Chapter 17
Physical Therapy: Tips and Pitfalls

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Abstract Postoperative physical therapy is important to obtain smooth recovery of shoulder functions and satisfactory return to daily living after surgery. In addition, physical therapy as a conservative treatment can lead to enhancement of shoulder function and consequent improvement of symptoms, and furthermore, can validate the indication of shoulder surgery even though the conservative treatment is not effective. In conservative physical therapy for rotator cuff tear, improving function of residual cuff tendons as well as coordination between the glenohumeral and scapulothoracic joint are essential. In postoperative physical therapy after rotator cuff repair, prescription of exercise in line with advances in healing of rotator cuff is necessary. For frozen shoulder, physical therapy intervention needs to be provided according to the phase of the disease. In physical therapy for throwing injuries, contributing factors to shoulder injury as well as functional problems induced by the injury need to be managed. For humeral fracture, therapeutic exercise should be performed without shear stress on the fractured part. In postoperative physical therapy after total shoulder arthroplasty (TSA) and reverse shoulder arthroplasty (RSA), loading during exercise needs to increase with attention to postoperative

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complications. In physical therapy after hook plate fixation for acromioclavicular joint dislocation, an exercise program should be designed based on the characteristics of the hook plate.

Keywords Physical therapy • Shoulder function • Rehabilitation

17.1 Rotator Cuff Tear

17.1.1 Conservative Treatment of Rotator Cuff Tears

Improvement of symptom in the patients with rotator cuff tears is attributed to subsiding of bursitis, decrease of muscle spasm, and compensation of adjacent cuff tendons for the torn cuff tendon [1].

In the acute phase, symptoms such as resting pain and elevation deficit emerge. Aggressive therapeutic exercise should be avoided in this phase. Instead, the therapist instructs resting position and Codman's stooping exercise to resolve inflammation reaction and to obtain muscle relaxation.

After confirmation of subsiding of the inflammation reaction, aggressive shoulder exercise will start. Inflammation reaction is considered to have subsided when the shoulder pain becomes localized.

17.1.1.1 Improving Function of Residual Rotator Cuff Tendons

Four muscles form the rotator cuff as a functional unit to stabilize the glenohumeral joint. Therefore, residual cuff tendons can play a role of stabilizing the joint by improving their function, even though a part of the rotator cuff is torn. For example, although infraspinatus tendon tear can result in weakness or deficit of active shoulder external rotation, enhancing the function of the teres minor enables the patients to perform external rotation in arm elevation position (Fig. 17.1).

17.1.1.2 Improving Function of the Scapulothoracic Joint

The humeral head is superiorly migrated by contraction of the deltoid muscle during arm elevation when rotator cuff tear progresses to some extent. The superior migration of the humeral head makes passage of the greater tuberosity under the acromion difficult, and arm elevation is thereby restricted. The superior migration of the humeral head can be avoided if the patients are able to contract the deltoid muscle with downward rotation of the scapula, which means that the glenoid faces inferiorly, although this motion is different from the normal scapulohumeral rhythm. After the greater tuberosity passes under the acromion with the deltoid contraction at lower elevation angle where the arm is less affected by gravity, patients need to practice shoulder elevation with compensatory upward rotation of

Fig. 17.1 Exercise to improve function of residual rotator cuff muscles. To improve compensatory function of residual cuff muscles, rotation exercises are performed in various shoulder positions. For example, external rotation in arm elevation position can facilitate compensatory function of the teres minor

the scapula. To do so, improving coordination between the glenohumeral and scapulothoracic joint as well as mobility in downward rotation and depression of the scapula is essential (Fig. 17.2).

17.1.2 Postoperative Physical Therapy [2]

After rotator cuff repair, it is important that the therapeutic exercise program proceed in a step-by-step manner according to the healing process of the repaired rotator cuff.

17.1.2.1 Range-of-Motion Exercise

From a couple of days after the surgery, gentle passive range-of-motion exercises for the directions where the repaired rotator cuff is not stretched start to prevent adhesion around the repaired site. For supraspinatus tendon tear, passive elevation in the scapular plane and external rotation starts immediately after the repair, whereas passive range of motion in the direction to adduction, internal rotation, and horizontal adduction, which can add stress to the repaired supraspinatus tendon, start from 5 to 6 weeks after the repair.

17.1.2.2 Muscle-Strengthening Exercise

Active assistive exercises start from 4 weeks after the surgery. Active exercise, followed by resistive exercise, starts with gradual increase of loading from 5 weeks after the surgery.

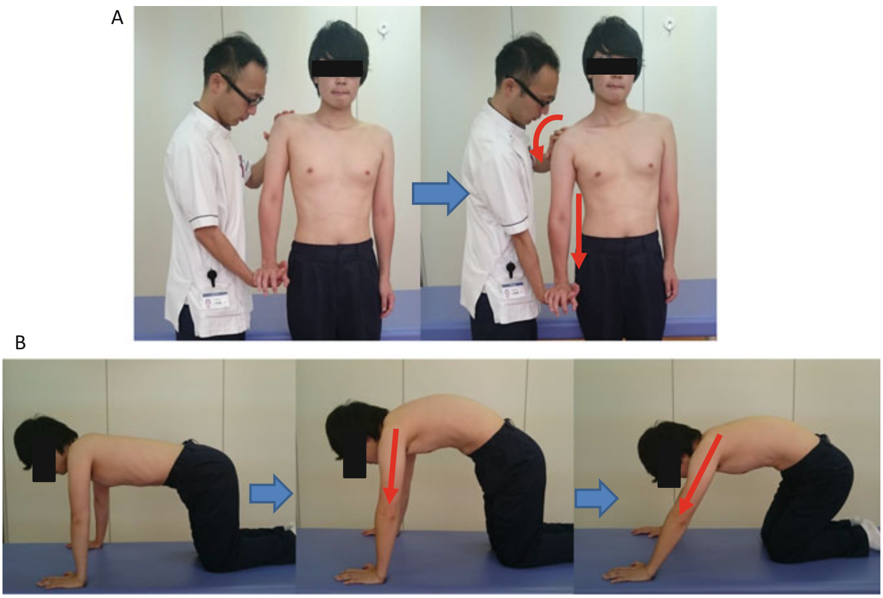

Fig. 17.2 Exercise to improve coordination between the humeral and scapular motions. Patient pushes the therapist's hand down with fully extended elbow. This motion facilitates scapular depression and downward rotation. Consequently, the glenohumeral joint is relatively abducted (**a**). In all-fours position, the patient protracts his scapula by pushing the floor, and then changes the direction of pushing forward so that the patient's trunk moves backward. This exercise can facilitate the scapular motion more dominantly compared to the humeral motion. In addition, this exercise can be performed with less activity of the deltoid muscle causing superior shift of the humeral head because of weight-bearing condition (**b**)

17.1.2.3 Other Tips and Pitfalls

Excessive tension of shoulder girdle muscles is often observed because of pain and immobilization immediately after the surgery. Therapeutic exercise without relaxing the hypertone of shoulder muscles can risk increasing stress to the repaired rotator cuff. Relaxation approaches to the elbow, forearm, and trunk before the exercise for the glenohumeral joint should start immediately after the surgery.

17.2 Frozen Shoulder

17.2.1 Intervention in Each Phase of the Disease

17.2.1.1 Acute Phase After Onset

Although the inflammatory reaction is necessary for the involved tissue to recover from the pathological condition, this reaction should be minimized to prevent a high intensity of scar formation resulting in severe joint contracture. Therefore, keeping the involved shoulder joint at rest is the fundamental intervention strategy in this phase. However, it is a challenge for the patient to do that because the patients never consider the symptoms to be severe and tend to place priority on their daily activities.

17.2.1.2 Peak Inflammation Phase

Unnecessary intervention can disturb a subsiding inflammation reaction and induce broad formation of scar tissue in the joint capsule, although negative effects of prolonged rest are also a problem as is the continuous inflammation. There is no clear way to define exercises that promote recovery while preventing excessive inflammatory reaction. In this phase, the synovium of the joint capsule appears to be red and sore because of active capillary angiogenesis. The shoulder joint should be moved without stimulating the synovium. Pain is the most useful indicator to control the loading to the involved tissues.

17.2.1.3 Late Inflammation Phase

Scar tissues in the capsule are formed in proportion to severity of inflammation reaction. It is anticipated that high-intensity exercises will lead to reactivation of inflammation because of proliferation of capillary vessels in the synovium. Low-intensity exercise such as active assistive or active exercises without pain provocation should be performed to prevent the exacerbation of joint contracture.

17.2.1.4 Frozen Phase

Stretching exercises can be included in the treatment program in this phase when the capillary vessels in the synovium decrease and the process of joint contracture is completed. However, high-intensity stretching to gain immediate and temporal improvement is less meaningful because of scar formation in the joint capsule. Rather, it is more important to provide low-intensity mechanical stress to the scar tissues, to promote circulation around the joint, and thereby to attempt to remodel the connective tissues of the shoulder joint. In that sense, a treatment program including active exercise as well as stretching exercise may be more effective than stretching exercise alone.

17.2.1.5 Thawing Phase

In this phase, the joint contracture, which did not respond stretching exercise, improves naturally. It is common that this “thawing” occurs approximately 1 year after the onset. Stretching exercise is effective in this phase; however, high-intensity stretching exercise ignoring the consideration of pain is not recommended.

17.2.2 Targets and Techniques of Stretching

17.2.2.1 Muscles

Shortening of shoulder muscles also progresses secondary to joint contracture, and then worsen to the degree stretching does not immediately respond to intervention. The main targets of stretching are the rotator cuff muscles, pectoralis major, teres major, etc. Severity of contracture in each muscle is different depending on the patients. Stretching with bone movement, contract–relaxation, press-out stretching, and deep tissue massage are used to regain the flexibility of each muscle.

17.2.2.2 Ligaments

17.2.2.2.1 Coracohumeral Ligament

In the frozen shoulder, serious scar formation tends to occur in the coracohumeral ligament, and the contacted ligament becomes a factor causing severe restriction of shoulder joint motion. In macroscopic finding during open surgery, it appears to be impossible to stretch the contracted coracohumeral ligament. Therefore, physical therapy needs to continue patiently until sufficient improvement in the flexibility of the ligament is obtained. Horizontal abduction, with external rotation at shoulder adduction, or extension stretches this ligament. The stretched ligament can be palpated immediately lateral to the side of the coracoid process.

17.2.2.2.2 Glenohumeral Ligament

As shown in Fig. 17.3, all fibers of the glenohumeral ligament are lengthened at both internal and external rotations in shoulder elevation in the scapular plane compared with that at neutral rotation. External rotation at shoulder elevation or abduction stretches the inferior glenohumeral ligaments. External rotation at shoulder adduction stretches all fibers of the glenohumeral ligament. These motions also stretch the anterior and anteroinferior capsule because the glenohumeral ligament merges with the joint capsule.

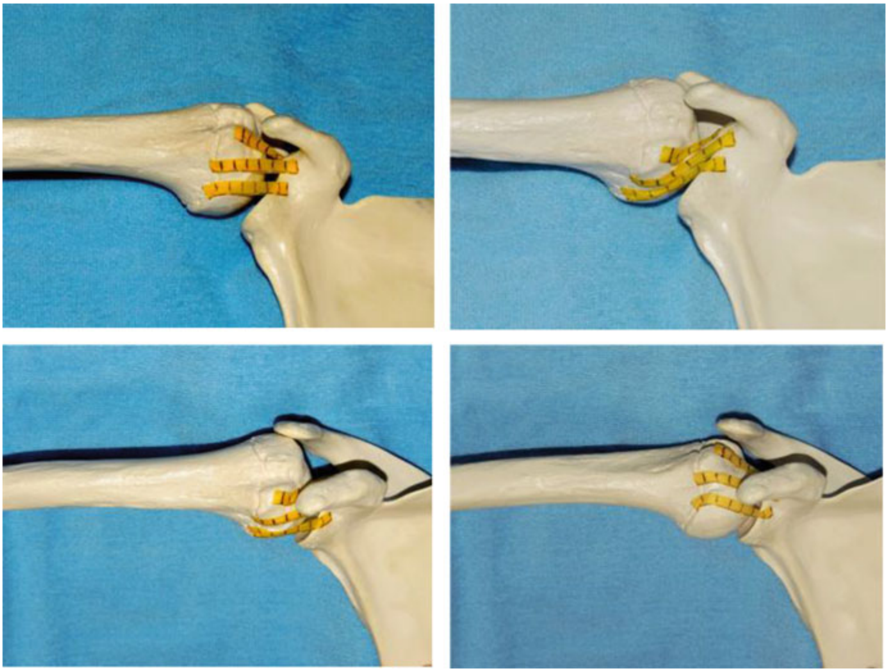

Fig. 17.3 Behavior of the glenohumeral ligament during rotation in shoulder elevation position in the scapular plane. Both internal and external humeral rotation without change of glenohumeral elevation angle lengthens all fibers of the glenohumeral ligament compared to the length at neutral rotation. (**a**) Observation from anterior aspect during internal rotation. (**b**) Observation from anterosuperior aspect during external rotation

17.2.2.3 Capsule

Bone movement (osteokinematic motion), joint distraction, and gliding in closed-pack position are used to stretch the capsule.

17.2.2.4 Flexibility of the Thorax

Patients with kyphosis have poor flexibilities of the thorax as well as of the spine. Adduction of the scapula is restricted by the poor flexibilities of the thorax even though the scapulothoracic joint itself is flexible enough to move because the scapula is positioned more ventrally as the result of kyphosis and poor flexibility of the thorax. In the whole shoulder girdle, the ranges of abduction and horizontal abduction are affected. Passive motion exercises to dorsal, ventral, and caudal directions are performed slowly and carefully to obtain the flexibility of the thorax. Mobilization of the costovertebral joint is also effective. Care should be taken to avoid rib fracture when these techniques are used for elder people.

17.2.2.5 Scapulothoracic Joint

The scapular position is controlled by tethering with the rhomboids and levator scapulae from the spinal side and with the serratus anterior from the anterior side. The trapezius controls scapular upward rotation. It is considered that the pectoralis minor and latissimus dorsi help in stabilizing the scapular so as not to separate it from the thorax. Although the range of scapulothoracic motion is restricted, the cause is most likely hypertonic contraction of scapulothoracic muscles rather than contractures of their muscle tissues. Active assistive exercise to guide directions of optimal scapular motions will be effective.

Physician and therapist should check the relationship between the range of scapular motion and the position of the spine and then judge whether scapular motion is a true problem. For normal scapular motion during shoulder abduction, scapular upward rotation occurs with the glenoid facing forward along the shape of the rib cage around 120° of abduction. Therefore, range of horizontal abduction in the glenohumeral joint is required during shoulder abduction. Scapular motion will be blocked because glenohumeral horizontal abduction is restricted by the lesser flexibility of the anterior capsule and ligaments in the shoulder with contracture. In this case, the anterior connective tissues should be treated because the cause of the restriction is not contracture in the scapulothoracic joint.

17.2.3 Stretching Technique Without Inducing Subacromial Impingement

17.2.3.1 Humeral Neck Axis Rotation (Figs. 17.4 and 17.5)

When the long axis of the anatomic neck of the humerus (humeral neck axis) is placed perpendicular to the glenoid surface, the spinning motion of the humeral head about the long axis can avoid subacromial impingement because the greater and lesser tuberosities do not approach the undersurface of the coracoacromial arch. To place the humeral neck axis perpendicular to the glenoid surface, the glenohumeral joint needs to be manipulated as follows. First, therapists imagine the humeral neck axis as an axis of cone with 90° of apex angle and place it perpendicular to the glenoid surface; then, they need to move the humerus on the slope of the cone (offsetting the neck shaft angle) and to keep the forearm at 30° of external rotation relative to the tangent line wherever the upper arm is located (offsetting the retroversion angle). This maneuver produces a spinning motion of the humeral head in the humeral neck axis. Stretching is performed at the end range of this spinning motion. In healthy people, ranges of external and internal rotations in this motion are approximately 75° and 55°, respectively.

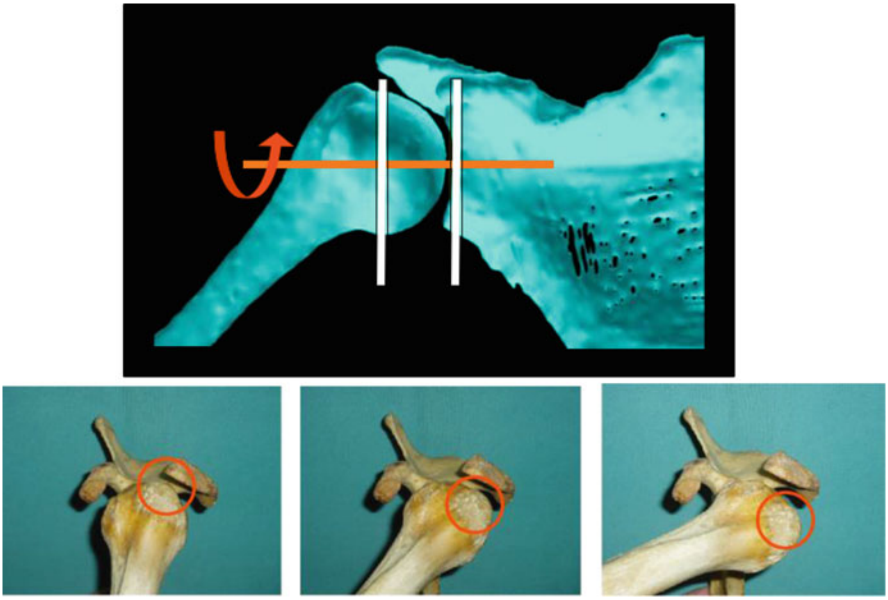

Fig. 17.4 Diagram and photograph of humeral neck axis rotation. The humerus is rotated along the long axis of humeral neck in the glenohumeral position where the plane of the humeral anatomic neck is placed parallel to the plane of the glenoid (**a**). When the humerus is rotated forward on the humeral neck axis, the greater tuberosity moves parallel to the coracoacromial arch (**b**)

17.2.3.2 Press-Out Stretching (Figs. 17.6 and 17.7)

Instead of bone movement, muscle is stretched by pushing it out like a bowstring. This technique can be applied to stretching of the teres major, pectoralis major and minor, triceps brachii, etc., although this technique cannot cover all shoulder muscles because sufficient spaces to push them out are needed.

17.3 Throwing Injuries

17.3.1 Goal of Physical Therapy for Throwing Injuries

The goal of physical therapy for throwing injuries in the shoulder is not only to regain an ability to throw. Regaining the ability to throw is a process to achieve the final goal because it is important not only to improve impairment induced by the injuries but also to manage contributing factors to the injuries, and furthermore to encourage the athletes to change their behavior to prevent the recurrence of injury.

Fig. 17.5 Humeral neck axis rotation in side lying. First, shoulder is abducted by 45° and is rotated externally by 30° in side-lying position. When shoulder is rotated with keeping the elbow and hand position from the ground, the humeral neck axis rotation can be performed in the shoulder joint

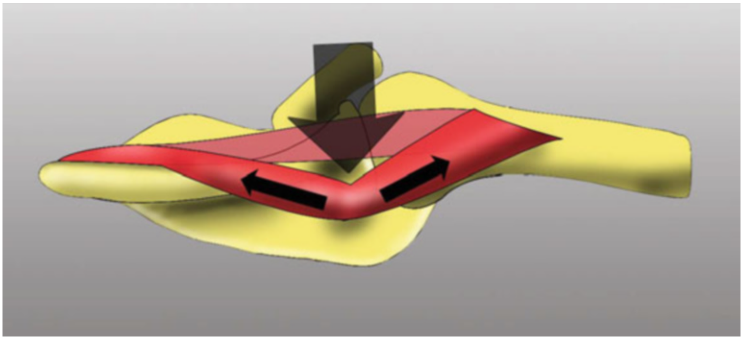

Fig. 17.6 Diagram representing principle of press-out stretch for the teres major. The teres major can be stretched by pressing its muscle belly dorsally

Throwing injuries are injuries induced by repetitive loading to the joint, which come from various causes. Even though athletes regain the ability to throw once, lack of management for contributing factors, which originally led to the throwing shoulder injuries, can cause recurrence of the injuries and, in some cases, may make them more severe. It should be noted that reducing the overload to the shoulder joint and preparing conditions to protect the joint are more important than only regaining the ability to throw.

Fig. 17.7 Photograph of press-out stretch

17.3.2 Managements of Local Parts and Whole Body

In throwing shoulder injuries, structural and functional problems around the shoulder exist. Particularly, functional problems induced by damages of the shoulder structure should be managed based on physiological recovery process. This management is an important issue in the physical therapy for the early phase after the throwing injuries. In the process of management, assessment of the local parts related to the injuries needs to be precisely performed while excluding the influences of the other body parts. Management also needs to focus on the local part depending on its purpose.

Functional problems in adjacent joints can cause overload in the shoulder because the shoulder moves on the thorax and is strongly affected by the adjacent joints. In addition, the primary causes of the throwing shoulder injuries, which add overload to the shoulder joint, can be the same as the functional problem of the adjacent joint. Furthermore, subject to throw is required to achieve precisely the aim with speed and trajectory expected by the athletes in throwing, particularly pitching. To do so, each part of the body sequentially and smoothly works together. Therefore, dysfunction of a part of the body makes the stress on other body parts higher. A shoulder problem can be also caused by functional problems of the other body parts [3].

Based on the purpose of the physical therapy for throwing shoulder injuries, management of these contributing factors from various parts other than the shoulder is also another important issue and should be chosen depending on the condition and ability of throwing athletes and the phase of the recovery process. Attitude to select proper management depending on the situation of the cases is essential without premature decision on whether management should be provided to the injured part or contributing factors to the injury.

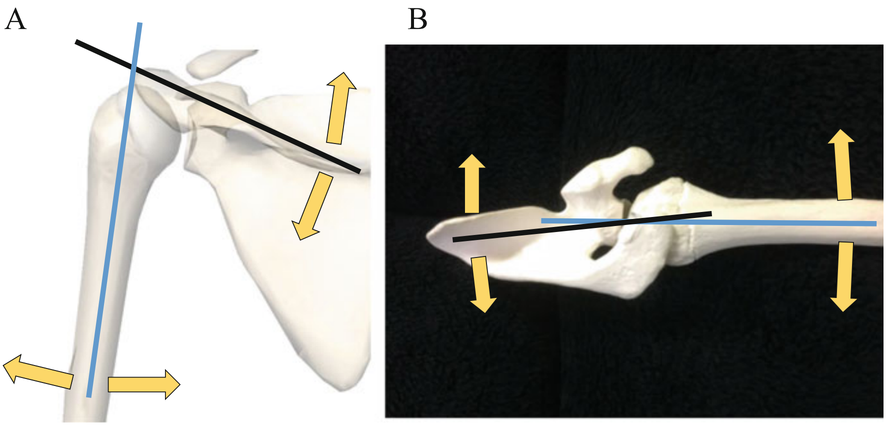

Fig. 17.8 Assessment of relationship between scapula and humerus. (**a**) Changes of spinohumeral angle in scapular plane. (**b**) Changes of scapular plane and humerus in horizontal plane

17.3.3 Functional Assessment

Based on characteristics of shoulder function, the humerus, scapula, and other body parts should work together to keep the appropriate joint position and to thereby protect the joint [4, 5]. Therefore, only assessing either the humerus and scapula in a certain position or condition is insufficient to obtain the information for decision making in physical therapy. From this point of view, not only measuring range of humeral motion relative to the ground, but also assessing the scapular position relative to the ground and the humeral position relative to the scapula are important (Fig. 17.8).

In addition, throwing shoulder injuries are often caused by a combination of various contributing factors rather than a simple cause. Hence, the information from an assessment needs to be considered as the result of the combination of several factors. Interaction of each contributing factor should be examined with information related to other factors.

For example, if manual muscle testing for arm elevation at 45° of elevation in the scapular plane causes scapular downward rotation with pain, this downward rotation may indicate a problem on scapular stabilization. However, there is a possibility of necessary evil, namely compensatory motion to reduce the pain as well, because the scapula and humerus change their positions to each other depending on the situation. To confirm the cause of the scapular downward rotation, the same manual muscle testing should be performed with stabilizing the scapula as well (Fig. 17.9). The pain will decrease in the testing with scapular stabilization if a problem of ability to stabilize the scapular causes scapular downward rotation in the testing without scapular stabilization. On the other hand, the pain will increase in the testing with scapular stabilization if the downward rotation is a compensatory motion to reduce the pain. Moreover, even if there is a problem on scapular

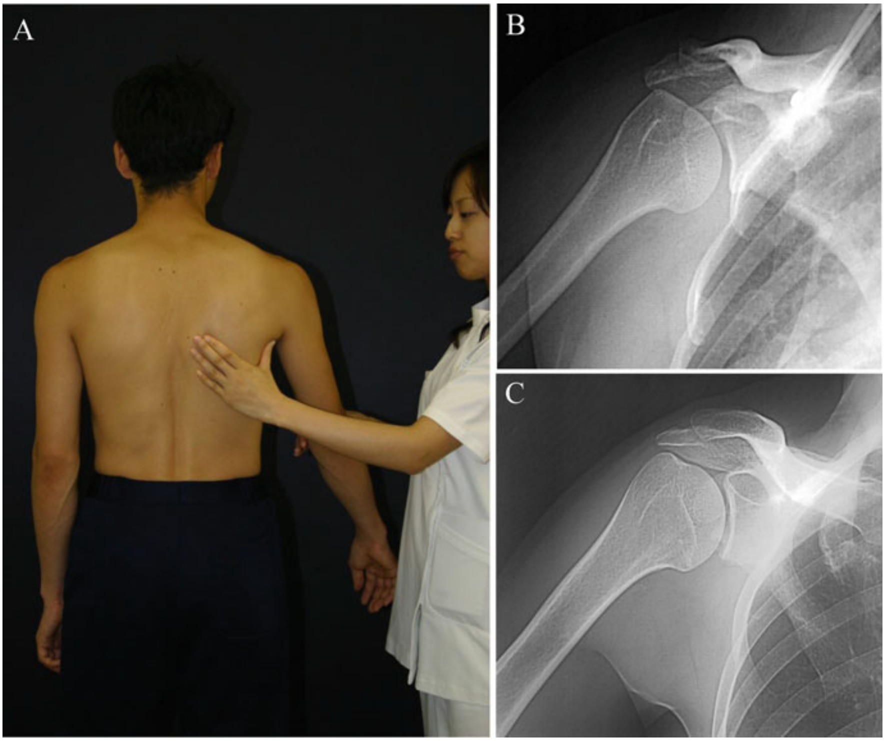

Fig. 17.9 Manual muscle testing for arm elevation at 45° of elevation in the scapular plane. (**a**) Examiner holds the inferior angle of patient's scapula with her thumb and index finger when stabilizing the scapula during the testing. (**b**) X-ray image without examiner's assistance to hold scapula. (**c**) X-ray image with examiner's assist to hold scapula

stabilization during the muscle testing for arm elevation, strengths of all scapular muscles are sometimes normal in the manual muscle testing. In this case, functions of trunk or lower extremity may affect the problem on scapular stabilization.

Figure 17.10 shows muscle strength of the scapular adductors with two different knee positions in healthy subjects and a baseball player who had shoulder pain. The baseball player has injured his medial collateral ligament of the knee and developed shoulder pain when he made a return to play. He showed scapular downward rotation with pain during manual muscle testing for arm elevation at 45° of elevation in the scapular plane, but the pain disappeared with manual stabilization of the scapula. Although dysfunction of the scapular muscles was suspected, strengths of all scapular muscles were normal on the manual muscle testing to evaluate the scapular muscles individually. Because of excessive trunk motion during the scapular muscle testing, the same testing was repeated with trunk stabilization and knee-flexed position, which then revealed the obvious weakness of the scapular adductors. In addition, weakness of the gluteus maximus muscle was also found.

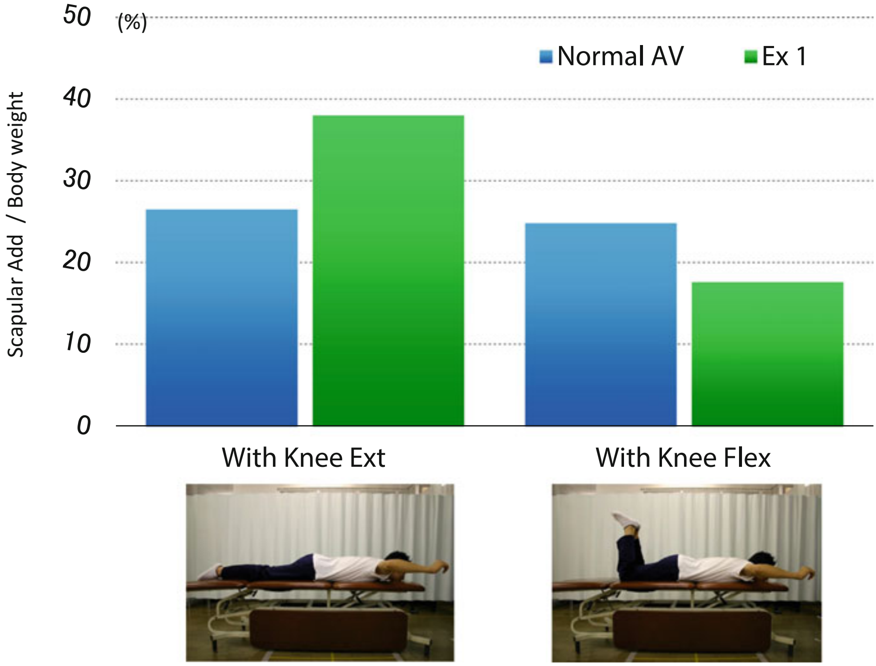

Fig. 17.10 Comparison of strength of scapular adduction between healthy subjects and an example athlete with throwing injury. *Bars* indicate force of scapular adduction normalized by body weight (*Scapular add*/*Body weight*) during muscle testing in prone position with extended and flexed knee positions. The example athlete (*Ex 1*) shows significant decrease of scapular adduction force in prone with flexed knee position whereas averaged scapular adduction forces in healthy subjects (*Normal AV*) in both knee positions are almost the same

It was speculated that this player did not have enough ability to stabilize the trunk and scapula and to reduce stress on the glenohumeral joint during the stepping phase in a throwing motion because of the weakness of the gluteus maximus muscle, although sufficient recovery of knee muscle strength was obtained. After approaching this problem, this player obtained satisfactory function and ability to throw without pain and could make a return to play.

As mentioned, clinical reasoning needs to be advanced based on the characteristics of the subject, time course, and environmental information as well as evidence obtained from previous studies.

In summary, physical therapy for throwing shoulder injuries is not substantially different from that for other shoulder diseases. However, in addition to management for functional problems induced by the injury, management for contributing factors to shoulder injury such as problems from each part of the body, psychological factors, and environmental factors needs to be emphasized. Because throwing shoulder injuries are affected by various factors, assessment of each factor, including testing condition, environment, and time course, and their interaction, is crucial.

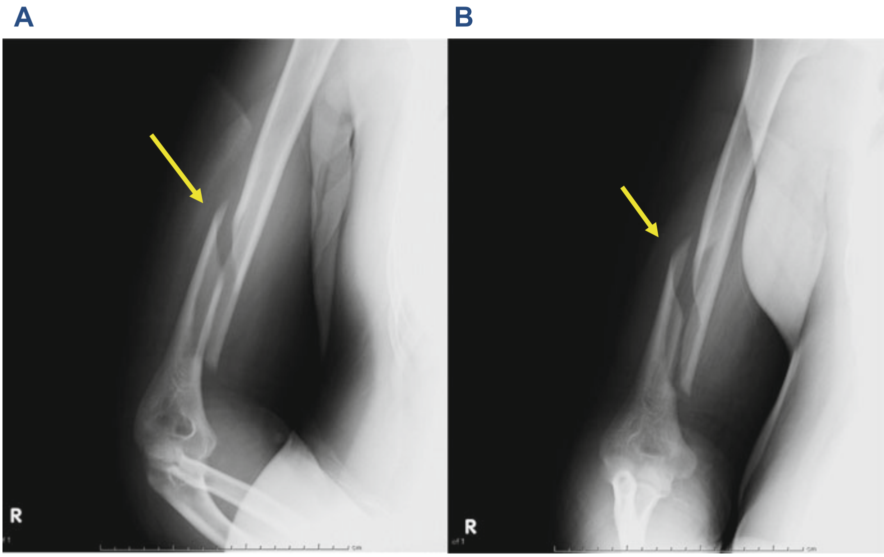

Fig. 17.11 A typical humeral shaft fracture. (**a**) Lateral view. (**b**) Anterior view

17.4 Humeral Shaft Fracture

The purposes of physical therapy for fracture of the humerus are to promote healing of the fracture and to recover shoulder function [6]. The important tips in the physical therapy are presented next with an example of typical fracture (Fig. 17.11).

17.4.1 Improvement of Scapular Motion

It is very important for obtaining shoulder function to improve scapular mobility without loading to the fractured part (Fig. 17.12) [7].

17.4.2 Techniques to Grasp the Fractured Part and to Improve Range of Motion

Excessive rotational and shear stresses to the fractured part can disturb bone healing [6]. When therapists attempt to improve range of shoulder abduction, they grasp the fractured part as shown in Fig. 17.13 and move the shoulder with compression

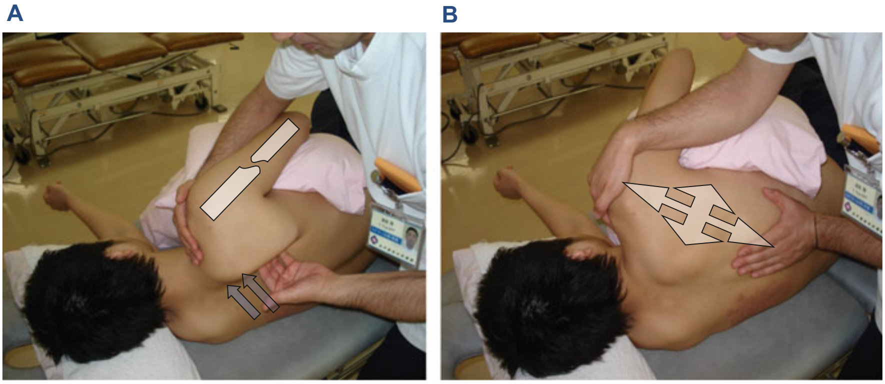

Fig. 17.12 Stretching and exercise to improve scapular mobility. (**a**) Stretching of scapular adductors by lifting the medial border of the scapula to dorsal and lateral directions while supporting the humerus with a pillow. (**b**) Passive exercise of the scapula to diagonal directions, namely, anterosuperior–posteroinferior and anteroinferior–posterosuperior directions

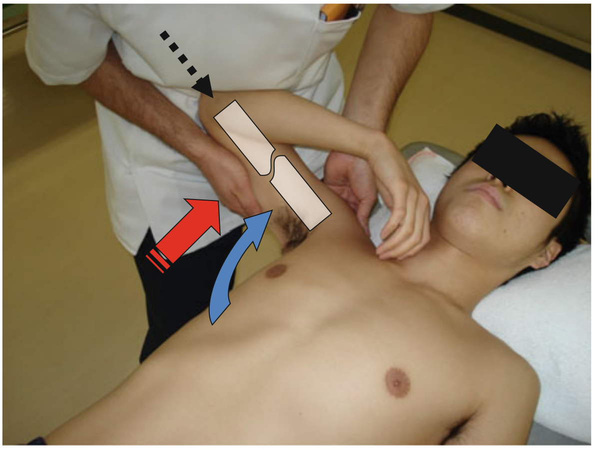

Fig. 17.13 Passive shoulder abduction exercise. The therapist grasps the fractured part with his right hand (*red arrow*) and slightly compresses the humerus along the long axis of the humerus with his abdomen (*dotted black arrow*) to prevent displacement of the distal humerus, and then abducts the patient's shoulder. The therapist simultaneously prevents superior migration of the humeral head with his left hand

along the long axis of the humerus and with depression of the humeral head according to concave-convex rule [8]. When improving range of shoulder rotation, therapists need to control the whole part of the humerus and then move as shown in Fig. 17.14.

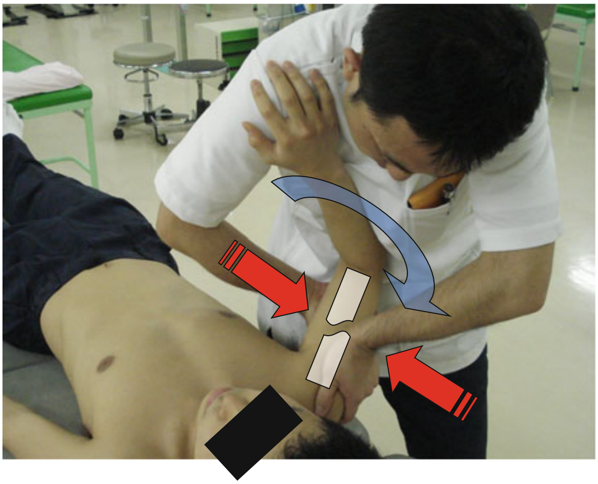

Fig. 17.14 Passive shoulder rotation exercise. The therapist grasps the fractured part with his both hands (*red arrows*). Then, with slight compression along the long axis of the humerus with his abdomen, the therapist rotates the patient's humerus with his whole body movement

17.5 Total Shoulder Arthroplasty

17.5.1 Total Shoulder Arthroplasty (TSA)

TSA is indicated for patients who have severe pain and restriction of shoulder motion resulting from osteoarthritis in the glenohumeral joint and who have resistance to oral medication, intraarticular injection, and physical therapy. In addition, the requirements for TSA are sufficient function of rotator cuff muscles and the glenoid with small bone defect where a glenoid component can be inserted.

17.5.1.1 Tips and Pitfalls in Postoperative Physical Therapy After TSA

Postoperative physical therapy starts under the supervision of physical therapists from the day after surgery. The patients wear a shoulder abduction orthosis for 3 weeks after TSA to protect the affected part in shoulder and to obtain relaxation.

An important point in this phase is to obtain range of shoulder flexion and external rotation proactively while therapists give attention to pain. Passive exercise for range of external rotation should be carefully performed to avoid shoulder anterior dislocation in the early phase after the surgery, because the subscapularis is repaired in the TSA. From 3 weeks after TSA, the patients start active assistive exercises, followed by active exercises in antigravity position, with the supervision of physical therapists. In addition, patients are encouraged to use the involved shoulder actively in daily living. From 6 weeks after TSA, strengthening exercises of shoulder muscles are gradually promoted so that the patients can obtain an ability to do lightly loaded work and, from 12 weeks after the surgery, can completely return to daily activities.

17.5.2 Reverse Shoulder Arthroplasty

RSA is indicated for elderly patients more than 70 years old who show pseudoparalysis with irreparable massive rotator cuff tear or have cuff tear arthropathy.

In contrast to TSA, which is based on normal shoulder anatomy, a socket and prosthetic ball are placed in the proximal humerus and on the glenoid, respectively.

17.5.2.1 Tips and Pitfalls in Postoperative Physical Therapy After RSA

Postoperative physical therapy starts under the supervision of physical therapists from the day after surgery as done after TSA. The patients wear a shoulder abduction orthosis for 3–4 weeks after RSA to protect the affected part of the shoulder. Because the main purpose of wearing the orthosis is not to immobilize the affected shoulder, the patients are allowed to move their elbow on the affected side and to use their hand during washing the face and eating.

A primary shoulder position of postoperative dislocation is the combined position of shoulder extension, adduction, and internal rotation, so-called "hand behind back." This position is prohibited in the early phase after RSA. In addition, touching the contralateral axilla is prohibited to prevent the dislocation in this phase. With increase of loading from 6 weeks after RSA, risks of fracture, dislocation in shoulder hyperextension, and loosening and breakage of the components and implants need to be taken into consideration. The patients and therapists aim at complete return to daily activities from 12 to 24 weeks after the surgery.

17.6 Acromioclavicular Joint Dislocation

Acromioclavicular (AC) joint dislocation is usually categorized with Rockwood classification [9]. Type III–VI indicates complete dislocation and are generally surgical indications. Of various surgery methods for AC joint dislocation, hook plate fixation is reported as a common surgery for the acute phase of the dislocation [10, 11]. It is necessary to consider the characteristics of the hook plate fixation on the postoperative physical therapy after AC joint reconstruction.

17.6.1 Considerations in Physical Therapy After Surgery Using Hook Plate

Hook plate fixation is a noninvasive to the inside of the AC joint and can hold the AC joint by using the hook portion under the acromion as leverage. As it also allows some degree of AC joint motion, range-of-motion exercise can be conducted in the early phase of postoperative rehabilitation [12]. However, even though the hook plate enables a good fixation of the AC joint, there is a chance of developing complications such as acromion fracture ("cut-out"), expansion of the hook hole [12, 13], erosion in the bottom side of the acromion [14], and subacromial bursitis from impingement if there is concentrated stress on the hook portion of the acromion. Therefore, it is necessary to consider the stress on the hook portion during the range-of-motion exercises in postoperative rehabilitation. In addition, in case of severe damage or detachment of the upper trapezius and anterior deltoid on the clavicle, the repair of these muscles is necessary in the type III–VI. These two muscles are important because the upper trapezius and anterior deltoid pull the clavicle up and down, respectively, and thereby stabilize the AC joint.

17.6.2 Five Tips and Pitfalls in Postoperative Physical Therapy

17.6.2.1 Stress on the Hook Portion

Because the hook portion is placed underneath the acromion, subacromial bursitis may occur because of subacromial impingement. Improvement of range of shoulder motion should carefully proceed with caution to the subacromial impingement sign. There are also possibilities for erosion and cut-out of the hook portion to occur. Ludewig et al. [15] have reported that the scapula posteriorly tilts by 19° and upwardly rotates by 11° relative to the clavicle during shoulder elevation. Immoderate shoulder elevation exercise at early phase of postoperative treatment (postoperative 1–2 weeks) may cause concentrated stress on the hook portion underneath the acromion. It is important to set a limit of the range of elevation to proceed with therapeutic exercise as planned. It is also necessary to pay attention to trick motion of the scapula associated with contracture of the glenohumeral joint because it may produce a load on the hook portion.

17.6.2.2 Setting the Limit of Shoulder Elevation Angle

Inman [16] has reported the rotation of the clavicle on the long axis increase from 90° elevation. Although fixation with the hook plate has excellent stability, the protection of the surgical site is more important than obtaining a larger range of shoulder elevation at the early phase after the surgery. Setting the limit of range of shoulder elevation at 90° is an important first step to progress with postoperative rehabilitation successfully.

17.6.2.3 Recovery of Upper Trapezius and Anterior Deltoid

During the early postoperative stage, before scar tissue forms in the muscle repair process, the repair of the upper trapezius and anterior deltoid should not experience interference. Active or resistive shoulder elevation that induces contraction of both muscles and shoulder extension (hand behind the back) which stretches both muscles should be avoided.

At a month after the surgery, increasing the range of shoulder motion exercise and muscle-strengthening exercise will carefully start with observing the responses of the muscles (e.g., stretching sensation and pain) to active flexion and passive extension.

17.6.2.4 Home Exercise and Activity of Daily Living (ADL) Guidance

Therapists should explain the purpose of the surgery, the advantages and cautions of the surgery method, postoperative course, how to proceed with exercises, and guidance in ADL, and they need to place emphasis on communication to obtain cooperation from the patient. No matter how carefully therapists conduct postoperative physical therapy, it will hinder the recovery of the surgical site and impaired shoulder function if patients fail to comply with guidance in home exercise and ADL.

17.6.2.5 Timing of the Hook Plate Removal

The hook plate is used to hold the AC joint in reduced position and to allow shoulder exercises for postoperative physical therapy without hindering the recovery of the continuity of the damaged ligament. The hook plate needs to be placed for 3 months after the surgery at a minimum [17, 18], as more than 3 months are necessary for healing of the ligaments [19]. After hook plate removal, patients will be permitted to move their shoulder in the full range of motion, and then the treatment will be completed.

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