid retention tends to cause compression of the median nerve; and as many as 20% of pregnant women may experience carpal tunnel symptoms, which tend to go away after delivery (Magee, 1997; Mercier, 1995).

Carpal tunnel syndrome is characterized by numbness and tingling in the middle and index fingers, or these plus the thumb and the lateral half of the ring finger (Moore and Agur, 1995). The tingling of the fingers can often be reproduced or worsened if the wrist is held in a position of maximum flexion for a period of at least 1 minute (Phalen’s test). Carpal tunnel syndrome is also often accompanied by night pain, which has been conjectured to be due to wrist flexion or the slight swelling associated with decreased activity during sleeping (Mercier, 1995). In severe cases, the pain associated with CTS may radiate into the forearm, arm, and even shoulder. If compression persists, motor function may also be affected, leading to weakness of wrist flexion; finger flexion; and flexion, abduction, and opposition of the thumb. With more advanced cases this weakness may be evidenced by the lack of fine coordination, loss of grip strength, tendency to drop things, and difficulty turning the lids on jars.

Treatment often involves the use of a splint that prevents extreme wrist flexion or extension, and modification or elimination of the movements that aggravate the condition. Anti-inflammatory medications and physical therapy modalities such as ultrasound may reduce the symptoms (O’Connor, Marshall, and Massy-Westropp, 2004). When symptoms allow, flexibility and strength exercises for the wrist-hand complex are often recommended. However, initially, flexion-extension exercises of the wrist or fingers can increase pressures in the canal and aggravate the condition, and the effectiveness of exercise for this condition is controversial. In cases that do not respond to conservative treatment and in which symptoms are severe or motor weakness is developing, surgical release of the transverse carpal ligament is sometimes recommended and has been shown to generally have good outcomes (Barclay, 2002; Kao, 2003).

**Summary**

The upper extremity has many structural parallels to the lower extremity and also some important differences. Many of these differences are necessary to meet the primary demand of the upper extremity for mobility and manipulation of objects, in contrast to the demand for stability, support, and locomotion of the lower extremity. A summary of the bones and joints of the upper extremity can be seen in figure 7.60, while figure 7.61 shows the superficial muscles of the arm. Refer back to figures 7.17 and 7.18 (pp. 393-394) for a summary of additional muscles of the shoulder complex. The ringlike shoulder girdle hangs on the axial skeleton, connected to the axial