
Therapeutic Exercise Foundations and Techniques

FOURTH EDITION

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To Jerry and our growing family—as always, your love and support has sustained me
through this project

—*CK*

To Rick and my extended family—a source of constant support and joy

—*LC*

To our parents—who have been supportive throughout our lives

To our students—who have taught us so much

To our colleagues—who have been helpful and stimulating in our professional growth

—*LC and CK*

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Preface

Each revision of this textbook is a challenging, demanding, sometimes daunting, and in the final analysis, satisfying task. We believe this edition, as with past editions, is inclusive and up-to-date in light of current research and trends in practice. It continually amazes us how quickly the knowledge base and creative interpretations of basic and applied research including outcome studies influence the delivery of healthcare. Since publication of the Third Edition of *Therapeutic Exercise* in 1996, the American Physical Therapy Association has published and revised the *Guide to Physical Therapist Practice*, many new studies on patient outcomes have been published, technology for communication has expanded, and the healthcare environment has demanded continued high-quality care but more efficient delivery of services. Each of these major factors has influenced the way we think and practice and thus has influenced the presentation of material in this text.

Our original intent when developing the first edition of this textbook over 16 years ago was to provide a foundation of concepts and techniques upon which an individualized program of therapeutic exercise could be built. With each revision we have expanded the content to include new methods of exercise intervention that have been shown to be beneficial in remediating a patient's physical impairments and functional limitations. The foundational material remains an important component of this text. Yet, functional exercise progressions that are built on basic exercise techniques and that prepare patients or clients to return to optimal levels of independence are also integral components of this text. In addition to principles of exercise, background information on various pathologies and musculoskeletal surgeries, descriptions of exercise techniques, and management guidelines are included to assist the reader in the development and

progression of comprehensive therapeutic exercise interventions.

What will be most obvious to those who are familiar with previous editions of this text are the changes in format and design of this edition. The double-column format and the use of color were selected to help the reader to locate information more easily and to enhance organization of the material. We have kept the succinct language and straightforward presentation of the content that has been well received in the previous editions; in addition we have expanded the discussion of concepts and techniques to provide the reader with a more comprehensive analysis of the material. Major changes we have made in this Fourth Edition include the following:

- Complete rewriting of Chapter 1 incorporating information on the disablement process and the potential impact of therapeutic exercise on that process, as well as the components of a comprehensive, systematic approach to patient management consistent with the guidelines proposed in the *Guide to Physical Therapist Practice*. A revised outline of a systematic and detailed musculoskeletal examination that used to be in Chapter 1 is now in Appendix A.
- Extensive reorganization of Chapter 3, Resistance Exercise, to include the multi-faceted aspects of muscle performance. In addition, principles and techniques of proprioceptive neuromuscular facilitation for applications of the extremity patterns have been added.
- Addition of material on mobilization with movement (MWM), based on the work of Brian Mulligan, by contributor Jack Miller, an accredited Mulligan concept teacher. The concepts and principles of MWM are presented in Chapter 6, with specific techniques described in each of the respective regional chapters on the extremities (Chapters 9–14).

- Addition of a new chapter on aquatic exercise (Chapter 7) by contributor Robert Schrepfer, MS, PT. Research supporting the use of the aquatic environment in the rehabilitation process of musculoskeletal impairments is integrated with various techniques of exercise interventions.
- Addition of a section at the completion of each chapter entitled *Independent Learning Activities*. This section has several types of activities for students using this text. The subsection called *Critical Thinking and Discussion* has discussion points or a series of questions to stimulate active learning and problem solving or to direct the student to further inquiry. The subsection called *Laboratory Practice* directs the learner toward activities that can be practiced in order to develop specific skills related to the application of therapeutic exercise interventions. The subsection called *Case Studies* presents several case scenarios and questions that reflect the content of the chapter to help the learner integrate the information presented and apply it to real-life situations.
- Reorganization of the spine chapters with the addition of material that reflects current thinking on ways to categorize patient conditions and approaches to intervention (Chapter 15), and the presentation of exercise interventions with emphasis on activation of core stabilizers and stabilization techniques integrated into a comprehensive approach to management of spinal impairments and functional limitations (Chapter 16). Those readers familiar with previous editions will notice that the chapter on spinal traction is not in this edition. Nevertheless we still believe that spinal traction is a useful tool for intervention in the treatment of spinal disorders. Because it can be used to stretch joints and tissues in the spinal region, content specific to this purpose is integrated into the stretching section of the treatment chapter (Chapter 16).
- The chapter on Principles of Exercise for the Obstetric Patient (Chapter 17) has been revised and

expanded by contributor Barb Settles Huge, PT, to include basic information and interventions for the management of urinary incontinence.

- A thorough revision of Chapter 18, Management of Vascular Disorders of the Extremities, now includes descriptions and illustrations of exercises for the comprehensive management of lymphedema.
- In previous editions there were two chapters on interventions for and management of pulmonary conditions. The content of those chapters has been reorganized and merged into one chapter (Chapter 19).
- The chapter on Critical Analysis of Exercise Programs, which had been in previous editions, has been deleted from this edition. The idea of using knowledge and skills of kinesiology, examination, and safe application of exercise interventions based on an examination and evaluation of each patient or client is fundamental to all we do as therapists. Therefore it was determined that a separate chapter was no longer needed and the concepts from this chapter were integrated throughout the text.
- Appendices have been added to this edition that include a summary of a systematic musculoskeletal examination and a reprinting of management guideline boxes from multiple chapters for quick reference and for comparison and contrast in Appendix A and B respectively.

As we put the final touches on this revision, we are once again pleased to present our efforts to students and professionals within the healthcare community. It is always our hope that our efforts will contribute to the effective care and services provided to patients and clients. And finally to our families, colleagues and friends who provided encouragement and supported us without hesitation, we extend a resounding THANK YOU!!

Carolyn Kisner
Lynn Allen Colby

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Robert Schrepfer, MS, PT—for writing Chapter 7, Aquatic Exercise.

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Jack Miller, BSc(PT), Dip, ManipTher (NZ), FCAMT, Accredited Mulligan Concept Teacher—for writing material on the Mulligan concept of Mobilization with Movement in Chapter 6 and describing techniques for inclusion in each of the extremity chapters.

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Chapter 9

The Shoulder and Shoulder Girdle

OBJECTIVES

After studying this chapter, the reader will be able to:

- 1 Identify important aspects of shoulder girdle structure and function for review.
- 2 Establish a therapeutic exercise program to manage soft tissue and joint lesions in the shoulder girdle region related to stages of recovery after an inflammatory insult to the tissues.
- 3 Establish a therapeutic exercise program to manage common musculoskeletal lesions, recognizing unique circumstances for their management.
- 4 Discuss the background of, indications for, and outcomes of common surgical procedures for soft tissue and joint pathology of the shoulder.
- 5 Explain the goals and appropriate interventions for postoperative management of shoulder and shoulder girdle dysfunction.
- 6 Establish a postoperative intervention program that includes therapeutic exercise for management of common surgical procedures.

The design of the shoulder girdle allows for mobility of the upper extremity. As a result, the hand can be placed almost anywhere within a sphere of movement, being limited primarily by the length of the arm and the space taken up by the body. The combined mechanics of its joints and muscles provide for and control the mobility. When establishing a therapeutic exercise program for impaired function of the shoulder region, as with any other region of the body, the unique anatomic and kinesiology features must be taken into consideration as well as the state of pathology and functional limitations imposed by the impairments. The first section of this chapter briefly reviews anatomic and kinesiology information on the shoulder complex. The following sections then describe common prob-

lems and guidelines for conservative and postsurgical management. The last three sections describe exercise techniques commonly used to meet the goals of treatment during the stages of tissue healing and phases of rehabilitation.

► Review of the Structure and Function of the Shoulder and Shoulder Girdle

Bony Parts: Proximal Humerus, Scapula, and Clavicle (see Fig. 6–13)

The shoulder girdle has only one bony attachment to the axial skeleton. The clavicle articulates with the sternum via the small sternoclavicular joint. As a result, considerable mobility is allowed in the upper extremity. Stability is provided by an intricate balance between the scapular and glenohumeral muscles and the structures of the joints in the shoulder girdle.

Synovial Joints

Glenohumeral (GH) joint

Characteristics

This joint is an incongruous, ball-and-socket (spheroidal) triaxial joint with a lax joint capsule. It is supported by the tendons of the rotator cuff and the glenohumeral (superior, middle, and inferior) and coracohumeral ligaments. The concave bony partner, the glenoid fossa, is located on the superior-lateral margin of the scapula. It faces anteriorly, laterally, and upward, which provides some stability to the joint. A fibrocartilaginous lip, the glenoid labrum, deepens the fossa for greater congruity and serves as the attachment site for the capsule. The convex bony partner is the head of the humerus. Only a small portion of the head comes in contact with the fossa at any one time, allowing for considerable humeral movement and potential instability.¹²⁷

Arthrokinematics

According to the convex-concave theory of joint motion (see Chapter 6), with motions of the humerus (physiologic motions), the convex head rolls in the same direction and slides in the opposite direction in the glenoid fossa (Box 9–1). Of interest, and apparent contradiction of this theory, one study reported that through the midrange of the arc of passive motion there is minimal displacement of the humeral head. However, beyond midrange the overall displacement of the head is anterior with shoulder flexion and posterior with shoulder extension in normal joints.⁶⁶ This cadaveric study demonstrated that the integrity of the capsular ligamentous system influenced the displacement, and that both hyper- and hypomobility of the capsule changed the overall displacement of the humeral head with passive range of motion. In another study, Howel et al,⁷⁹ using radiographs, measured humeral head displacement in normal and unstable shoulders. These investigators reported posterior displacement of the humeral head during end-range horizontal abduction with the humerus at 90 degrees and in full external rotation in normal subjects, yet anterior displacement in subjects with anterior instability. These studies support the importance of joint mobility testing to examine restricted accessory motions to determine if interventions with joint mobilization techniques should be used and the direction of the mobilization force rather than just using the convex-concave rule to determine direction of mobilizations.

Stability

Static and dynamic restraints provide joint stability (Table 9–1).^{32,44,150,183,187}

The structural relationship of the bony anatomy, ligaments, and glenoid labrum and the adhesive and

cohesive forces within the joint provide static stability. The tendons of the rotator cuff blend with the ligaments and glenoid labrum at the sites of attachment so that when the muscles contract, they provide dynamic stability by tightening the static restraints. The coordinated response of the muscles of the cuff and tension in the ligaments provide varying degrees of support depending on the position and motion of the humerus.^{143,150,172} In addition, the long head of the biceps and long head of the triceps brachii reinforce the capsule with their attachments and provide superior and inferior shoulder joint support respectively when functioning with elbow motions.⁹² The long head of the biceps in particular stabilizes against humeral elevation⁹² and contributes to anterior stability of the glenohumeral joint by resisting torsional forces when the shoulder is abducted and externally rotated.^{14,143} Neuromuscular control, including movement awareness and motor response, underlies coordination of the dynamic restraints.^{183,187}

Acromioclavicular (AC) Joint

Characteristics

This joint is a plane, triaxial joint, which may or may not have a disk. The weak capsule is reinforced by the superior and inferior acromioclavicular ligaments. The convex bony partner is a facet on the lateral end of the clavicle. The concave bony partner is a facet on the acromion of the scapula.

Arthrokinematics

With motions of the scapula, the acromial surface slides in the same direction in which the scapula moves, because the surface is concave. Motions affecting this joint include upward rotation (the

Box 9–1 Summary of Joint Arthrokinematics of the GH Joint

Physiologic Motion of Humerus	Roll	Slide	Translation*
Flexion	Anterior	Posterior	Anterior [†]
Horizontal adduction	Anterior	Posterior	Anterior [†]
Internal rotation	Anterior	Posterior	Anterior [†]
Extension	Posterior	Anterior	Posterior [†]
Horizontal abduction	Posterior	Anterior	Posterior [†]
External rotation	Posterior	Anterior	Posterior [†]
Abduction	Superior	Inferior	

*Joints with normal capsular integrity

[†]Cadaveric study with passive humeral motion⁶⁶

[‡]Radiographic study with arm abducted to 90 degrees and positioned in external rotation⁷⁹

Table 9–1 Static and Dynamic Stabilizers of the Scapula and Glenohumeral Joint

Description	Static Stabilizers	Dynamic Stabilizers
Scapula Weight of upper extremity creates downward rotation and forward tipping moment on the scapula	Cohesive forces of subscapular bursa	Upper trapezius and serratus anterior, middle trapezius and rhomboids
Glenohumeral Joint In dependent position: if scapula is in normal alignment, weight of arm creates an adduction moment on the humerus	Superior capsule and suprahumeral ligament are taut Adhesive and cohesive forces of synovial fluid and negative joint pressure hold surfaces together Glenoid labrum deepens fossa and improves congruency	Rotator cuff, deltoid, and long head of biceps brachii
When the humerus is elevating and the scapula is rotating upward	Tension placed on static restraints by the rotator cuff Glenohumeral ligaments provide stability against forward, upward, and inferior translation of humeral head	Rotator cuff and deltoid; elbow action brings in two-joint muscle support: <ul style="list-style-type: none"> • Long head of biceps stabilizes against humeral elevation • Long head of triceps stabilizes against inferior translation

scapula turns so that the glenoid fossa rotates upward), downward rotation, winging of the vertebral border, and tipping of the inferior angle.

Stability

The acromioclavicular ligaments are supported by the strong coracoclavicular ligament. No muscles directly cross this joint for dynamic support.

Sternoclavicular (SC) Joint

Characteristics

This joint is an incongruent, triaxial, saddle-shaped joint with a disk. The joint is supported by the anterior and posterior sternoclavicular ligaments and the interclavicular and costoclavicular ligaments. The medial end of the clavicle is convex superior to inferior and concave anterior to posterior. The joint disk attaches to the upper end. The superior-lateral portion of the manubrium and first costal cartilage is concave superior to inferior and convex anterior to posterior.

Arthrokinematics

The motions of the clavicle occur as a result of the scapular motions of elevation, depression, protraction (abduction), and retraction (adduction) (Box 9–2). Rotation of the clavicle occurs as an accessory motion when the humerus is elevated above the horizontal position and the scapula upwardly rotates; it cannot occur as an isolated voluntary motion.

Stability

The ligaments crossing the joint provide static stability. There are no muscles crossing the joint for dynamic stability.⁴²

Functional Articulations

Scapulothoracic Articulation

Motions of the Scapula

Normally there is considerable soft tissue flexibility, allowing the scapula to slide along the thorax and participate in all upper extremity motions. Motions of the scapula are:

- Elevation, depression, protraction (abduction), and retraction (adduction), seen with clavicular motions at the SC joint. They are also component motions when the humerus moves.
- Upward and downward rotation, seen with clavicular motions at the SC joint and rotation at the AC joint, occurs concurrently with motions of the

Box 9–2 Summary of Arthrokinematics of the SC Joint

Physiologic Motion of Clavicle

	Roll	Slide
Protraction	Anterior	Anterior
Retraction	Posterior	Posterior
Elevation	Superior	Inferior
Depression	Inferior	Superior

humerus. Upward rotation of the scapula is a necessary component motion for full range of motion (ROM) of flexion and abduction of the humerus.

- Winging of the medial border and tipping of the inferior angle, seen with motion at the AC joint concurrently with motions of the humerus. Tipping of the scapula is necessary to reach the hand behind the back in conjunction with internal rotation and extension of the humerus. Winging is an accessory motion with horizontal adduction of the humerus.

Scapular Stability

In the dependent position, the scapula is stabilized primarily through a balance of forces. The weight of the arm creates a downward rotation, abduction, and forward tipping moment on the scapula. The downward rotation is balanced by the dynamic support of the upper trapezius and serratus anterior. The forward tipping and abduction is balanced by the dynamic support of the rhomboids and middle trapezius.^{94,151} (See Table 9–1.)

With active arm motions the muscles of the scapula function in synchrony to stabilize and control the position of the scapula so that the scapulohumeral muscles can maintain a good length-tension relationship as they function to stabilize and move the humerus. Without the positional control of the scapula, the efficiency of the humeral muscles decreases. The upper and lower trapezius with the serratus anterior upwardly rotate the scapula whenever the arm abducts or flexes, and the serratus anterior abducts (protracts) the scapula on the thorax to align the scapula during flexion or pushing activities. During arm extension or during pulling activities, the rhomboids function to downwardly rotate and adduct (retract) the scapula in synchrony with the latissimus dorsi, teres major, and rotator cuff muscles. These stabilizing muscles also eccentrically control acceleration motions of the scapula in the opposite directions.¹²⁸

With a faulty scapular posture from muscle imbalances, muscle length and strength imbalances also occur in the humeral muscles, altering the mechanics of the glenohumeral joint. A forward tilt of the scapula is associated with a tight pectoralis minor muscle and possibly a weak serratus anterior or trapezius. This scapular posture changes the posture of the humerus in the glenoid, assuming a relatively abducted and internally rotated position. This results in shortened glenohumeral internal rotators and stretched or weakened lateral rotators.

Suprahumeral Space

The coracoacromial arch, composed of the acromion and coracoacromial ligament, overlies the subacromial/subdeltoid bursa, the supraspinatus tendon, and a portion of the muscle.⁹⁴

These structures allow for and participate in normal shoulder function. Compromise of this space from faulty muscle function, faulty joint mechanics, injury to the soft tissue in this region, or structural anomalies of the acromion lead to impingement syndromes.^{28,31} After a rotator cuff tear, the bursa may communicate with the glenohumeral joint cavity.⁴⁴

Shoulder Girdle Function

Scapulohumeral Rhythm

- Motion of the scapula, synchronous with motions of the humerus, allows for 150 to 180 degrees of shoulder ROM into flexion or abduction with elevation. The ratio has considerable variation among individuals but is commonly accepted to be 2:1 (2 degrees of glenohumeral motion to 1 degree of scapular rotation) overall motion. During the setting phase (0–30 degrees abduction, 0–60 degrees flexion), motion is primarily at the glenohumeral joint, whereas the scapula seeks a stable position. During the midrange, the scapula has greater motion, approaching a 1:1 ratio with the humerus; later in the range, the glenohumeral joint again dominates the motion.^{41,94,157}
- The synchronous motion of the scapula allows the muscles moving the humerus to maintain an effective length-tension relationship throughout the activity and helps maintain congruency between the humeral head and fossa while decreasing shear forces.^{41,94,157}
- Muscles causing the upward rotation of the scapula are the upper and lower trapezius and serratus anterior. Weakness or complete paralysis of these muscles results in the scapula being rotated downward by the contracting deltoid and supraspinatus as abduction or flexion is attempted. These two muscles then reach active insufficiency, and functional elevation of the arm cannot be reached, even though there may be normal passive ROM and normal strength in the shoulder abductor and flexor muscles.¹⁵⁷

Clavicular Elevation and Rotation with Humeral Motion

- Initially, with upward rotation of the scapula, 30 degrees of elevation of the clavicle occurs at the

SC joint. Then, as the coracoclavicular ligament becomes taut, the clavicle rotates 38 to 50 degrees about its longitudinal axis, which elevates its acromial end (because it is crank-shaped). This motion allows the scapula to rotate an additional 30 degrees at the AC joint.

- Loss of any of these functional components will decrease the amount of scapular rotation and, thus, the ROM of the upper extremity.

External Rotation of the Humerus with Full Elevation Through Abduction

- During abduction of the arm in the frontal plane, for the greater tubercle of the humerus to clear the coracoacromial arch, the humerus must externally rotate as it is elevated above the horizontal.
- Weak or inadequate external rotation will result in impingement of the soft tissues in the suprahumeral space, causing pain, inflammation, and eventually loss of function.

Internal Rotation of the Humerus with Full Elevation Through Flexion

- Medial rotation begins around 50 degrees of passive shoulder flexion when all structures are intact.¹²⁹ With full range of shoulder flexion and elevation, the humerus medially rotates 90 degrees, and the medial epicondyle faces anteriorly.^{21,22,129}
- As the arm elevates above the horizontal position in the sagittal plane, the anterior capsule and ligaments become taut, causing the humerus to rotate medially. The bony configuration of the posterior aspect of the glenoid fossa contributes to the inward rotation motion of the humerus as the shoulder flexes.¹⁵⁷ Most of the shoulder flexor muscles are also medial rotators of the humerus.¹⁵⁷
- The infraspinatus and teres minor stabilize the humeral head against the inward rotating forces, helping to maintain alignment and stability of the head in the fossa. Weakness in these muscles may contribute to excessive anterior translation and instability.³²

Elevation of the Humerus Through the Plane of the Scapula—Scapion

- The plane of the scapula is described as 30 degrees anterior to the frontal plane. Motion of the humerus in this plane is popularly called **scapion**^{171,182} or scapular plane abduction.⁴¹

- In this range, there is less tension on the capsule and greater elevation is possible than with pure frontal or sagittal plane elevation. Neither internal nor external rotation of the humerus is necessary to prevent greater tubercle impingement in elevation through scaption.^{41,171} Many functional activities occur with the shoulder oriented in this plane.

Deltoid-Short Rotator Cuff and Supraspinatus Mechanisms

- The majority of the force of the deltoid muscle causes upward translation of the humerus; if unopposed, it leads to impingement of the soft tissues within the suprahumeral space between the humeral head and the coracoacromial arch.
- The combined effect of the short rotator muscles (infraspinatus, teres minor, and subscapularis) causes a stabilizing compression and a downward translation of the humerus in the glenoid.
- The combined actions of the deltoid and short rotators result in a balance of forces that abduct the humerus and control the humeral head.
- The supraspinatus muscle has a significant stabilizing, compressive, and slight upward translation effect on the humerus; these effects, combined with the effect of gravity, lead to abduction of the arm.
- Interruption of function leading to fatigue or poor coordination of any of these muscles can cause microtrauma and eventual dysfunction in the shoulder region.

Referred Pain: Common Sources of Pain in the Shoulder Region

Cervical Spine

- Vertebral joints between C-3 and C-4 or between C-4 and C-5
- Nerve roots C-4 or C-5

Referred Pain from Related Tissues

- Dermatome C-4 is over the trapezius to the tip of the shoulder.
- Dermatome C-5 is over the deltoid region and lateral arm.
- Diaphragm: pain perceived in the upper trapezius region.
- Heart: pain perceived in the axilla and left pectoral region.
- Gallbladder irritation: pain perceived at the tip of shoulder and posterior scapular region.

Nerve Injury: Common Sites in the Shoulder Girdle

Brachial Plexus in the Thoracic Outlet

Common sites for compression are the scalene triangle, costoclavicular space and under the coracoid process, and pectoralis minor muscle.⁹⁶

Suprascapular Nerve in the Suprascapular Notch

This injury occurs from direct compression or from nerve stretch, such as when carrying a heavy bookbag over the shoulder.

Radial Nerve in the Axilla

Compression occurs from continual pressure, such as when leaning on axillary crutches.

► Joint Hypomobility: Nonoperative Management

Glenohumeral (GH) Joint

Related Diagnoses and Etiology of Symptoms

Rheumatoid arthritis and osteoarthritis. These disorders follow the clinical picture described in Chapter 8.

Traumatic arthritis. This disorder occurs in response to a fall or blow to the shoulder or to microtrauma from faulty mechanics or overuse.

Postimmobilization arthritis or stiff shoulder. This disorder occurs as a result of lack of movement or secondary effects from conditions, such as heart disease, stroke, or diabetes mellitus.

Idiopathic frozen shoulder. This disorder, which is also called *adhesive capsulitis* or *periarthritis*, is characterized by the development of dense adhesions and capsular restrictions, especially in the dependent fold of the capsule, rather than arthritic changes in the cartilage and bone, as seen with rheumatoid arthritis or osteoarthritis. The insidious onset usually occurs between the ages of 40 and 60 years, without a known cause (primary frozen shoulder), although problems already mentioned, in which there is a period of pain and/or restricted motion, such as with rheumatoid arthritis, osteoarthritis, trauma, or immobilization, may lead to a frozen shoulder (secondary frozen shoulder). In primary frozen shoulder, the pathogenesis may be from a provoking chronic inflammation in musculotendi-

nous or synovial tissue such as the rotator cuff, biceps tendon, or joint capsule that results in formation of capsular thickening and adhesions, particularly in the folds of the inferior capsule.^{42,63,117,120} Consistent with this is a faulty posture and muscle imbalance predisposing the suprahumeral space to impingement and overuse syndromes.¹

Clinical Signs and Symptoms

Acute joint problems. Pain and muscle guarding limit motion, usually external rotation and abduction. Pain is frequently experienced radiating below the elbow and may disturb sleep.

Subacute joint problems. Capsular tightness begins to develop. Limited motion is detected, consistent with a capsular pattern. Usually external rotation and abduction are most limited, and internal rotation and flexion are least limited. Often, the patient will feel pain as the end of the limited range is reached. Joint-play testing will also reveal limited joint play. If the patient can be treated as the acute condition begins to subside by gradually increasing shoulder motion and activity, the complication of joint and soft tissue contractures can usually be minimized.^{117,112}

Chronic joint problems. Progressive restriction of the glenohumeral joint capsule magnifies the signs of limited motion in a capsular pattern and decreased joint play. There is significant loss of function with an inability to reach overhead, outward, or behind the back. Aching is usually localized to the deltoid region.

Idiopathic frozen shoulder. This clinical entity follows a classic pattern.*

- **“Freezing.”** Characterized by intense pain even at rest and limitation of motion by 2 to 3 weeks after onset. These acute symptoms may last 10 to 36 weeks.
- **“Frozen.”** Characterized by pain only with movement, significant adhesions, and limited glenohumeral motions with substitute motions in the scapula. Atrophy of the deltoid, rotator cuff, biceps, and triceps brachii muscles occurs. This stage lasts 4 to 12 months.
- **“Thawing.”** Characterized by no pain and no synovitis but significant capsular restrictions from

*See references 42, 60, 63, 117, 120, 145, 175.

adhesions. This stage lasts 2 to 24 months or longer. Some patients never regain normal ROM. Spontaneous recovery occurs on the average of 2 years from onset.^{60,63} Inappropriately aggressive therapy at the wrong time may prolong the symptoms.¹⁸ Treatment guidelines are the same as acute for the freezing stage, and subacute and chronic for the frozen and thawing stages, respectively.

Common Impairments

- Night pain and disturbed sleep during acute flares
- Pain on motion and often at rest during acute flares
- Decreased joint play and ROM, usually limiting external rotation and abduction with some limitation of internal rotation and elevation in flexion
- Possible faulty postural compensations with protracted and anteriorly tipped scapula, rounded shoulders, and elevated and protected shoulder
- Decreased arm swing during gait
- General muscle weakness and poor endurance in the glenohumeral muscles with overuse of the scapular muscles leading to pain in the trapezius and posterior cervical muscles
- Guarded shoulder motions with substitute scapular motions

Common Functional Limitations/Disabilities

- Inability to reach overhead, behind head, out to the side and behind back; thus, having difficulty with dressing (such as putting on a jacket or coat or women fastening undergarments behind their back), with reaching hand into back pocket of pants (to retrieve wallet), with reaching out a car window (to use an ATM machine) with self-grooming (such as combing hair, brushing teeth, washing face), and with bringing eating utensils to the mouth
- Difficulty lifting weighted objects, such as dishes into a cupboard
- Limited ability to sustain repetitive activities

GH Joint Management: Protection Phase

See guidelines for management in Chapter 8 and Box 8–1.

Control Pain, Edema, and Muscle Guarding

- The joint may be immobilized in a sling to provide rest and minimize pain.
- Initiate intermittent periods of controlled motion and gentle joint oscillation techniques as soon as

the patient tolerates movement to minimize adhesion formation.

Maintain Soft Tissue and Joint Integrity and Mobility

- **Passive range of motion (PROM)** in all ranges of pain-free motion (see Chapter 2). As pain decreases, progress to active ROM with or without assistance using activities such as rolling a small ball or sliding a rag on a smooth table top in flexion, abduction, and circular motions. Initiate use of an overhead pulley. Be sure the patient is taught proper mechanics and avoids faulty patterns such as scapular elevation or a slumped posture.
- **Passive joint traction and glides**, with the joint placed in a pain-free position (see Chapter 6). Begin with grade I; progress to grade II as symptoms subside.
- **Pendulum (Codman's) exercises** are techniques that use the effects of gravity to distract the humerus from the glenoid fossa.^{31,36} They help relieve pain through gentle traction and oscillating movements (grade II) and provide early motion of joint structures and synovial fluid. No weight is used during this phase of treatment (see Figure 9–10).

Precaution: If there is increased pain or irritability in the joint after use of these techniques, either the dosage was too strong or the techniques should not be used at this time.

Contraindication: Stretching (grade III) techniques. If there are mechanical restrictions causing limited motion, appropriate stretching can be initiated only *after* the inflammation subsides.

- **Gentle muscle setting** to all muscle groups of the shoulder. Also include scapular and elbow muscles because of their close association with the shoulder. Instruct the patient to gently contract a group of muscles while you apply slight resistance—just enough to stimulate a muscle contraction. It should not provoke pain. The emphasis is on rhythmic contracting and relaxing of the muscles to help stimulate blood flow and prevent circulatory stasis.

Maintain Integrity and Function of Associated Areas

- Educate the patient in the importance of keeping the joints distal to the injured site as active and

mobile as possible. Teach the patient or family member to perform ROM exercises of the elbow, forearm, wrist, and fingers several times each day while the shoulder is immobilized. If tolerated, active or gentle resistive ROM is preferred to passive for a greater effect on circulation and muscle integrity.

- Reflex sympathetic dystrophy (sympathetically maintained pain) is a potential complication after shoulder injury or immobility; give special attention to the hand with additional exercises, such as having the patient repetitively squeeze a ball or other soft object.
- If edema is noted in the hand, instruct the patient to elevate the hand, whenever possible, above the level of the heart.

Note: Conditions in which there is potentially a prolonged acute/inflammatory stage such as with rheumatoid arthritis and during the freezing stage of idiopathic frozen shoulder, it is critical to teach the patient active-assistive exercises to maintain muscle integrity and as much mobility as possible without exacerbating the symptoms.

GH Joint Management: Controlled Motion Phase

Follow the guidelines as described in Chapter 8, Box 8–2 emphasizing joint mobility, neuromuscular control, and instructions to the patient for self-care.

Note: For normal shoulder joint mechanics, there must be good scapular posture and control, and the humerus must be able to externally rotate. To avoid suprahumeral impingement, do not stretch above 90 degrees until there is adequate glenohumeral external rotation. With a traumatic injury that involves the AC or SC joints, these joints tend to become hypermobile with improper stretching. Care should be taken to provide stabilization to the scapula and clavicle so as not to stretch these joints when mobilizing the glenohumeral joint.

Control Pain, Edema, and Joint Effusion

- Carefully monitor increasing activities. If the joint was splinted, progressively increase the amount of time that the shoulder is free to move each day.
- **Range of motion.** Begin with active ROM up to the point of pain, including all shoulder and scapular motions. Use self-assistive ROM techniques, such as the overhead pulleys, wand exercises, or hand slides on a table.

Precaution: With increased pain or decreased motion, the activity may be too intense or the patient may be using faulty mechanics. Reassess the technique and modify it if faulty joint mechanics exist.

Progressively Increase Soft Tissue and/or Joint Mobility

- **Passive joint mobilization techniques.** Progress to stretch grades (grade III sustained or grade III and IV oscillation) using techniques that focus on the restricting capsular tissue at the end of the available ROM^{86,122} (see Table 9–1 and Figs. 6–15 through 6–20 in Chapter 6).
 - Use a grade I distraction with all gliding techniques.
 - If the joint is highly irritable and gliding in the direction of restriction is not tolerated, glide in the opposite direction. As pain and irritability decrease, begin to glide in the direction of restriction.⁸⁶
 - Advanced progressions in the shoulder include prepositioning the humerus at the end of the ROM, rotating the humerus then either applying a grade III distraction or a grade III glide to stretch the restrictive capsular tissue or adhesions (see Figs. 6–17, 6–20, and 9–8).
 - Pendulum exercises can also be used for joint stretching by adding a cuff weight to the wrist or a weight to the hand to cause a grade III joint distraction force (see Fig. 9–10). To direct the stretch force to the glenohumeral joint, stabilize the scapula against the thorax manually or with a belt.

Precaution: Vigorous stretching should not be undertaken until the chronic stage of healing.

- **Self-mobilization techniques.** Teach the patient the following techniques for a home program:
 - **Caudal glide.** Patient position and procedure: Sitting on a firm surface and grasping the fingers under the edge. He or she then leans the trunk away from the stabilized arm (Fig. 9–1).
 - **Anterior glide.** Patient position and procedure: Sitting with both arms behind or lying supine supported on a solid surface. He or she then leans the body weight between the arms (Fig. 9–2).
 - **Posterior glide.** Patient position and procedure: Prone, propped up on both elbows. The body weight shifts downward between the arms (Fig. 9–3).

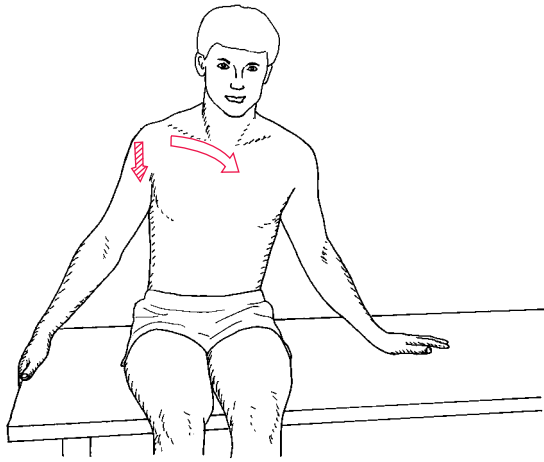


Figure 9-1 Self-mobilization; caudal glide of the humerus occurs as the person leans away from the fixed arm.

- **Manual stretching.** Cautiously initiate manual stretching techniques to restricting tissue.
- **Self-stretching exercises.** As the joint reaction becomes predictable and the patient begins to tolerate stretching, teach self-stretching using techniques in which the body is moved in relation to the stabilized arm (see Figs. 9-13 through 9-17).⁴⁶

Inhibit Muscle Spasm and Correct Faulty Mechanics

Muscle spasm may lead to a faulty deltoid-rotator cuff mechanism and scapulohumeral rhythm when the patient attempts abduction (Fig. 9-4). The head of the humerus may be held in a cranial position within the joint, making it difficult and/or painful to abduct the shoulder because the greater tuberosity impinges on the coracoacromial arch. In this case, repositioning the head of the humerus with a caudal

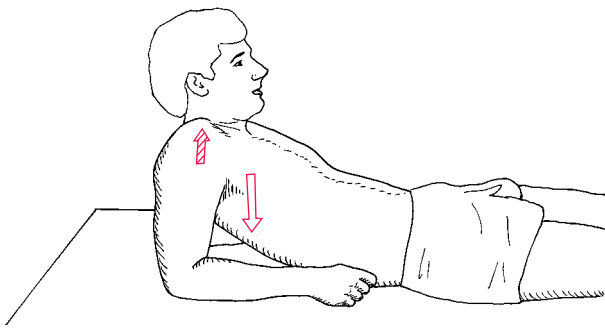


Figure 9-2 Self-mobilization; anterior glide of the humerus occurs as the person leans between the fixed arms.

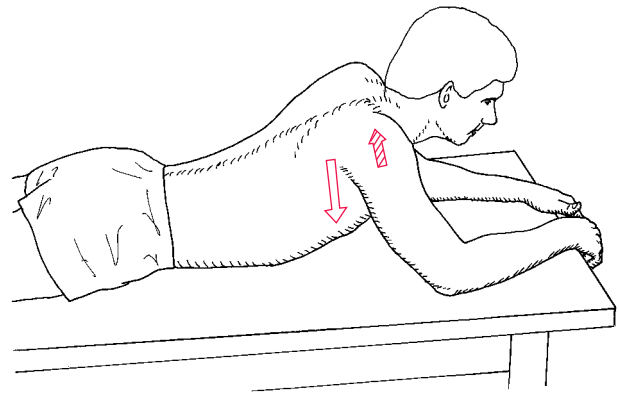


Figure 9-3 Self-mobilization; posterior glide of the humerus occurs as the person shifts his weight downward between the fixed arms.

glide is necessary before proceeding with any other form of shoulder exercise. The patient also needs to learn to avoid “hiking the shoulder” when abducting or flexing the arm. The following techniques may address these problems and faulty mechanics. See also mobilization with movement techniques in the next section.

- Gentle joint oscillation techniques will help decrease the muscle spasm (grade I or II).
- Sustained caudal glide joint techniques will help reposition the humeral head in the glenoid fossa.
- Protected weight bearing, such as leaning hands against a wall or on a table, stimulates co-contraction of the rotator cuff and scapular stabilizing muscles. If tolerated, gentle rocking

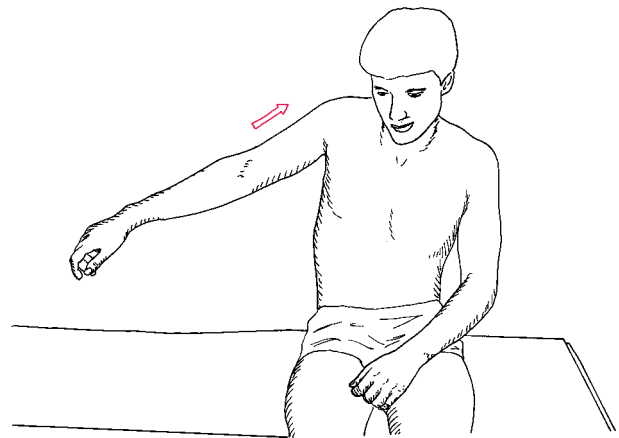


Figure 9-4 Poor mechanics with patient hiking the shoulder while trying to abduct the shoulder, thus elevating rather than depressing the humeral head.

forward/backward and side to side requires the muscles to begin controlling motion. Because weight bearing causes joint compression, the benefits of intermittent compression stimulates synovial fluid motion; progress within the tolerance of the joint.

- Training the external rotators of the shoulder will help to depress the humeral head as the arm abducts. Teach the patient active and progress to resistive external rotation exercises (see Fig. 9–36).

Improve Joint Tracking

Mobilization with movement (MWM) techniques may assist with retraining muscle function for proper tracking of the humeral head.¹¹⁰

- **Shoulder MWM for painful restriction of shoulder external rotation** (Fig. 9–5). Patient position and procedure: Supine lying with folded towel under scapula; the elbow is near the side and flexed to 90 degrees. A cane is held in both hands.
 - Stand on the opposite side of the bed facing the patient, and reach across the patient's torso to cup the anteromedial aspect of the head of the humerus with reinforced hands. Apply a pain-free graded posterolateral glide of the humeral head on the glenoid. Instruct the patient to use the cane to push the affected arm into the previously restricted range of external rotation.

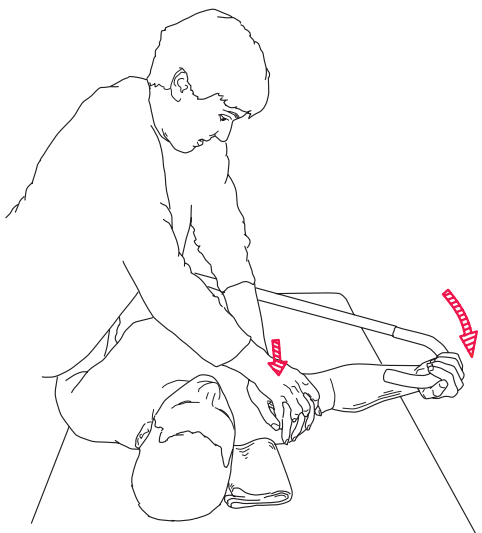


Figure 9–5 MWM to improve external rotation. A posterolateral glide is applied to the humeral head while the patient pushes the arm into the end-range of external rotation with a cane.

- Sustain the movement for 10 seconds and repeat in sets of 5 to 10. It is important to maintain the elbow near the side of the trunk and ensure no pain is experienced during the procedure. Adjust the grade and direction of the glide as needed to achieve pain-free function.
- **Shoulder MWM for painful restriction of internal rotation** and inability to reach hand behind back (Fig. 9–6). Patient position and procedure: Standing with a towel draped over the unaffected upper trapezius and affected hand at current range of maximum pain-free position behind back. The hand on the affected side grasps the towel behind the back.
 - Stand facing the patient's affected side. Place the hand closest to patient's back high up in the axilla with the palm facing outward to stabilize the scapula with an upward and inward pressure. With the hand closest to the patient's abdomen hook the thumb in the cubital fossa and grasp the lower humerus to provide an inferior glide. Your abdomen is in contact with the patient's elbow to provide an adduction force to the arm.
 - Have the patient pull on the towel with the unaffected hand to draw the affected hand up the back while the mobilization force is being applied in an inferior direction.
 - Ensure no pain is experienced during the procedure. Adjust grade and direction of glide as

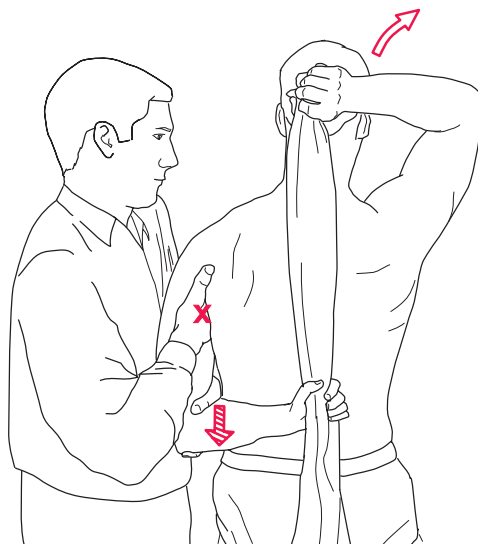


Figure 9–6 MWM to improve internal rotation. An inferior glide is applied to the humerus while the patient pulls the hand up the back with a towel.

needed to achieve pain-free function. Maximal glide should be applied to achieve end-range loading.

- **Shoulder MWM for painful arc or impingement signs.** MWM active elevation technique may be appropriate; see description with Figure 9–7A and B.

Progressively Increase Strength

- Determine any faulty postures or shoulder girdle mechanics that the patient displays when moving the upper extremity in various functional patterns.
- Initiate stabilization exercises to the scapular and glenohumeral musculature in open- and closed-chain as described later in this chapter.
- Exercises to manage faulty spinal posture are described in Chapter 16. Initiate dynamic strengthening, utilizing light resistance, with emphasis on developing control in weak musculature. As the patient develops control, progress the resistance. Strengthening exercises and progressions are described in the final section of this chapter.
- Once proper mechanics are restored, the patient should perform active ROM of all shoulder motions daily and return to functional activities to the extent tolerated.

GH Joint Management—Return to Function Phase

Progressively Increase Flexibility and Strength

- Progress stretching and strengthening exercises as the joint tissue tolerates. The patient should be actively involved in self-stretching and strengthening by this time so that emphasis during treatment is on correct mechanics, safe progressions, and exercise strategies for return to function.
- If capsular tissue is still restricting ROM apply vigorous manual stretching and joint mobilization techniques. Vermeulen et al.¹⁷⁴ reported good outcomes for increased ROM, decreased pain, and improved function in seven subjects with adhesive capsulitis utilizing intensive end-range mobilization and muscle relaxation techniques twice a week for 3 months. The improved function continued in six of the seven subjects 9 months after cessation of treatment.

Prepare for Functional Demands

If the patient is involved in repetitive heavy lifting, pushing, pulling, carrying or reaching, when joint range and strength allow, exercises are progressed to replicate these demands. See the last section of this chapter for suggestions.

Management Postmanipulation Under Anesthesia

Occasionally, no progress is made, and the physician chooses to perform manipulation under anesthesia. Following this procedure, there is an inflammatory reaction and the joint is treated as an acute lesion. Begin joint-play and passive ROM techniques while the patient is still in the recovery room. Surgical intervention with incision of the dependent capsular fold may be used if the adhesions are not broken with the manipulation. Postoperative treatment is the same with the following considerations.¹²⁰

- Keep the arm elevated overhead in abduction and external rotation during the inflammatory reaction stage; treatment principles progress as with any joint lesion.
- Begin therapeutic exercise the same day while the patient is still in the recovery room, with emphasis on internal and external rotation in the 90-degree (or higher) abducted position.
- Use joint mobilization procedures, particularly a caudal glide, to prevent re-adherence of the inferior capsular fold.
- When sleeping, the patient may be required to position the arm abducted for up to 3 weeks post-manipulation.¹²⁰

Joint Lesions: Acromioclavicular (AC) and Sternoclavicular (SC) Joints

Related Diagnoses and Etiology of Symptoms

Overuse syndromes. Overuse syndromes of the AC joint are frequently arthritic or post-traumatic conditions. The causes may be from repeated stressful movement of the joint with the arm at waist level, such as with grinding, packing assembly, and construction work,⁶⁴ or repeated diagonal extension, adduction, and internal rotation motions, as with spiking a volleyball or serving in tennis.

Subluxations or dislocations. Subluxations or dislocations of either joint are usually caused by falling against the shoulder or against an outstretched arm. In the AC joint, the distal end of the clavicle displaces posteriorly and superiorly on the acromion; the ligaments supporting the AC joint may rupture.¹¹⁹ Clavicular fractures may result from the fall.¹¹⁹ After trauma and associated overstretching of the capsules and ligaments of either joint, hypermobility is usually permanent because there is no muscle support to restrict movement.

Hypomobility. Decreased clavicular mobility may occur with sustained faulty postures involving clavicular and scapular depression or retraction. Complications from this may contribute to a thoracic outlet syndrome (TOS) with a compromise of space for the neuromuscular bundle as it courses between the clavicle and first rib (described later in this chapter).

Common Impairments

- Pain localized to the involved joint or ligament
- Painful arc with shoulder elevation
- Pain with shoulder horizontal adduction or abduction
- Hypermobility in the joints if trauma or overuse is involved
- Hypomobility in the joints if sustained posture or immobility is involved
- Neurological or vascular symptoms if TOS is present

Common Functional Limitations/Disabilities

- Limited ability to sustain repeated loaded movements related to forward/backward motions of the arm, such as with grinding, packing, assembly, and construction work.⁶⁴
- Inability to reach overhead without pain.
- Inability to effectively serve at tennis or spike a volley ball.
- See also limitations/disabilities from TOS if present.

Nonoperative Management of AC or SC Joint Strain or Hypermobility

- Rest the joint by putting the arm in a sling to support the weight of the arm.
- Cross-fiber massage to the capsule or ligaments.
- ROM to the shoulder and grade II traction and glides to the glenohumeral joint to prevent glenohumeral restriction.
- Teach the patient how to apply cross-fiber massage if joint symptoms occur after excessive activity.

Nonoperative Management of AC or SC Joint Hypomobility

Joint mobilization techniques are used to increase joint mobility (see Figs. 6–21 through 6–23).

Surgery for Clavicular Problems and Postoperative Management

Surgical resection of the distal clavicle is sometimes used when AC joint pain is unrelenting and causes

disability.⁶⁴ For example, an arthroscopic or open resection of the distal clavicle, as a component of a subacromial decompression procedure, is sometimes indicated for patients with primary shoulder impingement syndrome.^{125,133} Grade III instabilities, in which the clavicle has been acutely or chronically dislocated on the acromion, may be surgically reduced and stabilized with a variety of techniques.¹¹⁹ Techniques for management of acute dislocations include primary stabilization of the AC joint with Kirschner wires, Steinman pins, screws, or most recently bioabsorbable tacks. A muscle-tendon transfer, that includes the tip of the coracoid process and the attached tendons of the coracobrachialis and short head of the biceps to the undersurface of the clavicle¹²⁵ or resection of the distal clavicle with coracoacromial ligament reconstruction also can be performed.¹¹⁹ Based on a small body of evidence in the literature, it appears the best results are achieved with primary AC and coracoclavicular stabilization procedures. Chronic AC dislocations, which are usually associated with degenerative changes of the AC joint, are most often managed with distal clavicle resection coupled with coracoclavicular stabilization.^{125,141}

Although most SC dislocations are managed nonoperatively, an acute posterior dislocation of the SC joint that cannot be successfully reduced with a closed maneuver or an SC joint that dislocates recurrently are managed surgically. Surgical reduction of a traumatic anterior dislocation is not recommended.¹⁴⁰ Surgical options for posterior SC dislocations include open reduction with repair of the stabilizing ligaments or resection of a portion of the medial clavicle and fixation of the remaining clavicle to the first rib or sternum with a soft tissue graft.^{140,190}

Postoperative management usually involves immobilization in a sling or strapping. Exercise intervention should be directed at functional recovery as the signs of healing allow. No specific muscles cross the AC and SC joints, so scapular and glenohumeral strength is developed to provide indirect control.

► Glenohumeral Joint Surgery and Postoperative Management

Surgical intervention and postoperative rehabilitation for severe glenohumeral joint arthritis are often indicated to achieve the following goals: (1) relieve pain, (2) correct deformity, (3) improve mobility or

stability, and (4) restore or improve functional use of the upper extremity. The most common forms of surgical intervention used to treat severe arthritis of the shoulder and restore upper extremity function are either *glenohumeral joint arthroplasty* (total shoulder replacement), or *hemiarthroplasty* of the shoulder. In rare situations, *arthrodesis* (surgical ankylosis) of the glenohumeral joint is used as an alternative or salvage procedure.

Glenohumeral Arthroplasty

Indications for Surgery

The following impairments are widely accepted indications for glenohumeral arthroplasty.*

- Incapacitating pain (at rest or with motion) and severe glenohumeral joint destruction associated with advanced arthritis (OA, RA, or traumatic arthritis) or osteonecrosis of the head of the humerus as the result of a fracture of the anatomic neck of the humerus or long-term use of steroids for systemic disease
- Severe loss of upper extremity strength and control secondary to pain
- Inability to perform functional tasks with the involved upper extremity
- Decreased ROM

Procedures

Background: Selection of Procedure and Implant Design

Since the pioneering work of Neer in the 1960s¹¹⁶ several procedures and many types of prosthetic implants for the shoulder joint have been developed. A *total shoulder replacement* (TSR) *arthroplasty* is composed of a high-density polyethylene (plastic) glenoid component (some with metal backing) and a modular humeral component made of an inert metal. The glenoid component is usually cemented in place although biological or screw fixation has also been used. The humeral stem component is fit tightly (a press fit) into the intramedullary canal of the humerus for fixation but may need to be cemented in place in patients with severe osteoporosis.[†] A *hemiarthroplasty* involves only the replacement of the head and neck of the humerus with a metal stemmed prosthesis.^{39, 54, 103, 149}

The designs of total shoulder replacements, ranging from *unconstrained* to *constrained*, provide varying amounts of mobility and stability of the GH joint. The unconstrained design, also referred to as a *resurfacing* replacement, provides the greatest freedom of movement but is indicated only when the rotator cuff and deltoid mechanisms are intact or can be adequately repaired to provide dynamic stability to the glenohumeral joint.^{47, 55, 103, 114, 116, 149} *Semiconstrained* and *constrained* replacements have more stability built into their designs but are indicated only when the rotator cuff functions insufficiently.^{47, 55, 103, 112, 114} Loosening or excessive wear of the polyethylene glenoid component are the most common long-term complications after TSR.^{37, 38, 103} Although loosening of the humeral component can occur, the major concern after hemiarthroplasty is premature wear of the articular cartilage of the glenoid fossa.^{37, 38, 103}

Controversy exists over the specific criteria for selection of TSR versus hemiarthroplasty, but in general, it depends on the etiology and severity of the joint deterioration and soft tissue dysfunction.^{6, 103, 112} Patients with primary OA usually have loss or thinning of the articular cartilage of the head of the humerus and the posterior portion of the glenoid fossa,^{54, 103, 149} but the rotator cuff is intact in approximately 90% of these patients.¹³⁵ Selection of a resurfacing TSR usually yields the best results for shoulders with these characteristics. As many as 30 to 40% of patients with advanced RA of the glenohumeral joint have rotator cuff insufficiency, and many have bony erosion of the glenoid.¹⁶⁴ These characteristics lend themselves well to a TSR with bone grafting at the glenoid to improve prosthetic fixation and a repair of the rotator cuff. If an effective cuff repair cannot be achieved, then a more constrained design of TSR is selected by some surgeons.^{103, 149, 164}

A hemiarthroplasty is often used when the articular surface and underlying bone of the head of the humerus have deteriorated but the glenoid fossa is reasonably intact.¹⁰³ (This is referred to as osteonecrosis of the head of the humerus.) Patients with severe pain and loss of function as the result of massive, irreparable cuff tears may also be candidates for hemiarthroplasty.⁵⁴ Some surgeons prefer a hemiarthroplasty to a TSR for patients with RA in whom joint destruction is coupled with long-standing cuff insufficiency or contractures that cannot be resolved effectively. (This is often referred to

*See references 6, 12, 13, 39, 103, 114, 116, 149, 163, 164.

†See references 13, 102, 103, 112, 114, 163, 188.

as *cuff tear arthropathy*.¹⁰³ These problems may lead to superior migration of the head of the humerus within the glenoid fossa. If the glenoid is resurfaced under these conditions, the superior migration creates an incongruous articulation that accentuates the risk of loosening and premature wear of the glenoid implant.¹⁶⁴ These examples underscore the complexity of the clinical decision-making process involved in choice of operative procedure and prosthetic design.

Operative Procedures

The patient is placed in a semireclining position. The procedure involves an anterior approach with a deltopectoral incision that extends from the AC joint to the deltoid insertion. The pectoralis major is released, an anterior capsulotomy is performed, the GH joint is dislocated, a humeral osteotomy is performed, and the head of the humerus is removed. Deltoid reflection usually is not required. The glenoid fossa is also débrided.*

Concomitant procedures that may be performed include:

- Repair of a deficient rotator cuff
- Anterior acromioplasty for a history of impingement syndrome
- Subscapularis lengthening for a significant internal rotation contracture
- Bone graft of the glenoid if bone stock is insufficient for fixation of the glenoid implant

After implantation of the prosthetic components and repair of soft tissues, the shoulder is passively moved through all planes of motion to visually evaluate the stability of the prosthetic joint and the integrity of the repaired soft tissues. This determines the anatomic ROM possible and how aggressive the postoperative program can be.^{103,112}

Postoperative Management

Note: The guidelines for TSR and hemiarthroplasty are similar. Effective patient education and close communication among the surgeon, therapist, and patient are the basis of successful outcomes.

Special Considerations

Integrity of the rotator cuff. Patients with an intact rotator cuff mechanism prior to shoulder arthroplasty

are most likely to achieve significant functional improvements postoperatively.^{103,112,149} Coexisting rotator cuff deficiency that cannot be adequately repaired by a concomitant procedure necessitates a more cautious postoperative treatment plan that emphasizes joint stability over functional mobility.^{54,103}

Posture concerns. Since many patients undergoing shoulder arthroplasty are elderly, the postural changes associated with aging (increased thoracic kyphosis and scapular protraction) cause malalignment (excessive downward rotation) of the glenoid fossa, which predisposes the patient to shoulder impingement and pain during shoulder motions. For these patients, it is particularly important to emphasize an erect sitting or standing posture for joint stability during elevation of the arm and to incorporate spinal extension and scapular retraction exercises into the postoperative program.

Immobilization and Postoperative Positioning

At the close of the surgical procedure the operated arm is placed in some type of shoulder immobilizer, usually a sling and swathe or Velpeau dressing, to protect reattached and repaired soft tissues.^{6,103,164} Positioning is detailed in Box 9–3.

Initially the immobilizer is removed only for exercise and bathing. The patient is weaned from the immobilizer during the day as quickly as possible to prevent postoperative stiffness. The immobilizer is worn during sleep for approximately 6 weeks to pro-

Box 9–3 Positioning After Shoulder Arthroplasty: Maximum Protection Phase

Supine

- Arm immobilized in sling-swathe dressing
 - Elbow flexed to 90 degrees
 - Forearm and hand resting on abdomen
- Arm at patient's side in slight abduction and supported on a folded blanket or pillow
 - Forward flexion (10–20 degrees) and internal rotation of the shoulder
- Head of bed elevated about 30 degrees

Sitting

- Arm supported in sling or resting in the above position on a pillow in the patient's lap

With Tenuous Rotator Cuff Repair

- Shoulder positioned in abduction splint or airplane splint for an extended period of time

*See references 6, 13, 54, 103, 112, 114, 149, 163.

tect incised and reattached tissues until they are reasonably well healed.^{24,27,47,83,102,108,164}

Exercise

The guidelines for progression of exercises during each phase of rehabilitation set forth in this section are drawn from several published protocols, none of which has been shown to be more effective than another.*

Note: The guidelines in this section are for patients without rotator cuff deficiency. Modifications in guidelines are noted throughout this section for patients with a tenuous rotator cuff mechanism.

Precaution: Remember, pain relief is the primary goal of shoulder arthroplasty, with improvement in functional mobility a secondary goal. Although improvements in surgical techniques and implant technology now allow an accelerated progression of postoperative rehabilitation, it is still important to proceed judiciously during each phase of rehabilitation to avoid excessive muscle fatigue or irritation of healing soft tissues.

Since almost all published protocols for shoulder arthroplasty are time-based, few criteria for advancing a patient from one phase of rehabilitation to the next are reported in the literature. Specific criteria for progression should be established by close communication between the therapist and the surgeon and individualized for each patient.

Exercise: Maximum Protection Phase

This phase of rehabilitation, which emphasizes pain control protected motion and prevention of atrophy, may extend from 2 to 3 weeks or, if the patient has a tenuous rotator cuff, as long as 6 weeks.

■ **Maintain mobility of adjacent joints.**

- While the shoulder is immobilized, encourage the patient to keep the shoulder, neck, and upper trunk musculature as relaxed as possible. Use gentle massage to these areas, and have the patient perform active movements of the neck and scapula to maintain normal motion and minimize muscle guarding and spasm.
- Active ROM of the hand, wrist, and elbow when the arm can be removed from the sling.

■ **Regain shoulder mobility.**

- Initiate passive or therapist-assisted shoulder motions within a protected range and with the patient lying supine begun the day after surgery or no later than 48 hours postoperatively. Emphasize forward elevation of the arm in the plane of the scapula for patient comfort. Perform abduction and limited internal and external rotation within a protected range with the elbow flexed and the arm on a folded towel slightly away from the side of the trunk. In addition, some surgeons prescribe the immediate use of a CPM unit for passive elevation of the arm.
- Self-assisted shoulder ROM performed in supine. Incorporate reaching movements (to the nose, forehead, or over the head as comfort allows) to simulate functional movements. Initially, teach the patient to assist with the sound hand and later with a wand or dowel rod.
- Pendulum exercises without a hand-held weight and with the elbow flexed (for a shorter moment arm). Encourage the patient to periodically remove the sling and gently swing the arm during ambulation.
- Active-assistive shoulder ROM in sitting or standing with a wand, by performing “gear shift” exercises (see Fig. 9–11) or use of an overhead rope-pulley system to lessen the weight of the arm. Add horizontal abduction and adduction to ROM exercises. Remind the patient to maintain an erect trunk when performing assisted shoulder motions while seated or standing. Incorporate “shoulder rolls” by elevating, adducting, and then relaxing the scapulae to reinforce an erect posture of the trunk.

■ **Minimize muscle atrophy.**

- Gentle muscle-setting of shoulder musculature with the elbow flexed. Teach these exercises in preparation for discharge (usually 3–4 days postoperatively) by having the patient practice isometrically contracting the muscles of the sound shoulder. Postpone setting exercises of the operated shoulder until about 7 days postoperatively in the home exercise program.
- Scapular stabilization exercises in nonweight-bearing positions. Target the serratus anterior and trapezius muscles.

Precautions: Precautions for the maximum protection phase are noted in Box 9–4. A patient’s understanding of these precautions is of the utmost importance during this phase of rehabilitation.

*See references 24, 27, 47, 83, 91, 102, 108, 164.

Box 9–4 Precautions for Maximum Protection Phase of Rehabilitation After Shoulder Arthroplasty**Exercise**

- Begin exercises gradually and within a protected ROM.
 - Implement short but frequent exercise sessions (four to five per day).
 - Keep repetitions low and intensity gentle.
- Progress exercises more slowly in patients with a severely damaged and repaired rotator cuff mechanism.
 - After a repair of the supraspinatus or deltoid mechanism, avoid active antigravity abduction until the patient can initiate the movement without first shrugging the shoulder.
 - If the subscapularis has been repaired or divided for lengthening, perform external rotation with the arm at the side and *only to neutral*.
- During passive or assisted shoulder rotation with the patient lying supine, position the humerus slightly anterior to the midline of the body (by placing the arm on a folded towel) to avoid excessive stress to the anterior capsule and suture line.
- In sitting or standing, avoid excessive thoracic kyphosis during overhead reaching exercises. Emphasize spinal extension and scapular retraction.
- If an overhead rope-pulley system is used for assisted elevation of the arm, initially *have the patient face the doorway and pulley apparatus* so that shoulder elevation only occurs within a protected range.

ADL

- Avoid weight bearing on the operated extremity, such as pushing with the arm during transfers or when moving in bed, especially the first week after surgery.
- Avoid lifting heavy objects.
- Support the arm in a sling during extended periods of standing or walking.
- Wear the sling while sleeping.

Exercise: Moderate Protection/Controlled Motion Phase

This phase of rehabilitation places an emphasis on moving toward active (unassisted) control of the shoulder while continuing to increase shoulder mobility.^{24,27,83,91,108,164} If the rotator cuff is intact, these exercises in this phase may begin as easily as 2 to 3 weeks postoperatively; if the cuff repair is tenuous, these exercises sometimes are not initiated for at least 6 weeks after surgery.

- **Re-establish mobility and control of shoulder motions.**

- Transition from assisted to active ROM in all anatomic and diagonal planes of motion.
- Wall-climbing exercises, emphasizing overhead reaching.
- Addition of wand exercises behind the back to emphasize shoulder extension and internal rota-

tion as well as scapular winging and tipping (necessary for reaching behind the back).

- Use of active ROM in dressing and grooming.
- **Improve strength, endurance and stability of the shoulder girdle.**
 - Scapular stabilization (alternating isometrics and rhythmic stabilization) exercises in a variety of positions combined with minimal to moderate weight bearing; light weight bearing during functional activities.
 - Continuation of isometric exercise of shoulder musculature against gradually increasing resistance at multiple points in the ROM.
 - Dynamic strengthening of the scapula and shoulder musculature (from 0–90 degrees) using light weights or elastic resistance. Begin in the supine position to support and stabilize the scapula. Progress to the sitting position.
 - Upper extremity ergometry with the UBE or a portable reciprocal exerciser on a table. Emphasize progressive repetitions to increase muscular endurance.

Exercise: Minimum Protection/Return to Functional Activity Phase

The final phase of rehabilitation after shoulder arthroplasty usually begins no earlier than 6 weeks postoperatively (with an intact rotator cuff) or considerably later if the rotator cuff mechanism is deficient.^{91,103,112}

To advance to this phase of rehabilitation the following criteria should be met: (1) pain-free, active shoulder ROM through functional ranges and (2) greater than a Fair (3/5) grade of strength of shoulder musculature. To return to use of the involved arm for light ADL and modified recreational activities, 85% active ROM and a muscle strength grade of at least Good (4/5) should be achieved.¹⁰⁸ There is a continued effort to restore functional ROM during this final phase of rehabilitation. It is useful for the therapist to recheck the patient and possibly modify the exercise program during this phase. For optimal results, the home exercise program may need to be continued for at least 6 months to a year.

- **Continue to improve mobility.**

- End-range, therapist-assisted, or self-stretching
- Grade III joint mobilization and self-mobilization, if appropriate^{24,27,108}

■ **Continue to improve strength, stability, and endurance of the shoulder.**

- Low-load, high-repetition PRE of shoulder musculature in anatomic and diagonal planes and in patterns of movement that replicate functional tasks throughout the available ROM. Position the patient in gravity-resisted positions.
- Increased weight bearing through the upper extremity during functional activities.
- Use of the involved upper extremity for light lifting, carrying, pushing, or pulling activities against increasing loads.
- Use of the involved upper extremity for modified recreational or sport-related activities.

Outcomes

Almost all patients report a total relief of a substantial decrease in shoulder pain, as well as an improvement in functional use of the arm.^{6,13,91,102,112,114} If the rotator cuff and deltoid muscles are functioning well, a patient can expect to regain active ROM necessary for most functional activities within a year after surgery. Overall, patients with OA show greater improvement in ROM (forward flexion) than patients with RA. Both groups report similar improvement in pain relief and functional status.* It is usually necessary to modify activities of daily living as well as work-related and recreational activities after shoulder arthroplasty. Heavy lifting and high-impact activities should be avoided to minimize the potential for postoperative wear and tear or loosening of the prosthetic components.^{27,39,108,164}

Arthrodesis of the Shoulder

Indications for Surgery

The following are generally accepted indications for arthrodesis of the glenohumeral joint.^{12,39,103,138,180}

- Incapacitating pain
- Gross instability of the GH joint
- Complete paralysis of the deltoid and rotator cuff muscles
- Severe joint destruction from infection
- Failed shoulder arthroplasty in a young, active patient who is not a candidate for revision arthroplasty

- Good compensatory scapular motion and strength of the serratus anterior and trapezius muscles

Procedure

The GH joint is fused with pins and bone grafts in a position of 15 to 30 degrees of flexion and abduction and up to 30 to 45 degrees of internal rotation so that the hand can reach the middle of the body or mouth.^{103,138,139,164,180} The shoulder is immobilized in a shoulder spica cast or a thoracobrachial (airplane) orthosis that extends across the elbow joint. The immobilizer is worn for 3 to 5 months.

Postoperative Management

Place emphasis on maintaining mobility of peripheral joints. While the shoulder and elbow are immobilized, have the patient focus on maintaining mobility in the wrist and hand. If an orthosis with a hinged elbow joint is used, begin elbow flexion and extension when permissible, often as early as the day after surgery. After the immobilization device may be removed for exercise, begin active scapulothoracic ROM. Strengthen scapulothoracic musculature to maximize control and stability of the scapula.

Outcomes

A patient may expect to achieve 90 to 130 degrees of active elevation of the arm because of scapulothoracic mobility.^{103,138,180} After bony and soft tissue healing is complete, the shoulder is stable and pain free for activities that require strength or weight bearing at the shoulder. Patients are able to bring the hand to the mouth, behind the head, and to the hip.^{138,164,180} Over time, excessive stress may be placed on the AC joint, resulting in AC joint hypermobility and pain.^{138,139,164}

► **Painful Shoulder Syndromes: Rotator Cuff Disease, Impingement Syndromes, and Shoulder Instabilities**

Mechanical compression and irritation of the soft tissues (rotator cuff and subacromial bursa) in the suprahumeral space is called **impingement syndrome** and is the most common cause of shoulder pain.⁹⁸ Impingement is generally classified as primary or secondary.

Primary impingement is the result of intrinsic or extrinsic factors that encroach against the tissues in

*See references 39, 54, 102, 103, 114, 116, 149.

the subacromial space. Structural encroachment includes structural variations in the acromion,^{56,142} hypertrophic degenerative changes of the AC joint, or other trophic changes in the coracoacromial arch or humeral head, which decrease the suprahumeral space. Extrinsic factors that result in decreased suprahumeral space and repetitive trauma to the soft tissues during elevation of the arm include posterior capsular tightness, poor neuromuscular control of the rotator cuff or scapular muscles, faulty scapulothoracic posture or a partial or complete tear of the tissues in the suprahumeral space (either from traumatic or degenerative situations).^{70,97,98,113,155} Neer described three pathologic stages of impingement which demonstrate the potentially progressive nature of the pathology over time.¹¹³ These are outlined in Box 9–5.

Secondary impingement is used to describe symptoms from faulty mechanics that occur from hypermobility or instability of the GH joint with increased translation of the humeral head. The instability may be unidirectional or multidirectional. Unidirectional instability usually occurs from trauma and results in partial tearing of some of the supporting ligaments or glenoid labrum, but may also occur from lax capsular tissues. The trauma may occur in an anterior, posterior, or inferior direction. Physiologically lax connective tissue of the capsule may also lead to multidirectional instability. The hypermobility can cause other problems besides impingement such as subluxation, dislocation or rotator cuff tendinitis, which with repetitive microtrauma can lead to degenerative changes including bone spurs, tendon rupture, or capsular restrictions and frozen shoulder. Jobe has developed a classification system incorporating the progression of impingement and instability in the overhead athlete based on progressive microtrauma.⁸⁴ These are outlined in Box 9–5.

Symptoms from impingement, whether from primary causes or secondary instability, are usually brought on with excessive or repetitive overhead activities that load the shoulder joint, particularly in the midrange. Other types of musculotendinous strains that occur in the shoulder region may occur from overuse or trauma, such as in the anterior pectoral region from racket sports or in the long head of triceps and serratus anterior from impact trauma such as holding on to a steering wheel in an automobile accident.

Box 9–5 Categories of Painful Shoulder Syndromes

Impingement syndromes and other painful shoulder conditions have varying etiological factors and, therefore, can be categorized several ways.

Based on Degree or Stage of Pathology of the Rotator Cuff (Neer's Classification of Rotator Cuff Disease)¹¹³

- **Stage I.** Edema, hemorrhage (patient usually less than 25 years of age)
- **Stage II.** Tendinitis/bursitis and fibrosis (patient usually 25–40 years of age)
- **Stage III.** Bone spurs and tendon rupture (patient usually over 40 years of age)

Based on Impaired Tissue⁴²

- Supraspinatus tendinitis
- Infraspinatus tendinitis
- Bicipital tendinitis
- Subdeltoid (subacromial) bursitis
- Other musculotendinous strains (specific to type of injury or trauma)
 - Anterior—from overuse with racket sports (pectoralis minor, subscapularis, coracobrachialis, short head of biceps strain)
 - Inferior—from motor vehicle trauma (long head of triceps, serratus anterior strain)

Based on Mechanical Disruption and Direction of Instability or Subluxation

- Multidirectional instability from lax capsule with or without impingement
- Unidirectional instability (anterior, posterior, or inferior) with or without impingement
 - Traumatic injury with tears of capsule and/or labrum
 - Insidious (atraumatic) onset from repetitive microtrauma
 - Inherent laxity

Based on Progressive Microtrauma (Jobe's classification)⁸⁴

- **Group 1.** Pure impingement (usually in an older recreational athlete with partial undersurface rotator cuff tear and subacromial bursitis)
- **Group 2.** Impingement associated with labral and/or capsular injury, instability, and secondary impingement
- **Group 3.** Hyperelastic soft tissues resulting in anterior or multidirectional instability and impingement (usually attenuated but intact labrum, undersurface rotator cuff tear)
- **Group 4.** Anterior instability without associated impingement (result of trauma, results in partial or complete dislocation)

Based on Degree and Frequency

- Instability → subluxation → dislocation
- Acute, recurrent, fixed

Related Diagnoses and Etiology of Symptoms

The cause of impingement is multifactorial, involving both structural and mechanical impairments. Impingement syndrome is often used as the diagno-

sis when patient signs and symptoms are related to pain with overhead reaching, a painful arc midrange, and positive impingement tests. Other test results may more specifically identify the tissue involved, faulty mechanics associated with the condition, or degree of instability or injury.

Primary Impingement—Rotator Cuff Disease

Primary impingement is believed to occur as a result of mechanical wear of the rotator cuff against the anteroinferior one-third of the acromion in the suprahumeral space during elevation activities of the humerus. Structural variants, in the acromion and coracoacromial arch, may be the cause of primary impingement⁷⁷ and often have to be dealt with surgically. Other factors that influence the amount of suprahumeral space and may contribute to impingement include posture, muscle imbalances, and joint restrictions are dealt with using therapeutic exercise interventions. Neer¹¹³ identified impingement lesions of the rotator cuff and long head of the biceps in three progressive stages:

Stage I. Edema and hemorrhage: Typically occurs in patients who are below the age of 25 years.

Stage II. Fibrosis and tendinitis (the bursa may also become fibrotic and thickened): Seen typically in patients between 25 and 40 years of age.

Stage III. Bone spurs, rotator cuff tears, and biceps rupture: Typically seen in persons over 40 years of age.

Other authors have identified chronic inflammation, possibly from repetitive microtraumas in the joint region, as a stimulus for the development of frozen shoulder.^{63,117,120}

Tendinitis/Bursitis—Impaired Musculotendinous Tissues

Neer has identified tendinitis/bursitis as a stage II impingement syndrome. The following describe specific diagnoses and presenting signs and symptoms.

Supraspinatus tendinitis. The lesion is usually near the musculotendinous junction and results in a painful arc with overhead reaching. Pain occurs with the impingement test (forced humeral elevation in the plane of the scapula while the scapula is passively stabilized so that the greater tuberosity impacts against the acromion;^{70,113} or with the arm in internal rotation while flexing the humerus).⁷⁰ There

is pain on palpation of the tendon just inferior to the anterior aspect of the acromion when the patient's hand is placed behind the back. It is difficult to differentiate partial tears from subdeltoid bursitis because of the anatomic proximity.

Infraspinatus tendinitis. The lesion is usually near the musculotendinous junction and results in a painful arc with overhead or forward motions. It may present as a deceleration (eccentric) injury from overload during repetitive or forceful throwing activities. Pain occurs on palpation of the tendon just inferior to the posterior corner of the acromion when the patient horizontally adducts and laterally rotates the humerus.

Bicipital tendinitis. The lesion involves the long tendon in the bicipital groove beneath or just distal to the transverse humeral ligament. Swelling in the bony groove is restrictive and compounds and perpetuates the problem. Pain occurs with resistance to the forearm in a supinated position while the shoulder is flexing (Speed's sign) and on palpation of the bicipital groove.⁹⁹ A rupture or dislocation of this humeral depressor may escalate impingement of tissues in the suprahumeral space.^{113,121}

Bursitis (subdeltoid or subacromial). When acute, symptoms are the same as supraspinatus tendinitis. Once the inflammation is under control, there are no symptoms with resistance.

Other musculotendinous problems. The following are examples of other musculotendinous problems in the shoulder region.

- The pectoralis minor, short head of the biceps, and coracobrachialis are subject to microtrauma, particularly in racket sports requiring a controlled backward then a rapid forward swinging of the arm, as are the scapular stabilizers as they function to control forward motion of the scapula.⁹⁵
- The long head of the triceps and scapular stabilizers are often injured in motor vehicle accidents as the driver holds firmly to the steering wheel on impact.
- A fall on an outstretched hand or against the shoulder may also cause trauma to the scapular stabilizers, which, if not properly healed, will continue to cause symptoms whenever using the arm or when maintaining a shoulder posture.
- Injury, overuse, or repetitive trauma can occur in any muscle being subjected to stress.¹²⁴ Pain will occur when the involved muscle is placed on a

stretch or when contracting against resistance. Palpation of the site of the lesion will cause the familiar pain.

Secondary Impingement—Shoulder Instability/Subluxation

Multidirectional instability. Some individuals have physiologically lax connective tissue causing excessive mobility in the joints of the body. In the GH joint, the humeral head translates to a greater degree than normal in all directions.^{127,148,168} Many individuals, particularly those involved in overhead throwing or lifting activities, have some inherent laxity or develop laxity of the capsule and instability from continually subjecting the joint to stretch forces.^{56,84} With strong rotator cuff muscles a hypermobile joint is satisfactorily supported, but once they fatigue, poor humeral head stabilization leads to faulty humeral mechanics, trauma, and inflammation to the suprahumeral tissues.^{84,109} This trauma is magnified with the rapidity of control demanded in the overhead throwing action.⁵⁶ Similarly, in individuals with poor rotator cuff muscle strength and function, the ligaments become stressed with repetitive use and hypermobility, and impingement results. With instability, the impingement of tissue in the suprahumeral space is the secondary effect.⁵⁶

Unidirectional instability with or without impingement (anterior, posterior or inferior). Unidirectional instability may be the result of physiologically lax connective tissue but is usually the result of trauma and usually involves rotator cuff tears. The tears can be classified as acute, chronic, degenerative, or partial- or full-thickness tears. Often there is damage to the glenoid labrum and tearing of some of the supporting ligaments.

Traumatic tears or paralysis. Partial-thickness tears or full avulsion of the greater tubercle may occur in the elderly as the result of a fall on an outstretched arm.¹¹⁸ In young patients, trauma is usually associated with capsular injury, with or without labrum injury, resulting in instability. Dislocation of the humerus may occur with ensuing instability. The instability can lead to progressive degeneration and eventually tears in the supporting structures. Tears are associated with pain and most commonly weakness of shoulder abduction and external rotation.

- *Anterior instability* usually occurs with force

against the arm when it is in an abducted and externally rotated position and frequently involves detachment of the anterior capsule and glenoid labrum (Bankart lesion). There may also be a fractured piece or flattening of the anterior lip of the glenoid.⁶⁵ Positive signs include apprehension, load and shift, and anterior drawer tests.^{99,186}

- *Posterior instability* results from a forceful thrust against a forward flexed humerus or fall on an outstretched arm. There is a positive posterior drawer sign.^{99,186}
- *Inferior instability* results from rotator cuff weakness/paralysis and is frequently seen in patients with hemiplegia.⁶¹ It is also prevalent in patients with multidirectional instability. This is detected with a positive sulcus sign.^{99,186}

Insidious (atraumatic) onset. Neer has identified rotator cuff tears as a stage III impingement syndrome, a condition that typically occurs in persons over the age of 40 after repetitive microtrauma to the rotator cuff or long head of the biceps.¹¹³ With aging, the distal portion of the supraspinatus tendon is particularly vulnerable to impingement or stress from overuse strain. With degenerative changes, calcification and eventual tendon rupture may occur.^{56,126} Chronic ischemia caused by tension on the tendon and decreased healing in the elderly are possible explanations, although Neer states that, in his experience, 95% of tears are initiated by impingement wear rather than by impaired circulation or trauma.¹¹³

Common Impairments

Various impairments have been reported to be common in impingement syndromes; it is not known if they are the cause or effect of the faulty mechanics.^{32,97,98,128,178} A thorough examination of the cervical spine and shoulder girdle is necessary to differentiate signs and symptoms related to primary and secondary impingements or other causes of shoulder pain.^{23,85,99}

Postural Malalignment and Muscle Imbalances: Increased Thoracic Kyphosis with Accompanying Forward Head, Abducted, and Forward Tipped Scapula

Faulty upper quadrant posture leads to an imbalance in the length and strength of the scapular and glenohumeral musculature and decreases the effectiveness of the dynamic and passive stabilizing

structures of the GH joint.¹⁸⁷ Typically with increased thoracic kyphosis, the scapula is protracted and tipped forward, and the GH joint is in an internally rotated posture. With this posture, the pectoralis minor, levator scapulae, and shoulder internal rotators are tight, and the lateral rotators of the shoulder and upward rotators of the scapula test weak and have poor muscular endurance. There is no longer the stabilizing tension on the superior joint capsule and coracohumeral ligament or compressive forces from the rotator cuff muscles. Therefore, the effect of gravity tends to cause an inferior force on the humerus.

When reaching overhead there is faulty scapular and humeral mechanics resulting in faulty alignment of the scapula and altered function in the muscles controlling the scapula and glenohumeral joint. Ludewig and Cook⁹⁷ documented delayed upward rotation of the scapula during the 31- to 60-degrees range of humeral elevation, incomplete backward tipping of the scapula, and excessive scapular elevation in individuals with impingement. This mechanical alteration may contribute to decreased clearance under the anterior acromion. Overuse of the upper trapezius with scapular elevation may be a compensation for the weak posterior tipping action of the serratus anterior⁹⁷ and points to the importance of re-establishing control and balance in strength in this muscle along with flexibility in the pectoralis minor.

Decreased Thoracic ROM

Thoracic extension is a component motion that is needed for full overhead reaching; incomplete thoracic extension will decrease the functional range of humeral elevation.

Rotator Cuff Overuse and Fatigue

If the rotator cuff musculature or long head of the biceps fatigue from overuse, they no longer provide the dynamic stabilizing, compressive and translational forces that support the joint and control the normal joint mechanics. This is thought to be a precipitating factor in secondary impingement syndromes when there is capsular laxity and increased need for muscular stability.¹³¹ The tissues in the subacromial space may then become impinged from faulty mechanics. There is also a relationship between muscle fatigue and joint position sense in the shoulder that may play a role in impaired performance in repetitive overhead activities.³³

Muscle Weakness Secondary to Neuropathy

Muscle weakness may be related to nerve involvement. Long thoracic nerve palsy has been identified as a cause of faulty scapular mechanics from serratus anterior muscle weakness leading to impingement in the suprahumeral region.¹⁵¹

Hypomobile Posterior GH Joint Capsule

Tightness in the posterior joint capsule compromises the normal arthrokinematics and increases forces on the head of the humerus against the anterior capsule. Harryman et al⁶⁶ has demonstrated increased anterior translation in the humeral head when there is a tight posterior capsule.

Summary of Common Impairments with Rotator Cuff Disease and Impingement Syndromes

Note: Some, all, or none of these may be present.

- Pain at the musculotendinous junction of the involved muscle with palpation, with resisted muscle contraction, and when stretched
- Positive impingement sign (forced internal rotation at 90 degrees of flexion) and painful arc
- Faulty posture: Thoracic kyphosis, forward head, and forward (anterior) tipped scapula with decreased thoracic mobility
- Muscle imbalances: Hypomobile pectoralis major and minor, levator scapulae, and internal rotators of GH joint; weak serratus anterior and lateral rotators
- Hypomobile posterior GH joint capsule
- Faulty kinematics with humeral elevation: decreased posterior tipping of scapula related to weak serratus anterior; scapular elevation and overuse of upper trapezius; and uncoordinated scapulohumeral rhythm
- With a complete rotator cuff tear, inability to abduct the humerus against gravity
- When acute, pain referred to the C-5 and C-6 reference zones

Common Functional Limitations/Disabilities

- When acute, pain may interfere with sleep, particularly when rolling onto the involved shoulder.
- Pain with overhead reaching, pushing, or pulling.
- Difficulty with lifting loads.
- Inability to sustain repetitive shoulder activities

(such as reaching, lifting, throwing, pushing, pulling, or swinging the arm).

- Difficulty with dressing, particularly putting a shirt on overhead.

Nonoperative Management: Painful Shoulder Syndromes (Without Dislocation)

Note: Even though symptoms may be “chronic” or recurring, if there is inflammation, the initial treatment priority is to get the inflammation under control.

Management: Protection Phase

Control Inflammation and Promote Healing

- Use modalities and low-intensity cross-fiber massage to the site of the lesion. While applying the modalities position the extremity to maximally expose the involved region.^{43,45}
- Support the arm in a sling for rest.

Patient Education

The environment and habits that provoke the symptoms must be modified or avoided completely during this stage.⁴³

Maintain Integrity and Mobility of the Soft Tissues

- Initiate early motion with passive, active-assistive, or self-assisted ROM.
- Apply multiple-angle muscle setting and protected stabilization exercises. Of particular importance in the shoulder is to stimulate the stabilizing function of the rotator cuff, biceps brachii, and scapular muscles at an intensity tolerated by the patient.
- Use caution with exercises in this stage to avoid the impingement positions, which are often in the midrange of abduction or end-range position when the involved muscle is on a stretch.

Control Pain and Maintain Joint Integrity

Use pendulum exercises without weights to cause pain-inhibiting grade II joint distraction and oscillation motions (see Fig. 9–10).

Develop Support in Related Regions

- Teach the patient postural awareness and correction techniques.
- Initiate training of scapular and thoracic posture using shoulder strapping or scapular taping, tactile cues, and use of mirrors for reinforcement.

Repetitive practice of correct posture is necessary throughout the day.

- Forward head posture is often related to forward shoulder posture (see Chapter 15 for additional suggestions if this dysfunction is present).

Management: Controlled Motion Phase

Once the acute symptoms are under control, the main emphasis becomes use of the involved region with progressive, nondestructive movement and proper mechanics while the tissues heal. The components of the desired functions are analyzed and initiated in a controlled exercise program.^{44,45,87,182,183} If there is a functional laxity in the joint, the intervention is directed toward learning neuromuscular control of and developing strength in the stabilizing muscles of both the scapula and glenohumeral joint.^{29,87,90,150,171} If there is restricted mobility that prevents normal mechanics or interferes with function, mobilization of the restricted tissue is performed. Exercise techniques and progressions are described later in this chapter.

Patient Education

Patient adherence with the program and avoidance of irritating the healing tissue are necessary. The home exercise program is progressed as the patient learns safe and effective execution of each exercise.

Develop a Strong, Mobile Scar

- Position the tissue on a stretch if it is a tendon or in the shortened position if it is in the muscle belly and apply cross-fiber or friction massage to the tolerance of the patient.
- Follow this with an isometric contraction of the muscle in several positions of the range and at an intensity that does not cause pain.
- Teach the patient how to self-administer the massage and isometric techniques.

Improve Postural Awareness

Continue to reinforce proper postural habits. Every time an exercise is performed, make the patient aware of scapular and cervical posture with tactile and verbal reinforcement such as touching the scapular adductors and chin and reminding the patient to “pull the shoulders back” and “lift the head” while doing the shoulder exercises.

Modify Joint Tracking

Mobilization with movement (MWM) may be useful to modify joint tracking and reinforce full movement when there is painful restriction of shoulder elevation because of a painful arc or impingement¹¹⁰ (see Chapter 6 for description of principles).

- **Posterolateral glide with active elevation** (Fig 9-7A)
 - Patient position and procedure: Sitting with the arm by the side and head in neutral retraction. Stand on the side opposite the affected arm and reach across the patient's torso to stabilize the scapula with the palm of one hand. The other hand is placed over the anteromedial aspect of the head of the humerus.
 - Apply a graded posterolateral glide of the humeral head on the glenoid. Request that the patient perform the previously painful elevation. Maintain the posterolateral glide mobilization throughout both elevation and return to neutral. Ensure no pain is experienced during the procedure. Adjust the grade and direction of the glide as needed to achieve pain-free function.
 - Add resistance in the form of elastic resistance or a cuff weight to load the muscle.
- **Self-treatment.** A mobilization belt provides the posterolateral glide while the patient actively elevates the affected limb against progressive resistance to end range (Fig. 9-7B).

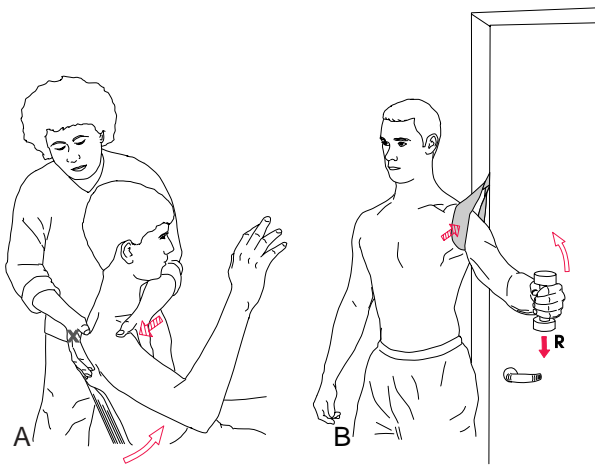


Figure 9-7 MWM to modify joint tracking and improve active elevation. A posterolateral glide is applied to the humeral head (A) manually, or (B) with a belt for self-treatment, while the patient actively elevates the humerus. A weight is used to strengthen the muscles through the pain-free range.

Develop Balance in Length and Strength of Shoulder Girdle Muscles

Design a program that specifically addresses the patient's limitations. Typical interventions in the shoulder girdle include but are not limited to:

- **Stretch shortened muscles.** These typically include the pectoralis major, pectoralis minor, latissimus dorsi and teres major, subscapularis, and levator scapulae.
- **Strengthen and train the scapular stabilizers.** These typically include the serratus anterior and lower trapezius for posterior tipping and upward rotation and the middle trapezius and rhomboids for scapular retraction. It is important that the patient learns to avoid scapular elevation when raising the arm. Therefore, practice scapular depression when abducting and flexing the humerus.
- **Strengthen and train the rotator cuff muscles,** especially the shoulder lateral rotators.

Develop Co-Contraction, Stabilization, and Endurance in the Muscles of the Scapula and Shoulder

- Isolate the scapular muscles in open-chain positions (side-lying, sitting, supine) and apply alternating isometric resistance to protraction/retraction, elevation/depression, and upward/downward rotation so the patient learns to stabilize the scapula against the outside forces (see Fig. 9-25).
- Combine scapular and glenohumeral patterns with the humerus in various positions of flexion, abduction, and rotation and apply alternating isometric resistance while the patient holds against the changing directions of the resistance force (see Fig 9-29).
- Closed-chain stabilization is performed with the patient's hands fixated against a wall, a table, or the floor (quadruped position) while the therapist provides a graded, alternating isometric resistance or rhythmic stabilization. Observe for abnormal scapular winging. If it occurs the scapular stabilizers are not strong enough for the demand; so the position should be changed to reduce the amount of body weight (see Fig 9-30).
- Increased muscular endurance by increasing the amount of time the individual holds the pattern against the alternating resistance. The limit is reached when any one of the muscles in the pattern can no longer maintain the desired hold. The goal at this phase should be stabilization for approximately 3 minutes.

Progress Shoulder Function

As the patient develops strength in the weakened muscles, develop a balance in strength of all shoulder and scapular muscles within the range and tolerance of each muscle. Increase coordination between scapular and arm motions; dynamically load the upper extremity within tolerance of the synergy with submaximal resistance. Improve muscular endurance and develop control from 1 to 3 minutes.

Management: Return to Function Phase

As soon as the patient has developed control of posture and the basic components of the desired activities without exacerbating the symptoms, initiate specificity of training toward the desired functional outcome.

Increase Muscular Endurance

Increase repetitive loading of defined patterns from 3 to 5 minutes.

Develop Quick Motor Responses to Imposed Stresses

- Increase the speed at which the stabilization exercises are applied.
- Initiate plyometric training in both open- and closed-chain patterns if power is needed.

Develop Function

Progress to specificity of training; emphasize timing and sequencing of events.

- Progress eccentric training to maximum load.
- Simulate desired functional activities, first under controlled conditions, then under progressively challenged situations using acceleration/deceleration drills.
- Assess the total-body function while doing a desired activity and modify any component that causes faulty patterning.

Educate the Patient

Inform the patient of the time frames for healing and any exercises and activities that can be done. Instruct the patient on how to progress the program when discharged as well as how to prevent recurrences. Suggestions are summarized in Box 9–6.

Impingement Syndromes: Surgical and Postoperative Management**Indications for Surgery**

The following are generally accepted indications for surgical management of impingement syndromes.*

Box 9–6 Patient Instructions to Prevent Recurrences of Shoulder Pain

- Prior to exercise or work, massage the involved tendon or muscle; follow with isometric resistance and then with full ROM and stretching of the muscle.
- Take breaks from the activity if repetitive in nature. If possible, alternate the stressful, provoking activity with other activities or patterns of motion.
- Maintain good postural alignment; adapt seating or work station to minimize stress. If sport-related, seek coaching in proper techniques or adapt equipment for safe mechanics.
- Prior to initiating a new activity or returning to an activity not conditioned for, begin a strengthening and training program.

- Insufficient subacromial joint space leading to pain during overhead activities as the result of primary impingement of soft tissues at the anterior edge and undersurface of the acromion.
- Stage II (Neer classification) impingement with nonreversible fibrosis or bony alterations (degenerative spurring) of the subacromial compartment.
- Intact or minor tears of the rotator cuff; calcific deposits in the cuff tendons; symptomatic subacromial crepitus.
- Unsuccessful conservative (nonoperative) management for 3 to 6 months or as long as a year.

Procedures

Impingement syndromes of the shoulder are managed by a variety of surgical methods known as *subacromial decompression* procedures or *anterior acromioplasty*.^{1,50,68,133,147} An arthroscopic subacromial decompression involves removal of a portion of the anterior acromion (arthroscopic acromioplasty) and debridement of the undersurface of the acromion through several portal sites.^{1,4,50,68,133} The inferior aspect of the remaining portion of the acromion is often beveled to provide adequate gliding space for the inflamed tendons.¹⁴² In an arthroscopic approach, the deltoid is left intact.

An open procedure involves an arthrotomy through an anterolateral incision at the lateral border of the acromion. The anterior and lateral origins of the deltoid are detached from the acromion and later repaired before closure.^{71,112,115,132} In open and arthroscopic approaches, the coracoacromial ligament is released. In both approaches sometimes the distal clavicle is also resected.^{1,68}

Postoperative Management

The position and duration of immobilization of the shoulder and initiation and progression of exercise

*See references 4, 50, 68, 71, 115, 132, 133, 142, 147.

vary with the surgical approach. Rehabilitation after arthroscopic acromioplasty is quite rapid, primarily because the deltoid is left intact. Since the arthroscopic approach is used far more frequently for surgical management of primary impingement syndrome than an open acromioplasty, *the postoperative guidelines and the progression of exercises outlined in this section are appropriate after arthroscopic subacromial decompression*. If arthroscopic decompression is combined with a mini-open (arthroscopically assisted) repair of the rotator cuff, many of the same exercises are appropriate but in a slower progression. With an open acromioplasty, which is frequently used in combination with a traditional open rotator cuff repair, as noted previously, the deltoid must be detached and then repaired. Accordingly, the progression of exercises, discussed later in this chapter for open rotator cuff repair, is advisable.

Regardless of the type of procedure selected, close communication among the patient, therapist, and surgeon is necessary throughout all phases of postoperative rehabilitation. Effective patient education is the basis of early self-management by the patient and positive functional outcomes.

Immobilization

The shoulder is usually positioned in adduction and internal rotation, and the forearm is supported in a sling with the elbow flexed to 90 degrees. The sling is removed for exercise the day after surgery but otherwise is worn for several days for comfort.^{50,162,185}

Exercise: Maximum Protection Phase

The goals and interventions for exercise in this phase of rehabilitation, which usually extends from 1 to 2 weeks postoperatively, are consistent with the guidelines for nonoperative management of acute impingement syndrome outlined previously in this chapter. *Emphasis is placed on immediate but pain-free assisted movement.*^{50,83,162,185} Use of modalities and prescribed anti-inflammatory medication is indicated to control inflammation and pain.

■ **Control pain.**

- Cervical spine active ROM and shoulder relaxation exercises

■ **Prevent or correct postural malalignment.**

- Active exercises of the scapula with emphasis on retraction
- Posture awareness training, placing emphasis on an erect trunk (avoiding excessive thoracic kyphosis) during exercises and ADL

■ **Prevent loss of mobility of all joints and muscles in the involved upper extremity.**

- CPM from 0 to 90 degrees of shoulder flexion initiated in the recovery room or the day after surgery, predicated on the philosophy of the surgeon.¹⁰⁴ It is used for only 48 hours postoperatively for patients undergoing inpatient surgery.
- Active ROM of the elbow, wrist, and hand through full ranges.
- Active-assistive shoulder ROM begun on the first postoperative day, emphasizing shoulder flexion, scaption, abduction, and horizontal abduction and adduction within pain-free ranges. Start in the supine position to provide additional stability to the scapula against the thorax using therapist-assisted, short-arc motion, progressing to full-arc ROM; then transition to self-assisted ROM with the uninvolved hand and finally with a wand. Progress to assisted elevation of the arm in the seated position.
- Active-assistive external and internal rotation with a wand, first in supine and later while seated. Keep the elbow flexed to 90 degrees and the arm slightly flexed and abducted during assisted rotation.
- Gear-shift exercises in sitting.
- Pendulum exercises for pain control and mobility.
- Assisted shoulder extension in a standing position with a wand held behind the back.
- Assisted scaption above the level of the shoulder with a rope-pulley system through a pain-free range.
- Transition to active-free (unassisted) ROM of the shoulder by 10 days to 2 weeks postoperatively.

■ **Prevent atrophy and improve strength, stability, and endurance of the shoulder girdle musculature.**

- *Pain-free, low-intensity, multiple-angle isometrics of GH musculature against minimal resistance. Begin isometrics a few days to a week postoperatively. Lightly resist with the uninvolved upper extremity. Focus on increasing repetitions more than resistance.*^{97,151}
- Alternating isometric and rhythmic stabilization exercises for scapulothoracic muscles with the involved arm supported by the therapist. Target the serratus anterior and trapezius muscles.

Exercise: Moderate Protection/Controlled Motion Phase
Rehabilitation proceeds very rapidly after arthroscopic subacromial decompression. Controlled

active motion is emphasized while moderate protection of the shoulder is maintained by only performing pain-free movements. This phase of rehabilitation usually begins by 2 weeks postoperatively.

Criteria to advance to this phase include pain-free active elevation of the arm well above the level of the shoulder and at least Fair (3/5) muscle testing grade of shoulder musculature.^{83,184,185} The priorities during this phase are to restore full ROM, strengthen key muscle groups, and begin to use the involved arm for light functional activities.^{45,83,88,89,162,185}

■ **Restore and maintain full, pain-free passive mobility of the shoulder.**

- Joint mobilization, emphasizing posterior and caudal glides of the humerus and scapulothoracic mobility.
- Gentle stretching of range-limiting muscles that could restrict sufficient upward rotation of the scapula and rotation of the humerus necessary for full elevation of the arm overhead, specifically the levator scapulae, rhomboids, middle trapezius, latissimus dorsi, and pectoralis major and minor. Remember, shortening of these muscles contributes to impingement of soft tissues during overhead movements of the arm.
- Self-stretching (cross-chest stretch) of the posterior deltoid and posterior capsule of the GH joint, which is usually tight in stage II and stage III impingement. A tight posterior capsule causes excessive anterior translation and superior migration of the head of the humerus in the glenoid, which, in turn, causes impingement of soft tissues during overhead reach.^{66,104}
- Active shoulder motions, incorporating the gained ROM into exercises and functional movement patterns during ADL.

■ **Continue to improve strength, stability, endurance and control of scapulothoracic and GH muscles.**

- Stabilization exercises against greater resistance and in weight-bearing postures.^{88,89} Use a Bodyblade® in various positions of the shoulder.
- Upper extremity ergometry. Initiate in a standing position rather than while seated to avoid an impingement arc.^{88,89}
- Dynamic exercises of isolated shoulder muscles against low levels of resistance (1–5 lb) and gradually increasing repetitions. Use manual or mechanical resistance. Once again, begin shoulder

elevation in the supine position to stabilize the scapula against the thorax; progress to sitting. Target the upward rotators of the scapulothoracic joint (serratus anterior, the upper and lower trapezius) and the rotator cuff muscles,¹⁵⁴ as well as the latissimus dorsi, teres major, and biceps brachii, which act as humeral head depressors and, therefore, oppose superior translation during active elevation of the arm. Initially perform resisted motions of the humerus below the level of the shoulder; later progress to overhead exercises if motions remain pain-free.

Note: If winging of the scapula occurs with progressive resistance or weight bearing, provide manual support or decrease the imposed loads. Emphasize isolated strengthening of the serratus anterior and trapezius muscles.

- Use the involved arm for light functional activities.

**Exercise: Minimum Protection/
Return to Function Phase**

The final phase of rehabilitation usually begins by 6 weeks postoperatively at which time soft tissues are reasonably well healed and require minimum protection. Criteria to progress to this phase is full, pain-free, active ROM of the shoulder, 70 to 75% strength of shoulder musculature compared with the sound shoulder, and a negative impingement test.^{83,185} Criteria to return to full activity, which usually occurs by 8 to 12 weeks postoperatively, depends primarily on desired functional outcomes and the potential demands and stresses that will be placed on the shoulder. A patient wishing to return to competitive sports will require a more demanding progression of advanced exercises than a sedentary individual.^{68,83} Include the following goals, exercises, and activities in the final phase of rehabilitation.^{83,89,162,184,185}

- Progress exercises to include advanced activities, such as more rapid motions and directional changes.
- Isokinetic exercises.
- Kinesthetic/proprioceptive training, using rapid, alternating resistance with rhythmic stabilization.
- Plyometric training.¹⁸¹
- Simulate functional activities in drills and then gradually return to actual work or sports-related functional activities. Refer to detailed, sports-specific protocols in the literature to return to

such sports as golf, volleyball, throwing sports, and tennis. Modify functional activities, if necessary, to prevent recurrence of impingement.

Note: Exercises for the final phase of nonoperative rehabilitation of impingement syndrome, cuff tears, and instabilities discussed earlier in this chapter are also appropriate in the final stage of postoperative rehabilitation.

Outcomes

There appears to be no significant difference in the *long-term* results (pain-free ROM and return to desired functional activities) after either open or arthroscopic surgery for primary impingement syndrome with or without associated rotator cuff disease.⁵⁰ Based on the results of numerous outcome studies of open and arthroscopic procedures, between 85 and 95% of patients report good to excellent results 1 to 2.5 years postoperatively.^{2,184,185} In general, patients reporting the least satisfaction with their function after surgery are those involved in high-demand athletic activities, involving overhead throwing and those with work-related injury receiving workers' compensation.¹⁰⁴ Follow-up studies have documented several advantages of an arthroscopic over comparable open surgical management of impingement syndrome. They are: less postoperative pain; earlier restoration of full ROM and strength; earlier return to work, often as early as 1 week postoperatively; less cost (shorter hospital stay or outpatient surgery); and a more favorable cosmetic result.^{1,68,104}

Rotator Cuff Tears: Surgical and Postoperative Management

Indications for Surgery

- Partial-thickness or full-thickness tears of the rotator cuff tendons as the result of repetitive microtrauma and chronic impingement, which lead to irreversible degenerative changes in soft tissues. Some patients with stage II and most with stage III lesions, who continue to be symptomatic and have functional limitations after 6 months to a year of nonoperative treatment, are candidates for surgery.*
- Acute, traumatic rupture (frank, full-thickness tears) of the rotator cuff tendons, often combined

with avulsion of the greater tuberosity, labral damage, or acute dislocation of the GH joint in individuals with no known history of cuff injury. Full-thickness, traumatic tears occur most often in young, active adults.

Procedures

Depending on the severity and location of the tear of the rotator cuff tendons, the extent of associated lesions, the quality of the torn tissues as well as other considerations, there are several operative options. *Partial-thickness cuff tears*, if managed surgically after failed nonoperative treatment, are usually debrided arthroscopically along the margins of the tear rather than repaired. Debridement is often combined with subacromial decompression.^{2,8,105,161,169}

Repair is indicated for most *full-thickness cuff tears* after a trial of nonoperative management or sometimes immediately after an acute injury. Options for repair now include *arthroscopic cuff repair*, *mini-open (arthroscopically assisted) repair*, or a traditional *open repair*. Concomitant subacromial decompression is usually indicated particularly with chronic cuff disease. Capsular tightening or reconstruction may also be performed if unidirectional or multidirectional instability of the GH joint is present. The three approaches involve the following:

- In an arthroscopic repair, only a few small incisions are made for portal sites.^{4,29,57,105,161,164}
- In a mini-open approach, an anterolateral incision is made at the acromion and is extended distally along the fibers of the deltoid muscle. The deltoid is then longitudinally split for several centimeters to allow visualization of the cuff tear. The proximal insertion of the deltoid remains intact.^{8,57,68,105,134,169,170}
- In an open repair, a deltopectoral approach is used. An anterolateral incision begins at the inferior aspect of the lateral portion of the clavicle and extends inferiorly and obliquely to the lateral aspect of the acromion. The proximal insertion of the deltoid must be detached and reflected for exposure of the rotator cuff. After the cuff repair is complete, the deltoid is reattached to the acromion.[†]

Small to medium cuff tears (<1–3 cm) are usually managed with an arthroscopic or mini-open repair. Large tears (3–5 cm) are usually repaired with an open procedure or less frequently with a mini-open

*See references 2, 4, 8, 15, 68, 72, 74, 105, 134, 136, 155, 168.

†See references 15, 72, 74, 93, 105, 136, 164, 169.

procedure. Massive tears (>5 cm) are almost exclusively repaired with an open procedure and sometimes require transposition of other adjacent soft tissues to reinforce the repair. In massive cuff tears, other structures, such as the biceps tendon, may also have to be repaired.¹⁰⁵ In addition to the size and location of the cuff tear and the presence of associated injury, other factors influence the surgeon's selection of surgical approach and types of procedure and fixation used. They include the amount of retraction present in the torn tendons, the quality of the bone and remaining cuff tendons, and, of course, the training and previous experience of the surgeon.^{105,164} The cuff repair involves either a *tendon-to-tendon repair* or, more commonly, a *tendon advancement* and reattachment to bone. Fixation is accomplished with either direct nonabsorbable or absorbable sutures, percutaneous tacks, or staples.^{57,68,105,164,169}

Postoperative Management

After surgical repair of a rotator cuff tear, there are numerous factors that can determine the position and duration of immobilization, the selection and application of exercises, and the rate of progression of each patient's postoperative rehabilitation program. These factors and their potential impact are summarized in Table 9–2.

It should be apparent that many of these factors may also affect postoperative outcomes. There is little consensus of opinion reported in the literature or practiced in the clinical setting as to how and to what extent each of these factors, singularly or collectively, have an impact on the decisions made about a patient's postoperative rehabilitation program by the surgeon and the therapist.* Hence, published guidelines and protocols for postopera-

*See references 8, 25, 49, 83, 111, 133, 134, 184.

Table 9–2 Factors that Influence Progression of Rehabilitation After Repair of the Rotator Cuff

Factors	Potential Impact on Rehabilitation
<ul style="list-style-type: none"> Onset of injury Size and location of the tear Associated pathologies such as GH instability or fracture Preoperative strength and mobility of the shoulder Patient's general health History of steroid injections or previous, failed cuff surgery Preinjury level of activity of postoperative goals Age of patient Type of approach Type of repair Mobility (no excessive tension on the repaired tendon when arm at side) and integrity of the repair Patient's compliance with the program Philosophy, skill, and training of the surgeon 	<ul style="list-style-type: none"> Chronic impingement and atraumatic cuff deficiency → slower progression than after acute traumatic injury. Larger tears with more structures involved and probability of more extensive surgery → slower progression. Associated pathologies often lengthen the period of immobilization → slower progression of exercises or the need for additional precautions. Pre-existing weakness and atrophy of the dynamic stabilizers or limited passive and active mobility of the shoulder → slower postoperative progression. Patient in poor health; history of smoking; history of inflammatory disease → slower progression. Compromised bone and tendon tissue quality, which affects the security of the repair (fixation) → slower progression. Higher level goals require a more extended and advanced postoperative training program because of a higher risk of reinjury. Older patient who has an insidious (chronic) onset and may have articular changes → slower progression. Traditional open approach (with deltoid detachment and repair) → slightly slower progression than after an arthroscopic or arthroscopically assisted (mini-open/deltoid splitting) repair. Tendon to tendon → slower progression than tendon to bone. If mobility is inadequate → longer duration of exercise within a protected ROM during early rehabilitation. Lack of compliance (doing too much or too little) can affect outcome. All have an impact that could → either slower or more accelerated progression.

tive management of rotator cuff tears are diverse and sometimes contradictory. For example, many authors point out that if the deltoid is detached during the surgery, as is necessary in an open repair, deltoid strengthening should be postponed for approximately 6 weeks postoperatively until the repaired deltoid has healed.^{49,83,105} Yet another author suggests that rehabilitation should proceed similarly whether or not deltoid detachment was required.⁶⁸

As with postoperative protocols for so many other musculoskeletal pathologies of the shoulder or other joints, no one single protocol has been shown to be the most appropriate or effective for all patients who have undergone the same type of surgery for rotator cuff repair. The many variables summarized in Table 9–2 highlight the complexity of rotator cuff rehabilitation and why an exercise program based on a comprehensive examination and ongoing re-examination of the patient's response to intervention is so important. For instance, the preinjury strength of shoulder musculature will influence postoperative management. A young, active patient who sustains an acute tear most likely will have had a strong rotator cuff mechanism prior to injury, whereas an elderly patient with a history of chronic impingement often will exhibit preoperative weakness and atrophy. These two patients need to be managed differently during their rehabilitation. In addition, intraoperative observations by the surgeon, for example, of the quality of bone and remaining tendons or the mobility of the repair, will also influence the rate of progression of exercises postoperatively. These examples underscore the need for development of individualized rehabilitation programs or at least modification of pre-existing protocols for each patient through close communication between the therapist and the surgeon.

It is the purpose of this section to highlight and compare *general* guidelines and precautions for each phase of postoperative management of a *full-thickness* cuff tear after a mini-open repair (with deltoid splitting) and an open repair (with deltoid detachment and repair). To date, very limited information on postoperative management after arthroscopic repair is available.⁵⁸ The progression of exercises after an arthroscopic repair appears to be essentially comparable to or slightly more accelerated than after a mini-open (arthroscopically assisted) repair. Therefore, in this section, there is no significant

distinction made between postoperative management after these two approaches to cuff repair.

Note: Remember, repair of most cuff tears, particularly when associated with chronic impingement, also includes subacromial decompression. The same treatment principles and types of upper extremity exercises, such as assisted ROM, stabilization and strengthening exercises, stretching, and advanced activities already discussed and outlined for management after subacromial decompression for impingement syndrome, are also applicable and appropriate after a cuff repair with an arthroscopic, mini-open, or open approach. The key differences are that the rate of progression must proceed more gradually and additional precautions must be taken with open approaches. The progression of rehabilitation after debridement of a partial-thickness tear is comparable to postoperative management after subacromial decompression.

Immobilization

There are many inter-related factors that influence a surgeon's decision about the position and duration of immobilization of the operated shoulder after rotator cuff repair. Most of these factors were summarized in Table 9–2. Two of those factors, the type of surgical approach (mini-open or open) and the size of the tear, in part, determine whether the patient's operated upper extremity is supported in a sling (shoulder adducted, internally rotated, and elbow flexed to 90 degrees) or in an abduction orthosis (shoulder abducted 45 to 65 degrees, internally rotated and elbow flexed).

The rationale for initially immobilizing the operated shoulder in abduction is based on two principles. (1) In the abducted position, the repaired cuff, as well as the reattached deltoid in an open approach, are held in a relaxed position, which reduces the possibility of reflexive muscle contractions that could disrupt the repairs. (2) Supporting the arm in abduction rather than adduction reduces tension on the tendons and, therefore, may improve blood flow to the repaired tendon(s). Table 9–3 summarizes the diversity of opinions found in the literature on how the size of the tear and the type of surgical approach influence surgeons' decisions on postoperative immobilization after cuff repair.^{49,68,83,105,179}

Exercise

Early self-management by the patient through effective patient education is emphasized in each phase

Table 9–3 Relationships of Type and Duration of Immobilization to the Size of the Rotator Cuff Tear and Surgical Approach***Mini-Open (Arthroscopically Assisted/Deltoid Splitting) Approach**

Size of Tear	Small (<1 cm)	Medium to Large (>1–5 cm)	Massive (>5 cm)
Type and Duration	Sling or abduction splint 1–2 weeks; removal for exercise the day of surgery or 1 day postop	Sling or abduction orthosis 3–6 weeks; removal for exercise 1–2 days postop	Sling or abduction orthosis 4–8 weeks; removal for exercise 1–3 days postop

Open Approach

Size of Tear	Small (<1 cm)	Medium and Large (>1–5 cm)	Massive (>5 cm)
Type and Duration	Sling, sling and swathe, or abduction orthosis up to 6 weeks, depending on tissue quality; removal for exercise 1 day postop	Sling, sling and swathe, or abduction orthosis for 6 weeks depending on tissue quality; removal for exercise 2–3 days postop	Abduction orthosis for 6–8 weeks; removal of splint as early as 1 day postop; in some instances, orthosis is worn continually for 1 week before removal for exercise

*Age of the patient, onset of the injury, and quality of repaired tissue also influence position and duration of immobilization.

of postoperative rehabilitation. General **precautions** for exercise after either a mini-open or open procedure are addressed in Box 9–7 for each of the phases of rehabilitation. Note that the rate of progression is consistently more gradual after an open repair than after a mini-open repair.

Exercise: Maximum Protection Phase

The important priorities in this initial phase of rehabilitation are the protection of the repaired tissues and prevention of the adverse effects of immobilization. Therefore, in almost all situations the immobilization is removed for brief sessions of passive or assisted ROM within a limited (protected) range as soon as possible after surgery (see Table 9–3). The maximum protection phase extends for as little as 3 weeks after a mini-open repair or as long as 6 to 8 weeks after an open repair. The following goals and selected interventions combined with the appropriate use of pain medication may be initiated during the maximum protection phase.*

■ **Control pain.**

- Cervical spine ROM and shoulder relaxation exercises
- Grade I oscillations on the GH joint

■ **Prevent or correct postural malalignment,** especially excessive thoracic kyphosis. Exercises for posture training are described in Chapter 16.■ **Prevent loss of mobility in the involved upper extremity.**

- CPM from 0 to 90 degrees of shoulder flexion initiated in the recovery room or the day after surgery and continued for 48 hours. Use is based on the surgeon's philosophy.¹⁰⁵
- Assisted ROM of the elbow and active ROM of the wrist and hand.
- Active movements of the scapula.

■ **Develop control of scapulothoracic musculature.** (appropriate after open and mini-open procedures). Use submaximal isometrics to isolated scapular muscles.⁹⁷

Precaution: During this period of maximum protection provide support to the arm during scapular motions and avoid weight bearing on the operated arm to avoid excessive tension in repaired GH musculature.^{83,184}

■ **Prevent inhibition and atrophy of GH musculature,** especially the rotator cuff. Low-intensity

*See references 8, 25, 49, 83, 105, 133, 134, 184.

Box 9–7 Precautions for Exercise After Repair of a Full-Thickness Rotator Cuff Tear (Open or Mini-Open Procedure)

- Perform passive or assisted shoulder ROM within *safe and pain-free ranges* based on the surgeon's intraoperative observation of the mobility and strength of the repair and the patient's comfort level during exercise.
- Initially perform passive and active-assistive shoulder ROM in the supine position to maintain stability of the scapula on the thorax.
- See that the humerus is positioned slightly anterior to the frontal plane of the body and in slight abduction to minimize anterior translation of the humeral head and the potential for impingement.
 - In the supine position while at rest or during passive or assisted shoulder rotation exercises, support the humerus on a folded towel.
 - When initiating assisted shoulder extension, perform the exercise in prone (arm over the edge of the bed) from 90 degrees to just short of neutral. Later progress to exercises behind the back.
- When beginning isometric resistance to scapulothoracic musculature, be sure to support the arm to avoid excessive tension in repaired GH musculature.
- After an open repair, postpone isometric resistance exercises to the shoulder for at least 6 weeks unless advised otherwise.
- Avoid vigorous passive stretching, the use of contract-relax procedures or grade III joint mobilizations for at least 6 and often for 12 weeks postoperatively to give time for the repaired tendon(s) to heal and become strong.
- Delay dynamic strengthening after a mini-open procedure for a minimum of 8 weeks (for small, strong repair) and after an open procedure until 3 months postoperatively.
- Restore strength in the rotator cuff, especially the supraspinatus and infraspinatus muscles, before dynamically strengthening the shoulder flexors and abductors.
- Avoid weight bearing on the involved arm for approximately 6 weeks, particularly after an open procedure.
- Wait until about 6 weeks after a mini-open and 12 weeks after an open repair before using the operated arm for light functional activities.
- After an open repair, avoid use of the involved arm for *resisted* functional activities (pushing, pulling, lifting, carrying heavy loads) for 4 to 12 months postoperatively.

muscle setting exercises that are not provocative to healing cuff tendons against minimal resistance, as early as 1–3 weeks postoperatively.^{49,184}

This is *only recommended after a mini-open procedure and only if the repair is strong*. Even gentle isometrics are *not* recommended for 6 weeks after an open repair.

Note: Recommendations for the safest position of the shoulder in which to begin isometric training of the GH musculature after cuff repair are inconsistent. One sugges-

tion is to start in a position that creates minimum tension on the repaired cuff tendons (shoulder internally rotated and flexed and abducted to about 45 to 65 degrees and elbow flexed).⁴⁹ Another opinion recommends placing the shoulder in 100 to 110 degrees of flexion and 10 to 20 degrees of horizontal abduction. In this position the deltoid creates a compression force on the head of the humerus into the glenoid fossa, thus diminishing the superior shear forces generated by the deltoid than when the arm is in less flexion.¹⁸⁴ As the strength of the cuff muscles improves in the later phases of rehabilitation, the isometric activities can be performed with the arm positioned in less shoulder flexion.

Exercise: Moderate Protection/Controlled Motion Phase

Criteria to advance to this phase are approximately 120 to 145 degrees of pain-free, assisted elevation and 60 degrees of rotation of the involved arm.^{8,83} The focus of this phase of rehabilitation after both mini-open and open repairs is to achieve near-normal ROM by means of continued assisted ROM, transition to active ROM, and initiation of limited strengthening exercises so that the operated arm can be used for selected functional activities. This phase *begins* no earlier than 4 to 6 weeks and often as late as 6 to 12 weeks depending on the strength and mobility of the repaired cuff.^{8,25,49,105,133,134,184} The following goals and interventions are appropriate during this phase of rehabilitation.

- **Restore near-normal, nonpainful, passive mobility of the shoulder.**
 - Continuation of self-assisted ROM with an end-range hold by means of wand or pulley exercises, in single plane and combined (diagonal) patterns.
- Mobilization of the incision site if well-healed.

Precaution: The use of passive stretching and grade III joint mobilizations, if initiated during this phase of rehabilitation, must be done very cautiously. Vigorous stretching is not routinely considered safe for about 3 to 4 months, that is, until after the repaired tendons have healed and have become reasonably strong.^{105,184}

■ **Increase strength, stability, and endurance and restore dynamic control of the shoulder musculature.**

- Transition to active ROM of the shoulder through gradually increasing ranges
- Isometric and dynamic strengthening to key scapulothoracic stabilizers

- Submaximal multiple-angle isometrics against very gradually increasing resistance to rotator cuff and other GH musculature⁴⁹
- Dynamic strengthening and endurance training of the GH musculature against light resistance, begun at about 8 to 12 weeks^{105,133,134}
- Use of the involved upper extremity for *light* (no-load or low-load) functional activities at 6 weeks after a mini-open repair and delayed until 12 weeks after an open repair

Note: Since weakness and atrophy of the supraspinatus and infraspinatus muscles were probably present prior to injury, strengthen the rotator cuff before dynamically strengthening the shoulder abductors and flexors.

Precaution: Dynamic strengthening in this phase is only appropriate after a mini-open repair, not an open repair.

Exercise: Minimum Protection/ Return to Function Phase

Criteria to move into the final phase of rehabilitation and gradually return to unrestricted activities include full, pain-free ROM, progressive improvement of shoulder strength and a stable GH joint.⁸³ This phase usually begins no earlier than 3 to 4 months postoperatively for patients with strong repairs but as late as 4 to 5 months for tenuous repairs.^{49,83,184} If full ROM has not been restored with active-assistive and active exercises, passive stretching of the GH musculature and joint mobilization is now typically initiated. Advanced strengthening activities dominate this phase of rehabilitation. Patients may not be allowed to return to full activities for 6 months or possibly 1 year postoperatively depending on the patient's level of comfort, strength, and flexibility as well as the demands of the desired activities.

The goals and interventions in this final phase of rehabilitation are consistent with those previously discussed for late-stage nonoperative management of cuff disorders and for the final phase of rehabilitation after subacromial decompression. However, the progression of activities is more gradual and the time frame for adhering to precautions is extended after mini-open and open repairs.

Outcomes

Because the etiology and severity of rotator cuff tears are so diverse, the results of rotator cuff repair are also variable. Both mini-open (arthroscopically

assisted) and traditional open repairs result in comparably favorable functional outcomes and pain relief with small to medium size tears (<3 cm).^{9,68,105} Patients who have undergone a mini-open repair return to functional activities earlier (about a month earlier in one study) than those who have had an open repair.⁹ This outcome may be skewed by the fact that mini-open repairs are performed more often in younger patients with less severe tears. During postoperative rehabilitation, although gains in strength continue to occur for a year, the most substantial gains are seen in the first 6 months. In most cases, patients achieve 80% strength in the operated shoulder (compared to noninvolved shoulder) at 6 months and 90% at 1 year.¹⁴⁴ Early follow-up of patients who have undergone arthroscopic repair is promising and appears to yield similar results.^{58,161} In addition, immediate postoperative pain is significantly less, and the cosmetic outcome is more favorable with an arthroscopic repair.^{58,161}

Repairs of acute tears in young patients are more successful than repairs of chronic cuff impingement and insufficiency in elderly patients (over age 65 years).⁶⁴ Other factors that are directly related to more favorable cuff repair outcomes are smaller size tears and fewer associated impairments and pathologies, such as a biceps tendon tear or joint instability.¹⁰⁵ There is inconsistent evidence whether there is a direct relationship between the integrity of the repair and functional outcomes.⁶⁷

Shoulder Dislocations

Related Diagnoses and Mechanisms of Injury

Traumatic Anterior Shoulder Dislocation

There is complete separation of the articular surfaces of the glenohumeral joint caused by direct or indirect forces applied to the shoulder.¹²⁷ Anterior dislocation most frequently occurs when there is a blow to the humerus while it is in a position of external rotation and abduction. Stability normally is provided by the subscapularis, glenohumeral ligament, and long head of the biceps when in that position.^{92,143,172} Poor integrity of any of these structures can predispose the joint to dislocation, or a significant blow to the arm may damage them along with the attachment of the anterior capsule and glenoid labrum (Bankart lesion). When dislocated, the humeral head usually rests in the subcoracoid re-

gion, rarely subclavicular or intrathoracic. Traumatic anterior dislocation is usually associated with a complete rupture of the rotator cuff. Neurologic or vascular injuries may occur during dislocations.⁶⁵ The axillary nerve is most commonly injured, but the brachial plexus or one of the peripheral nerves could be stretched or compressed.

Traumatic Posterior Shoulder Dislocation

This injury is less common. Most posterior dislocations are subacromial, although subglenoid or subspinous posterior dislocations may occur. The mechanism of injury is usually a force applied to the humerus that combines flexion, adduction, and internal rotation, such as a fall on an outstretched arm.¹⁵² The person will complain of symptoms when doing activities such as push-ups, bench press, or follow-through on a golf swing.⁶⁵

Recurrent Dislocation

With significant ligamentous and capsule laxity, unidirectional or multidirectional recurrent subluxations or dislocations may occur with any movement that reproduces the abduction and external rotation forces or the flexion, adduction, and internal rotation forces, causing significant pain and functional limitation. Some individuals can voluntarily dislocate the shoulder anteriorly or posteriorly without apprehension and with minimal discomfort.^{127,152} The group in which the rate of recurrence after first traumatic dislocation is highest is the younger population (<30 years). Because they are more active and place greater demands on the shoulder, longer immobilization (>3 weeks) is advocated after dislocation than in the less than 30-year-old patient. Shorter immobilization (1–2 weeks) is advocated for older patients.^{104,107}

Common Impairments

- After an acute traumatic injury, symptoms from tissue damage include pain and muscle guarding from bleeding and inflammation.
- When a dislocation is associated with a complete rotator cuff tear, there is an inability to abduct the humerus against gravity, except the range provided by the scapulothoracic muscles.
- Asymmetric joint restrictions/hypermobilities. In an anterior instability, the posterior capsule may be tight; in a posterior instability, the anterior

capsule may be tight. After healing, there may be adhesions.

- With recurrent dislocations, the individual can dislocate the shoulder at will, or the shoulder may just dislocate when doing specific activities. Instabilities, as described previously in this chapter, are present.

Common Functional Limitations/Disabilities

- With rotator cuff rupture, inability to reach or lift objects to the level of horizontal, thus interfering with all activities using humeral elevation
- Possibility of recurrence when replicating the dislocating action
- With anterior dislocation, restricted ability in sports activities such as pitching, swimming, serving (tennis, volleyball), spiking (volleyball)
- Restricted ability, particularly when overhead or horizontal abduction movements are required in dressing, such as putting on a shirt or jacket, and with self-grooming, such as combing the back of the hair
- Discomfort or pain when sleeping on the involved side in some cases
- With posterior dislocation, restricted ability in sports activities such as follow-through in pitching and golf; restricted ability in pushing activities, such as pushing open a heavy door or pushing one's self up out of a chair or out of a swimming pool

Nonoperative Management: Dislocations

Management: Protection Phase After Closed Reduction of Anterior Dislocation

Note: Reduction manipulations should be undertaken only by someone specially trained in the maneuver because of the vulnerability of the brachial plexus and axillary blood vessels.

Protect the Healing Tissue

- After acute anterior dislocation in a young patient, the arm is immobilized for 3 to 4 weeks in a sling, which is removed only for exercise. During the first week, the patient's arm may be continuously immobilized because of pain and muscle guarding.
- An older, less active patient (over 40 years of age) may require immobilization for only 2 weeks.

- The position of dislocation must be avoided when exercising, when dressing, or doing other daily activities

Promote Tissue Health

Use protected ROM, intermittent muscle setting of the rotator cuff, deltoid, and biceps brachii muscles, and grade II joint techniques.

Precautions: In order not to disrupt healing of the capsule and other damaged tissues after anterior dislocation, ROM into external rotation is performed with the elbow at the patient's side, with the shoulder flexed in the sagittal plane, and with the shoulder in the resting position (in the plane of the scapula, abducted 55 degrees and 30 to 45 degrees anterior to the frontal plane), but not in the 90-degree abducted position. The forearm is moved from in front of the trunk (maximal internal rotation) to 0 or possibly 10 to 15 degrees external rotation. Extension beyond 0 degrees is contraindicated.

- Intermittent muscle setting of the rotator cuff, deltoid, and biceps brachii muscles
- Grade II joint techniques: Maintain joint play by using sustained grade II distraction or gentle grade II oscillations with the glenohumeral joint at the side or in the resting position (see Fig. 6–13).

Management: Controlled Motion Phase After Closed Reduction of Anterior Dislocation

Provide Protection

The patient continues to wear the sling for 3 weeks, then increases the time the sling is off; the sling is used when the shoulder is tired or if protection is needed.

Increase Shoulder Mobility

- Begin mobilization techniques using all appropriate glides except the anterior glide. The anterior glide is **contraindicated** even though external rotation is necessary for functional elevation of the humerus. To safely stretch for external rotation, place the shoulder in the resting position (abducted 55 degrees and horizontally adducted 30 degrees), then externally rotate it to the limit of its range, and then apply a grade III distraction force perpendicular to the treatment plane in the glenoid fossa (Fig. 9–8).
- Passively stretch the posterior joint structures



Figure 9–8 Mobilizing to increase external rotation when an anterior glide is contraindicated. Place the shoulder in resting position, externally rotate it, then apply a grade III distraction force.

with horizontal adduction self-stretching techniques.

Increase Stability and Strength of Rotator Cuff and Scapular Muscles

Both the internal and external rotators need to be strengthened as healing occurs.²⁶ The internal rotators and adductors must be strong to support the anterior capsule. The external rotators must be strong to stabilize the humeral head against anterior translating forces and to participate in the deltoid-rotator cuff force couple when abducting and laterally rotating the humerus. Scapular stability is important for normal shoulder function.

- Begin with *isometric resistance* exercises with the joint positioned at the side and progress to various pain-free positions within the available ranges.
- Initiate closed-chain, partial weight-bearing, and stabilization exercises.
- Progress to *dynamic resistance*, limiting external rotation to 50 degrees and avoiding the position of dislocation.
- At 3 weeks, begin supervised *isokinetic resistance* for internal rotation and adduction at speeds 180 degrees per second or higher.⁷ Position the patient standing with the arm at the side or in slight flexion and elbow flexed 90 degrees. The patient performs internal rotation beginning at the zero

position with the hand pointing anteriorly and moving across the front of the body. Progress to positioning the shoulder at 90 degrees flexion, then perform the exercise from zero to full internal rotation. Do not position in 90 degrees abduction.

- By 5 weeks, all shoulder motions are incorporated into exercises on isokinetic or other mechanical equipment except in the position of 90 degrees abduction with external rotation.

Return to Function Phase **After Anterior Shoulder Dislocation**

Restore Functional Control

- Develop a balance in strength of all shoulder and scapular muscles.
- Develop coordination between scapular and arm motions.
- Develop endurance for each exercise as previously described for shoulder instabilities.
- As stability improves, progress eccentric training to maximum load, increase speed and control, and progress to simulating desired functional patterns for activity.

Return to Maximum Function

- Help the patient learn to recognize signs of fatigue and impingement and stay within the tolerance of the tissues.
- The patient can return to normal activities when there is no muscle imbalance, when good coordination of skill is present, and when the apprehension test is negative. Full rehabilitation takes 2 1/2 to 4 months.⁷

Management After Posterior Dislocation of the Shoulder with Closed Reduction

The management approach is the same as anterior dislocation with the exception of avoiding the position of flexion with adduction and internal rotation during the acute and healing phases.

Protect the Part

The arm is immobilized. A sling may be uncomfortable because of the adducted and internally rotated position, particularly if the sling elevates the humerus so the head translates in a superior and posterior direction. The patient may be more comfortable with the arm hanging freely in a dependent position while kept immobile.

Increase Limited Ranges

Begin joint mobilization techniques using all appropriate glides except the posterior glide. Posterior glide is **contraindicated**. If adhesions develop, preventing internal rotation, mobility can safely be regained by placing the shoulder in the resting position (abducted 55 degrees and horizontally adducted 30 degrees), internally rotating it to the limit of its range, and then applying a grade III distraction force perpendicular to the treatment plane in the glenoid fossa (same as Fig. 9–8 but with the arm internally rotated).

Glenohumeral Joint Instabilities: Surgical and Postoperative Management

Indications for Surgery

The following are common indications for surgical stabilization of the GH joint.^{76,104,106,107,165,179}

- Recurrent episodes of GH joint dislocation or subluxation, which impairs functional activities
- Unidirectional or multidirectional instability during active shoulder movements that causes apprehension of placing the arm in positions of potential dislocation and, hence, compromises use of the arm for functional activities
- Instability-related impingement (secondary impingement syndrome) of the shoulder
- Significant inherent joint laxity resulting in recurrent instability
- High probability of subsequent episodes of instability after an acute dislocation in young patients involved in high-risk (overhead), work-related or sport activities
- Dislocations associated with significant cuff tears
- Failure to resolve the instability and restore function with nonoperative management

Procedures

Procedures designed to improve stability and prevent recurrent instability, while maintaining near-normal rotation of the GH joint, are performed today using either an arthroscopic or open approach. An open stabilization is done if an open reduction is required or if extensive damage to surrounding structures has also occurred.^{104,106,133,165} These procedures, which are designed to balance stabilization of the anterior, posterior, or inferior portions of the capsule with retention of functional mobility, can be organized into several categories.

- **Capsulorrhaphy** is a tightening of the capsule (*capsular shift*) to reduce capsular redundancy and overall capsule volume by incising, overlapping (imbrication) and then suturing, tacking, or stapling the lax or overstretched portion of the capsule.* A capsular shift procedure is tailored to the direction(s) of instability: anterior, inferior, posterior, or multidirectional (anteroinferior or posteroinferior). For example, if a patient has recurrent anterior instability, an anterior capsular shift is performed. The anterior portion of the capsule is incised, tightened by imbrication, and resutured. This can be done using an arthroscopic or open approach.† Posterior capsulorrhaphy, a far less common procedure, is briefly described at the conclusion of this section.
- **Electrothermally assisted capsulorrhaphy (ETAC)** is an arthroscopic procedure that uses thermal energy (radio frequency thermal-delivery or nonablative laser) to shrink and tighten loose capsuloligamentous structures. The procedure (also referred to as a *thermal-assisted capsular shift*) can be done alone or in combination with other arthroscopic procedures, such as debridement of a partial rotator cuff tear or subacromial decompression.^{48,53,106,167,173} It has been shown in animal and human cadaveric studies that thermal energy initially makes collagen fibrils more extensible, but as the collagen tissue of the capsuloligamentous structures heals, it shortens or “shrinks,” thus causing a decrease in capsular laxity.^{75,153} If one or more of the glenohumeral ligaments is detached or if rotator cuff lesions are detected that could be contributing to the instability, they are repaired arthroscopically prior to ETAC.
- **Bankart reconstruction** is an open or arthroscopic repair of a Bankart lesion (a detachment of the capsulolabral complex from the anterior rim of the glenoid), which commonly occurs during traumatic anterior dislocation. An anterior capsulolabral reconstruction involves reattachment of the labrum to the surface of the glenoid lip with bioabsorbable tacks, direct sutures, or suture anchors.‡ This is sometimes combined with a capsular shift if capsular laxity is present. In an open repair, access to the lesion and capsule is

through the subscapularis tendon (which must then be repaired) or through the rotator cuff interval, which allows the subscapularis to remain intact.^{3,104,106} In an arthroscopic repair, multiple portal sites are used. Generally, more secure fixation is achieved with an open repair than with an arthroscopic repair.

- **Soft tissue transfers.** Open transfer and realignment of the subscapularis tendon (*Putti-Platt* or *Magnuson-Stack* procedures) to stabilize the anterior capsule is rarely done today, as they have resulted in poor functional outcomes because of significant loss of external rotation.^{104,107,136}
- **Bony procedures.** Open transfer of the tip of the coracoid process to the anterior glenoid rim (with the short head of the biceps and the coracobrachialis still attached) to form a bony block (*Bristow procedure*) is only of interest from an historical perspective to understand how the management of recurrent anterior dislocation has evolved.^{104,107} As with procedures involving transfer of the subscapularis, the Bristow procedure also resulted in a significant loss of external rotation.
- **Repair of a SLAP lesion.** A tear of the proximal attachment of the biceps and the superior labrum is classified as a SLAP (superior labrum anteroposterior) lesion.^{133,165} Some SLAP lesions are associated with recurrent anterior glenohumeral instability. The lesion is debrided arthroscopically, and the torn portion of the superior labrum and biceps anchor are reattached with tacks or suture anchors. A concomitant anterior stabilization is also performed if instability is present.
- **Posterior capsulorrhaphy (posterior or posteroinferior capsular shift).** Recurrent, involuntary posterior or posteroinferior instabilities, if treated surgically, are managed with an open or arthroscopic stabilization procedure to tighten the capsule if the capsule is lax.[§] In addition, plication and advancement of the infraspinatus to reinforce the posterior capsule may also be necessary. Shoulders without an effective posterior glenoid can be surgically managed with labral reconstruction or, occasionally, with a glenoid osteotomy. In these procedures, a posterior incision is made, the deltoid is split, and the infraspinatus, teres minor, and posterior capsule are incised.^{137,166} In some instances of a traumatic mul-

*See references 3, 16, 62, 81, 104, 106, 107, 189.

†See references 3, 34, 35, 62, 81, 107, 127, 189.

‡See references 3, 5, 34, 35, 59, 81, 104, 133, 146.

§See references 17, 73, 76, 104, 106, 137, 165, 166.

tidirectional instability, an anterior approach is used even if the predominant instability appears to be posterior.^{104,137}

- **In summary**, GH stabilization procedures may be performed with an open or arthroscopic approach for correction of unidirectional or multidirectional instabilities. Associated procedures such as a repair of the rotator cuff may also be required.

Postoperative Management

General Considerations

As with rehabilitation after repair of rotator cuff tears, guidelines for postoperative management of recurrent instability of the GH joint are based on many factors. The factors that can influence the composition and progression of a postoperative program are summarized in Table 9–4. Additional factors, such as philosophy and training of the surgeon and several patient-related variables (general health, medications, preinjury functional status and postoperative goals, education, and compliance), and their potential impact have already been discussed in Table 9–2 are common to postoperative rehabilitation after rotator cuff repair and GH stabilization. As such, no additional discussion of these common fac-

tors and their influence is included in this section on postoperative management of instabilities.

The guidelines in this section address *general* principles of management across the three broad phases of postoperative rehabilitation after a variety of surgical stabilization and reconstruction procedures for recurrent, unidirectional, or multidirectional glenohumeral instabilities. These general guidelines cannot begin to address the many variations of postoperative management of shoulder instabilities that therapists encounter. Many detailed protocols or case-based descriptions of rehabilitation of different patient populations, specific types of instabilities or associated labral lesions, and different stabilization or reconstructive surgeries have been documented extensively in the literature.* These protocols can be used to complement the general guidelines in this section that apply to postoperative rehabilitation of the more common types of surgical stabilization procedures.

In many instances traumatic and atraumatic instabilities of the shoulder are coupled with lesions (tears) of the rotator cuff tendons. For example, it is

*See references 25, 48, 83, 88, 89, 106, 123, 173, 184.

Table 9–4 Factors that Influence the Rehabilitation Program After Surgery for Recurrent Instability of the GH Joint

Factors	Potential Impact on Rehabilitation
<ul style="list-style-type: none"> • Onset of instability 	<ul style="list-style-type: none"> • Capsular redundancy and greater risk of recurrent dislocation is more often associated with atraumatic instability, which requires more conservative postoperative rehabilitation than stabilization of recurrent instability of traumatic origin.¹⁰⁴
<ul style="list-style-type: none"> • Severity of associated lesions 	<ul style="list-style-type: none"> • The more severe the underlying pathology, the slower the progression of rehabilitation.
<ul style="list-style-type: none"> • Previous failure of a surgical stabilization procedure 	<ul style="list-style-type: none"> • Slower progression after previous failed surgery.
<ul style="list-style-type: none"> • Direction of instability 	<ul style="list-style-type: none"> • Stabilization of anterior instability: more rapid advancement than after stabilization of posterior or multidirectional instabilities.¹³⁷
<ul style="list-style-type: none"> • Type of surgical approach 	<ul style="list-style-type: none"> • Open stabilization or reconstruction: more rapid advancement than after arthroscopic procedures because of more secure methods of tissue fixation.¹⁸⁴
<ul style="list-style-type: none"> • Type of procedure 	<ul style="list-style-type: none"> • Thermally assisted capsulorrhaphy: slower progression than open capsular tightening.^{48,173} • Bony reconstruction: slower progression than after soft tissue reconstruction.
<ul style="list-style-type: none"> • Patient variables <ul style="list-style-type: none"> —tissue integrity —preoperative status of dynamic stabilizers —generalized joint laxity 	<ul style="list-style-type: none"> • The progression of postoperative rehabilitation is conservative for the inactive patient with multidirectional atraumatic instability who has generalized joint laxity and poor preoperative strength of the dynamic stabilizers.

estimated that the incidence of a tear of the rotator cuff tendons in the older patient (over 40 years of age) who experiences an anterior dislocation is at least 85%.⁸⁸ Consequently, many patients who undergo surgery for recurrent instability of the shoulder will also require a repair of the rotator cuff. Therefore, the postoperative guidelines after rotator cuff repair already outlined in this chapter must also be considered when treating a patient after a surgical stabilization of the GH joint.

Always keep in mind that regardless of the type of instability or associated pathology or choice of surgical procedure, the focus of rehabilitation must always be to *prevent recurrence of shoulder instability* while restoring an adequate level of strength and mobility to meet the patient's functional needs.

Immobilization

Position. The position in which the patient's shoulder is immobilized after surgery is determined by the *direction(s) of instability* prior to surgery. After surgical reconstruction for recurrent *anterior or anteroinferior* instability, the shoulder is immobilized in a sling or splint in adduction (or slight abduction) and internal rotation (forearm across the abdomen) with the arm slightly anterior to the frontal plane of the body.^{81,104} After surgery for *posterior or posteroinferior* instability the upper extremity is immobilized and supported in an orthosis in the "handshake" position (neutral rotation, 20–30 degrees of abduction) and sometimes slight extension of the shoulder).^{51,104,137}

Duration. The duration of immobilization, that is, the period of time before use of the immobilizer is completely discontinued, is determined by the surgeon and ranges from 1 to 3 weeks to as long as 6 to 8 weeks. Continuous immobilization of the operated shoulder (before shoulder ROM can be initiated) is usually maintained for only a day to a few days or up to 1 to 2 weeks unless a bony procedure has been performed. These time frames are dependent upon many of the same factors, summarized in Table 9–4, that influence all aspects of postoperative rehabilitation. For example, the duration of immobilization is usually shorter for an elderly patient than for a young patient because the elderly patient is more likely to develop postoperative shoulder stiffness than the younger patient.¹⁰⁴ Posterior or multidirectional instabilities usually require a longer period of immobilization than an anterior instability to mini-

mize the risk of recurrence.^{104,137,166} With recurrent posterior instability the shoulder may be continuously immobilized and ROM delayed for up to 6 weeks postoperatively.⁸⁸ The more extensive the soft tissue or bony reconstruction, the longer the immobilization.

Exercise

The decisions of when the arm may be temporarily removed from the immobilizer to begin shoulder exercises and to what extent specific shoulder motions are either permissible or contraindicated are also based on many of the factors summarized in Table 9–4. As with postoperative management of other surgical procedures, close communication between therapist and surgeon and careful patient education are both imperative for optimal postoperative outcomes.

The overall goal of postoperative exercise is to develop strength and stability as well as mobility of the shoulder consistent with functional needs while preventing recurrence of the instability. Specific goals and interventions for each phase of rehabilitation are essentially the same as those already outlined for postoperative management of primary impingement of the shoulder and rotator cuff tears and nonoperative management of recurrent instabilities. Therefore, it is appropriate to include the same variations of exercises in a postoperative program after surgical stabilization of the shoulder while implementing special precautions for specific surgeries. Precautions, particularly during the early weeks of rehabilitation after different types of stabilization procedures, are noted in Box 9–8.

Exercise: Maximum Protection Phase

Protection of the capsule that has been tightened or of reinforced and repaired structures, such as the labrum, is necessary for about 6 weeks. The goals and exercises for the maximum protection phase are summarized in the following section. Some additional precautions are also noted. Use of prescribed medications and modalities for pain control are indicated during this phase of rehabilitation.

■ Control pain.

- Active ROM of the cervical spine and shoulder relaxation exercises.
- Grade I and II joint mobilizations avoiding motions in the direction of the preoperative instability.

- **Prevent or correct postural malalignment,** especially excessive thoracic kyphosis. Emphasize spinal extension and scapular retraction.

Box 9–8 Summary of Precautions During Early Rehabilitation After Surgical Stabilization of the GH Joint

Anterior Stabilization Procedure

- Limit elevation of the arm to 90 to 100 degrees during the initial phase of rehabilitation.
- Limit ER, horizontal abduction, and extension during maximum protection phase (up to 6 weeks postoperatively). Recommendations for initial limitation of ER vary from 0 degrees (no ER past neutral),¹⁰⁴ 15 to 20 degrees,⁸³ and up to 40 degrees¹²³ depending on the type of pathology, surgical procedure, and intraoperative evaluation of shoulder stability. Progress these motions cautiously.
- Avoid positioning and activities that place stress on the anterior aspect of the capsule for about 4 to 6 weeks.
 - Avoid functional activities that require ER, especially if combined with horizontal abduction during early rehabilitation as when reaching to put on a coat or shirt.
 - Avoid upper extremity weight bearing particularly if the shoulder is extended as when pushing up from the armrests of a chair.

Repair of Bankart Lesion

- Progress rehabilitation more cautiously after an arthroscopic repair than after an open repair.¹⁸⁴
- Avoid resisted IR for approximately 4 weeks, particularly after arthroscopic reconstruction, to avoid rupture of the subscapularis.⁵⁹

Posterior Stabilization Procedure

- Limit elevation of the arm to 90 degrees during early rehabilitation.
- Limit IR to neutral or 15 to 20 degrees and horizontal adduction during maximum protection phase (up to 6 weeks postoperatively).
- Restrict upper extremity weight bearing, particularly when the shoulder is flexed, to avoid stress to the posterior aspect of the capsule, for example, during closed-chain scapulothoracic and GH stabilization exercises and functional activities for at least 6 weeks postoperatively.

Thermally Assisted Capsular Tightening

- Postpone initiation of ROM of the shoulder for approximately 10 days to 2 weeks, because collagen in the thermally treated capsuloligamentous structures is initially more extensible (more vulnerable to stretch) until it heals.^{106,173}

Bony Reconstruction

- Delay passive or assisted ROM for 6 to 8 weeks to allow bony healing.

- **Prevent loss of mobility in the involved upper extremity** while protecting the tightened or reconstructed capsule.
 - Active ROM of the elbow, forearm, wrist, and fingers the day after surgery.
 - Active scapulothoracic movements.
 - While seated, remove the sling (if permissible) and rest the forearm on a table with the shoulder

positioned in slight flexion and abduction and neutral rotation.

- Self-assisted ROM, wand exercises, and non-weighted pendulum exercises for the GH joint, initially *within protected ranges*, but gradually to near-normal ROM by 6 to 8 weeks, except for external rotation after an anterior stabilization and internal rotation after a posterior stabilization procedure. Begin shoulder rotation with the arm in a slightly abducted and flexed position.^{88,184}

Note: Shoulder motion is begun when temporary removal of the immobilizer is permitted. This may be as soon as the day after surgery for selected patients who have had an anterior stabilization procedure,⁸³ but more often is begun 1–2 weeks postoperatively.^{88,123} Remember, ROM is delayed for a longer period of time after a thermally assisted stabilization^{48,53,173} or a posterior stabilization procedure.^{51,88,137} Generally, motion can be progressed slightly more rapidly after an open stabilization than after an arthroscopic stabilization because stabilization of the capsule tends to be more secure by direct suturing in an open procedure than by bioabsorbable tacks in an arthroscopic procedure.¹⁸⁴

- **Develop control and strength of scapulothoracic, elbow, wrist, and hand musculature.**
 - Isometric and dynamic strengthening exercises

Precaution: Initially strengthen the scapular stabilizing muscles in an open-chain to avoid the need for weight bearing on the operated upper extremity. When weight-bearing activities are initiated, be cautious about the position of the operated shoulder to avoid undue stress to the vulnerable portion of the capsule for about 6 weeks postoperatively.

- **Prevent inhibition and atrophy of GH musculature.**
 - Multiple angle muscle-setting exercises (very gentle isometrics) of GH musculature as early as the first week or by 3 to 4 weeks postoperatively after some procedures.⁸³

Precaution: Be particularly cautious with musculature that has been torn or surgically detached, incised, or advanced and then repaired. Resistance to the subscapularis, which is longitudinally split during an anterior approach, may need to be delayed as long as 6 weeks.^{59,123}

- Use of the operated arm for *unresisted, non-weight-bearing, waist-level* functional activities by 2 to 4 weeks postoperatively.

- Possible initiation of dynamic exercises against *light* resistance below shoulder level at 4 to 6 weeks. Emphasize the GH stabilizers. During internal and external rotation position the arm at the side, slightly anterior to the frontal plane or in the plane of the scapula.

Note: In some cases dynamic exercises against light resistance are often delayed until 6 to 8 weeks when only moderate protection is necessary.

Exercise: Moderate Protection/Controlled Motion Phase

This phase of rehabilitation begins between 6 and 8 weeks postoperatively and continues until approximately 12 to 16 weeks. The focus is on achievement of normal active (unassisted) ROM of the shoulder, continued development of strength and endurance of scapulohoracic and GH musculature, and progressive use of the upper extremity through greater ranges of motion for functional activities. Goals and interventions include the following as well as those activities already suggested for nonoperative management.^{25,83,106,123,184}

- **Restore full, pain-free ROM of the shoulder** by 8 to 12 weeks except in motions limited by the specifics of the surgery.
- Continuation of active ROM.
- Stretching and grade III mobilizations in positions that do not provoke instability. After an anterior stabilization procedure for chronic (atraumatic) anterior instability, pay particular attention to increasing horizontal adduction, as the posterior structures are often tight preoperatively and continue to be tight postoperatively.
- **Continue to increase strength, endurance, stability, and control of shoulder musculature** through available ROM.
- Progression of dynamic strengthening to overhead positions if strength of dynamic stabilizers is adequate.

Precautions: After a posterior stabilization do not initially begin dynamic strengthening of the external rotators from full internal rotation. After anterior stabilization, do not initiate dynamic strengthening of the internal rotators from full external rotation, particularly in the 90-degree abducted position. When strengthening the shoulder extensors, *do not* extend the arm posterior to the frontal plane. Therefore, strengthen the extensors in prone with the arm over the

side of the table or standing and leaning forward with the hips flexed to approximately 90 degrees. Use the same precaution when strengthening the horizontal abductors and adductors. In addition, maintain the shoulder in neutral rotation during horizontal abduction and adduction.

- Upper extremity ergometry with a portable reciprocal exerciser on a table or with the UBE® for muscular endurance. Include forward and backward motions.
- Progressive upper extremity weight bearing during strengthening and stabilization exercises.
- Dynamic strengthening in diagonal and simulated functional movement patterns.

Exercise: Minimum Protection/

Return to Function Phase

Criteria to progress to this final phase of rehabilitation and the focus of exercise are similar to criteria already discussed for rehabilitation after rotator cuff repair. This phase usually begins as early as 10 to 12 weeks postoperatively or as late as 16 to 18 weeks, depending on individual characteristics of the patient and the surgical procedure. Participation in desired work-related and sports activities often takes up to 6 months postoperatively.

Precautions: Some patients may have permanent restrictions placed on functional activities that involve high-risk movements and that could potentially cause recurrence of the instability. After some anterior stabilization procedures, full ER in 90 degrees of abduction may not be advisable or possible.

Outcomes

A successful postoperative outcome involves regaining the ability to participate in desired functional activities without a recurrence of instability of the GH joint. Follow-up studies measure subjective and objective outcomes such as restoration of ROM and strength, rate of recurrence of pain, apprehension or instability, ability to participate in desired activities, and general patient satisfaction. Rates of recurrent instability (dislocation, subluxation, and/or apprehension) and patient satisfaction vary substantially from study to study. For example, reported rates of recurrent instability after anterior stabilization procedures range from 0 to 30%.¹⁰⁴

Although results of surgery and postoperative rehabilitation are usually reported for specific patholo-

gies, patient populations, and surgical stabilization procedures and are determined by means of a variety of outcome measures, a few generalizations can be made.

- Surgical stabilization of a recurrent unidirectional anterior instability yields better results than stabilization of posterior or multidirectional instabilities.^{17,104,137,189}
- Recurrent instability of traumatic origin responds more favorably to surgical management than atraumatic instabilities.^{17,104} In addition, the rate of recurrence of anterior instability over 5 years after repair of a Bankart lesion is as low as 1%.¹⁰⁴
- Rate of recurrence of instability is substantially higher in young patients (younger than 20–30 years of age) or patients who return to high-demand, competitive overhead sports than elderly patients (older than 40–50 years of age).^{104,106,133}
- The rate of recurrence of instability is also higher after an arthroscopic stabilization than after an open stabilization, most likely because of a higher rate of problems with arthroscopic fixation techniques than open fixation techniques. The rate of recurrence of posterior instability after arthroscopic stabilization has been reported to be particularly high, up to 30 to 40%.¹⁶⁶
- After some anterior stabilization procedures, full ER or horizontal abduction is sometimes not advisable or possible.⁸⁸ Likewise, some posterior stabilization procedures permanently limit full IR and, to some degree, overhead elevation of the arm.¹⁰⁴
- Although the rate of progression early on in a rehabilitation program is slightly more rapid after open stabilization procedures than after comparable arthroscopic procedures (because fixation is more secure in open procedures), the period of time required to return to full physical activity is comparable.^{88,104}
- Early follow-up of patients who have undergone thermally assisted anterior stabilization is encouraging,^{53,106} but long-term outcomes are not yet available.

► Thoracic Outlet Syndrome

The thoracic outlet is the region along the pathway of the brachial plexus from just distal to the nerve roots exiting the intervertebral foramen to the lower border of the axilla. The outlet is bordered medially by the

scalenus anterior, medius, and posterior and first rib; posteriorly by the upper trapezius and scapula; anteriorly by the clavicle, coracoid, pectoralis minor, and deltopectoral fascia; and laterally by the axilla. The plexus enters the outlet between the scalenus anterior and medius; the subclavian artery runs posterior to the scalenus anterior; and the subclavian vein runs anterior to the scalenus anterior. The blood vessels join the brachial plexus and course together under the clavicle, over the first rib, and under the coracoid process posterior to the pectoralis minor. Vascular and/or neurologic symptoms that are not consistent with nerve root or peripheral nerve dermatome and myotome patterns should lead the therapist to suspect thoracic outlet problems.⁹⁶

Related Diagnoses

Thoracic outlet syndrome (TOS) encompasses many diagnoses that involve upper extremity neurological and vascular symptoms including pain, paresthesia, numbness, weakness, discoloration, swelling, ulceration, gangrene, and in some cases, Raynaud's phenomenon. Diagnoses that have been used to describe TOS include cervical rib, scalenus anticus syndrome, costoclavicular syndrome, subcoracoid-pectoralis minor syndrome, droopy shoulder syndrome, and hyperabduction syndrome.*

Etiology of Symptoms

Walsh¹⁷⁷ has identified three causative factors that could be interrelated or exist separately: compressive neuropathy, faulty posture, and entrapment.

Compressive Neuropathy

Compression of the neurovascular structures can occur if there is a decrease in the size of the area through which the brachial plexus and subclavian vessels pass. Compression can occur from muscle hypertrophy in the scalenes or pectoralis minor, anatomic anomalies such as cervical rib or fractured clavicle, adaptive shortening of fascia, or a space-occupying lesion.

Faulty Posture

Changes in posture, particularly forward head with increased thoracic kyphosis, protracted scapulae,

*See references 40, 52, 130, 156, 159, 160, 177.

and forward shoulders narrow the spaces through which the neurovascular structures pass. Specifically, adaptive shortening of the scaleni and pectoralis minor muscles can potentially compress the neurovascular tissues or can cause repetitive trauma and adhesions with overuse.

Entrapment of the Neural Tissue from Scar Tissue or Pressure

Entrapment affects the ability of nerve tissue of the brachial plexus to tolerate tension as it courses through the various tissues in the thoracic outlet.

Location of Compression or Entrapment and Tests of Provocation

There are three primary sites for compression or entrapment of the neurovascular structures.

Interscalene Triangle, Bordered by the Scalenus Anterior and Medius Muscles and First Rib

If these muscles are hypertrophied, tight, or have anatomic variations they may compress the proximal portion of the brachial plexus and subclavian artery. Inflammation from overuse can lead to adhesions preventing normal mobility of the neural tissues with head and arm movements.

Symptoms from dysfunction in this area are reproduced with Adson's maneuver, which stretches the scalene muscles and places tension on the nerves. If the artery is compressed, there will also be a decreased pulse.⁹⁹ Palpation of the scalene muscles may also provoke symptoms.

Costoclavicular Space Between the Clavicle Superiorly and the First Rib Inferiorly

Compression of the neurovascular bundle can occur between the clavicle and first rib especially if the clavicle is depressed for periods of time as occurs when carrying a heavy suitcase or shoulder bag or with a faulty, slouched posture. A fractured clavicle or anomalies in the region can also lead to symptoms. An elevated first rib, which can occur with a first rib subluxation, or with upper thoracic breathing (as with asthma or chronic emphysema) will also narrow the costoclavicular space.

Symptoms caused by a depressed clavicle are reproduced when the shoulders are retracted and depressed as with the Military Brace Test.⁹⁹ If, when in this posture, a patient is asked to take in a breath and symptoms are reproduced, the rib elevation is causing the symptoms.

Axillary Interval Between the Anterior Deltopectoral Fascia, the Pectoralis Minor, and the Coracoid Process

Compression or restricted movement of the neurovascular structures may occur in this region if the pectoralis minor is tight from a faulty posture with the scapula tipped forward or from repetitive overuse.

Holding the arms in an elevated position places a stretch on the lower branches of the brachial plexus and blood vessels. If there is poor neurovascular mobility and tension is placed on the brachial plexus, a patient will have reproduction of symptoms when the arm is abducted. In addition, if the person does repetitive opening and closing of the hand and there is increased ischemic pain (Roos test),⁹⁹ there is vascular compromise. Palpation pressure against the pectoralis minor will reproduce the neurological symptoms if the muscle is tight.

Restricted Nerve Mobility

Restricted mobility of nerve roots or portions of the brachial plexus from scar tissue adhesion secondary to trauma and inflammation may cause symptoms when tension is placed on the nerves. The Halstead test⁹⁹ elongates portions of the brachial plexus and may obliterate the radial pulse, thus reproducing TOS symptoms. This test is similar to the upper limb tension test for the median nerve³⁰ and, therefore, may indicate restricted nerve gliding or tension.

Summary of Contributing Factors

There is a wide latitude of motion in the various joints of the shoulder complex that may result in compression or impingement of the nerves or vessels.

- **Postural variations**, such as a forward head or round shoulders, lead to associated muscle tightness in the scalene, levator, subscapularis, and pectoralis minor muscles and a depressed clavicle.
- **Respiratory patterns** that continually use the action of the scalene muscles to elevate the upper ribs lead to hypertrophy of these muscles. Also, the elevated upper ribs decrease the space under the clavicle.
- **Congenital factors** such as an accessory rib, a long transverse process of the C-7 vertebra, or other anomalies in the region can reduce the space for the vessels. A traumatic or arteriosclerotic insult can also lead to TOS symptoms.
- **Traumatic injuries** such as clavicular fracture or subacromial dislocations of the humeral head can

injure the plexus and vessels, leading to TOS symptoms.

- **Hypertrophy or scarring** in the pectoralis minor muscles can lead to TOS symptoms.
- **Injuries** that result in inflammation, scar tissue formation, and adhesions can restrict nerve tissue mobility when tension is placed on the nerve. This may occur anywhere from the intervertebral foramina at the spine to the distalmost portion of the peripheral nerve. There will be nerve tension signs from restricted mobility.

Common Impairments

- Intermittent brachial plexus and vascular symptoms of pain, paresthesia, numbness, weakness, discoloration, and swelling.
- Muscle length-strength imbalances in the shoulder girdle with tightness in anterior and medial structures and weakness in posterior and lateral structures.
- Faulty postural awareness in the upper quarter.
- Poor endurance in the postural muscles.
- Shallow respiratory pattern, characterized by upper thoracic breathing.
- Poor clavicular and anterior rib mobility.
- Nerve tension symptoms when the brachial plexus is placed on a stretch.

Common Functional Limitations/Disabilities

- Sleep disturbances that could be from excessive pillow thickness or arm posture.
- Inability to carry briefcase, suitcase, purse with shoulder strap, or other weighted objects on the involved side.
- Inability to maintain prolonged overhead reaching position.
- Inability to do sustained desk work, cradling a telephone receiver between head and involved shoulder, and driving a car.

Nonoperative Management

If the symptoms demonstrate that there is inflammation, treatment is first directed at eliminating the provoking mechanism and to control the inflammation. The primary emphasis of management is to decrease the mechanical pressure by increasing mobility of tissues in the thoracic outlet region, preventing recurrence of the compression loads by correcting

the postural alignment, and developing endurance to maintain the correct posture.^{10,177}

Patient Education

Teach the patient how to modify or eliminate provoking postures and activities, as well as introducing a home exercise program. Emphasize the importance of compliance to reduce the stresses on the nerve or vascular structures.

Mobilize Restricted Nerve Tissue

Use nerve mobilization maneuvers if nerve tension tests are positive. These are described in Chapter 15.

Increase Flexibility in Tight Structures

Use manual and self-stretching techniques. Common problems include but are not limited to the scalene, levator scapulae, pectoralis minor, pectoralis major, anterior portion of the intercostals and short suboccipital muscles, and to the sternoclavicular joint.

Train Weak Muscles

Develop a program to develop strength, endurance, and postural awareness. Common weaknesses include but are not limited to scapular adductors and upward rotators, shoulder lateral rotators, short anterior throat cervical flexor muscles, and thoracic extensors. Techniques for cervical exercises and posture correction are discussed in Chapter 16.

Correct a Faulty Respiratory Pattern and Elevated Upper Ribs

Teach diaphragmatic breathing patterns and relaxation exercises to relax the upper thorax (see Chapter 19).

Progress to Functional Independence

Determine activities that provoke the symptoms, and involve the patient in adapting the environment and faulty habits to minimize the stress.

► Reflex Sympathetic Dystrophy

Related Diagnoses and Symptoms

Reflex sympathetic dystrophy (RSD) is classified as a subcategory of the diagnosis Complex Regional Pain Syndrome (CRPS type I).¹⁷⁶ Common synonyms of

RSD include shoulder-hand syndrome, Sudeck's atrophy, sympathetically mediated pain syndrome, reflex neurovascular dystrophy, traumatic angiospasm or vasospasm, and sympathetically maintained pain (SMP).^{31,158,176}

Etiology and Symptoms

The underlying mechanism that stimulates onset of this condition is unclear. It develops in association with a persistent painful lesion such as a painful shoulder after a cardiovascular accident or myocardial infarction, cervical osteoarthritis, trauma such as a fracture or sprain, or after cardiac catheterization. The condition can last for months or years, but spontaneous recovery often occurs in 18 to 24 months. Three stages are identified.

Stage I: Reversible stage. This stage of vasodilation lasts 3 weeks to 6 months. Pain is the predominant feature, usually out of proportion to the severity of the injury. There is hyperhidrosis, warmth, erythema, rapid nail growth, and edema in the hand.

Stage II: Dystrophic or vasoconstriction stage. This stage lasts 3 to 6 months. It is characterized by sympathetic hyperactivity, burning pain, and hyperesthesia exacerbated by cold weather. There is mottling and coldness, brittle nails, and osteoporosis.

Stage III: Atrophic stage. This stage is characterized by pain either decreasing or becoming worse and by severe osteoporosis. Muscle wasting and contractures may occur.

Common Impairments

- Pain or hyperesthesia at the shoulder, wrist, or hand out of proportion to the injury.
- Limitation of motion develops. Typically, the shoulder develops limitation in a capsular pattern with most restriction in lateral rotation and abduction. In the wrist and hand, the most common restrictions are limited wrist extension and metacarpophalangeal and proximal interphalangeal flexion.
- Edema of the hand and wrist secondary to circulatory impairment of the venous and lymphatic systems, which, in turn, precipitates stiffness in the hand.
- Vasomotor instability.
- Trophic changes in the skin.

As the condition progresses, pain subsides but limitation of motion persists. The skin becomes cyanotic and shiny, intrinsic muscles of the hand atrophy, subcutaneous tissue in the fingers and palmar fascia thicken, nail changes occur, and osteoporosis develops.

Management

This is a progressive disorder unless vigorous intervention is used. The best intervention is prevention when it is recognized that development of RSD is a possibility, such as when there has been trauma to the shoulder. It requires that the therapist motivate the patient to safely move the entire upper extremity, minimize edema and vascular stasis with elevation and hand activity, and be alert to the development of adverse symptomology.

Medical intervention is a necessity to manage this syndrome. The physician may choose to block the sympathetic stimuli with sympatholytic drugs, local anesthetic blocks, stellate ganglion blocks, or upper thoracic sympathectomy, or may use oral steroids or intramuscular medication. This is done in conjunction with therapeutic exercise to interrupt the sympathetic response and manage impairments and functional limitations.

Educate the Patient

Emphasize the importance of following the program of increased activity.

Increase ROM of the Shoulder and Hand

Use techniques specific to the limiting structures and work within the pain-free range. Do not stretch when painful, or the symptoms may be exacerbated.

Facilitate Active Muscle Contractions

Use both dynamic and isometric exercise and controlled closed-chain activities for neuromuscular control as well as afferent fiber stimulation.

Relieve Pain

Use modalities such as ultrasound, vibration, transcutaneous electrical nerve stimulation (TENS), or ice.

Control Edema

Apply intermittent pneumatic compression and massage. Elevate and use elastic compression when not receiving the pneumatic compression treatment.

Desensitize the Area

Utilize desensitization techniques for brief periods five times per day, such as having the patient work with various textures, tap or vibrate over the sensitive area. The patient is instructed to wear a protective glove during activities of daily living.

► Exercise Techniques for Management During Acute and Early Subacute Stages of Tissue Healing (Protection and Early Controlled Motion Phases of Intervention)

During the *protection* and *early controlled motion* phases of intervention, when inflammation is present or just beginning to resolve and the healing tissues should not be stressed, some early motion may be utilized to inhibit pain and muscle guarding and help prevent deleterious effects of complete immobilization. This section describes and summarizes techniques that may be used for these purposes. During the acute and early subacute stages, when motion in the shoulder itself is limited to allow tissues to begin to heal, it is also valuable to treat associated areas such as the cervical and thoracic spine, the scapulae, and the remainder of the upper extremity (elbow, wrist, and hand) to begin correcting faulty posture, relieve stresses to the shoulder girdle, and prevent fluid stasis in the extremity.

General guidelines for management during the acute stage are described in Chapter 8, and specific precautions for various pathologies and surgical interventions in the shoulder are identified throughout the previous sections of this chapter. Early motion is usually passive (PROM) and applied within the pain-free range. When tolerated, active-assistive range of motion (A-AROM) is utilized.

Early Motion of the Glenohumeral Joint

Manual PROM and A-AROM techniques are described in detail in Chapter 2. This section expands on self-assisted exercises.

Wand Exercises

Several wand exercises are described in Chapter 2. Additional suggestions include:

- Initiate A-AROM using a cane, wand, or T-bar in the supine position to provide stabilization and

control of the scapula during the protection and early controlled motion phases. Motions usually included are flexion, abduction, flexion in the plane of the scapula (scaption), and rotation (Fig. 9–9A).

- If it is necessary to relieve stress on the anterior capsule, such as following surgical repair of the capsule or labrum, place a folded towel under the humerus to position the humerus anterior to the midline of the body when the patient performs internal or external rotation (Fig. 9–9B).
- When treating a shoulder impingement (primary or secondary), have the patient grasp the wand with the forearm supinated when flexing and abducting to emphasize external rotation.

Ball Rolling or Dusting a Table Top

Patient position and procedure: Sitting with the arm resting on a table and hand placed on a 6- to 8-inch ball or towel and the shoulder in the plane of the scapula. Have the patient initiate gentle circular motions of the shoulder by moving the trunk forward, backward, and to the side allowing the hand to roll the ball or “dust the table.” As pain subsides, have

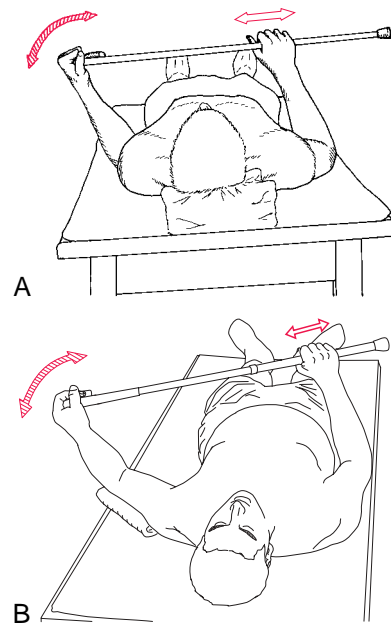


Figure 9–9 Self-assisted shoulder rotation using a cane (A) with the arm at the side and (B) in scaption. To relieve stress on the anterior capsule, elevate the distal humerus with a folded towel.

the patient use the shoulder muscles to actively move the ball or cloth through greater ROMs.

Pendulum (Codman's) Exercises

Patient position and procedure: Standing, with the trunk flexed at the hips about 90 degrees. The arm hangs loosely downward in a position between 60 and 90 degrees flexion or scaption (Fig. 9–10).

- A pendulum or swinging motion of the arm is initiated by having the patient move the trunk slightly back and forth. Motions of flexion, extension, and horizontal abduction, adduction, and circumduction can be done.³⁶ Increase the arc of motion as tolerated. This technique should not cause pain.
- If patients cannot balance themselves leaning over, have them hold on to a solid object or lie prone on a table.
- If the patient experiences back pain from bending over, use the prone position.
- Adding a weight to the hand or using wrist cuffs causes a greater distraction force on the glenohumeral joint. Weights should be used only when joint stretching maneuvers are indicated late in the subacute and chronic stages—and then only if the scapula is stabilized by the therapist or a belt is placed around the thorax and scapula, so that the stretch force is directed to the joint, not the soft tissue of the scapulothoracic region.

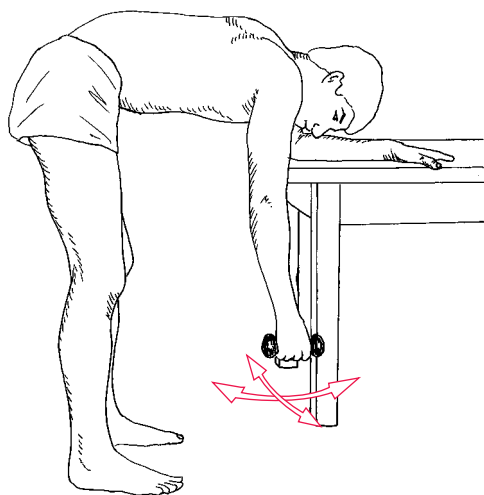


Figure 9–10 Pendulum exercises. For gentle distraction, no weight is used. Use of a weight causes a grade III (stretching) distraction force.

Precautions: Some patients may get dizzy when standing upright after being bent over; if so, have them sit and rest. With increased pain or decreased ROM, the technique may be an inappropriate choice. Pendulum exercises are also inappropriate for a patient with peripheral edema.

“Gear Shift” Exercises

Patient position: Sitting with the involved arm at the side, holding a cane or wand with the tip resting on the floor to support the weight of the arm. Instruct the patient to move the pole forward and back, diagonally, or laterally and medially in a motion similar to shifting gears in a car with a floor shift (Fig. 9–11).

“Table Dusting” or “Wall Washing”

Patient position: Standing with hand placed on a table or against a wall (on a towel or ball). Instruct the patient to perform clockwise and counterclockwise circular motions with the hand moving on the table or wall or rolling the ball. Progress this activity by having the patient reach upward and outward as far as tolerated without causing symptoms.

Early Motion of the Scapula

Passive and A-AROM of the scapula are described in Chapter 2. In the acute phase, the side-lying position

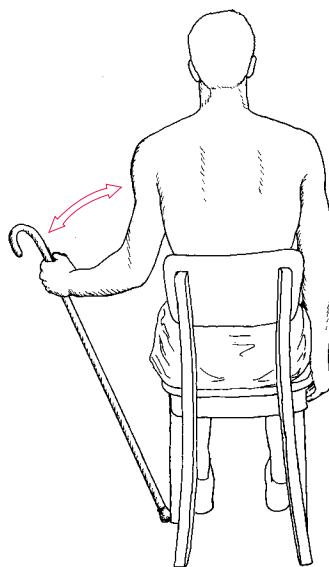


Figure 9–11 Gear shift exercise. Self-assisted shoulder rotation using a cane. Flexion/extension and diagonal patterns can also be done.

is usually more comfortable than prone-lying. If the patient can perform active scapular elevation/depression and protraction/retraction, use the sitting position.

Early Neuromuscular Control

Frequently, the muscles of the rotator cuff are inhibited after trauma or surgery.¹⁸² Initiate the following to stimulate activation and develop control in key muscles as soon as the patient tolerates.

Multiple-Angle Muscle Setting

Begin gentle multiple-angle muscle-setting exercises of the rotators internal and external in pain-free positions of humeral flexion or scaption. Activate the scapular and rest of the glenohumeral muscles with gentle muscle-setting techniques in positions that do not exacerbate symptoms.

Closed-Chain or Protected Weight Bearing

Have the patient lean onto his or her hands or elbows and gently move from side to side. This helps to seat the humeral head in the glenoid fossa and stimulate muscle action.

► Exercise Techniques to Increase Flexibility and Range of Motion

To regain neuromuscular control and function in the shoulder girdle, it may be necessary to increase flexibility in restricted muscles and fascia so that proper shoulder girdle alignment and functional ranges are possible. Techniques to stretch tight joints in the shoulder girdle were discussed earlier in this chapter. Principles of inhibition and passive stretching were

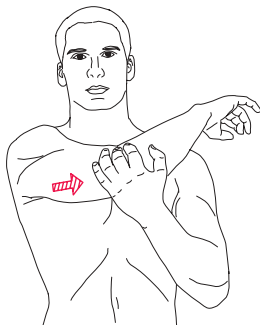


Figure 9-12 Self-stretching to increase horizontal adduction.

presented in Chapter 5. Specific manual and self-stretching techniques are described in this section.

Self-Stretching Techniques

Teach the patient a low-intensity prolonged stretch. Emphasize the importance of not bouncing at the end of the range.

To Increase Horizontal Flexion/Adduction—Cross-Chest Stretch

Patient position and procedure: Sitting or standing. Teach the patient to horizontally adduct the tight shoulder by placing the arm across the chest and then apply a sustained overpressure to the adducted arm by pulling the arm toward the chest being careful not to rotate the trunk (Fig. 9-12).

Note: This stretch is used when treating impingement syndromes to increase mobility in the structures of the posterior GH joint.

To Increase Flexion and Elevation of the Arm

Patient position and procedure: Sitting with the involved side next to the table, forearm resting along the table edge and elbow slightly flexed (Fig. 9-13A). Have the patient slide the forearm forward along the table while bending from the waist. Eventually the head should be level with the shoulder (Fig. 9-13B).

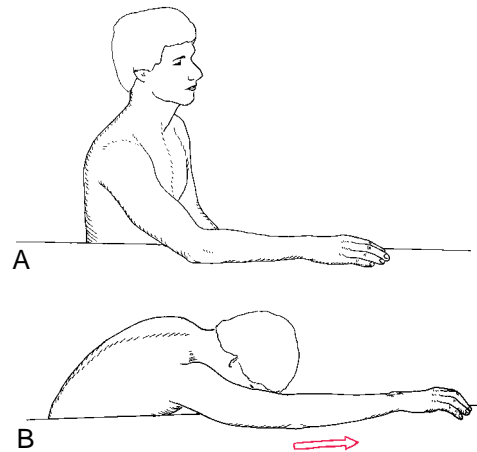


Figure 9-13 (A) Beginning and (B) end positions for self-stretching to increase shoulder flexion with elevation.

To Increase External (Lateral) Rotation

- Patient position and procedure: Standing and facing a doorframe with the palm of the hand against the edge of the frame and elbow flexed 90 degrees. While keeping the arm against the side or in slight abduction (held in abduction with a folded towel or small pillow under the axilla) have the patient turn away from the fixed hand (Fig. 9–14A).
- Patient position and procedure: Sitting with his or her side next to a table with the forearm resting on the table and elbow flexed to 90 degrees. Have the patient bend from the waist, bringing the head and shoulder level with the table (Fig. 9–14B).

Precaution: Avoid this stretch position if there is anterior GH instability.

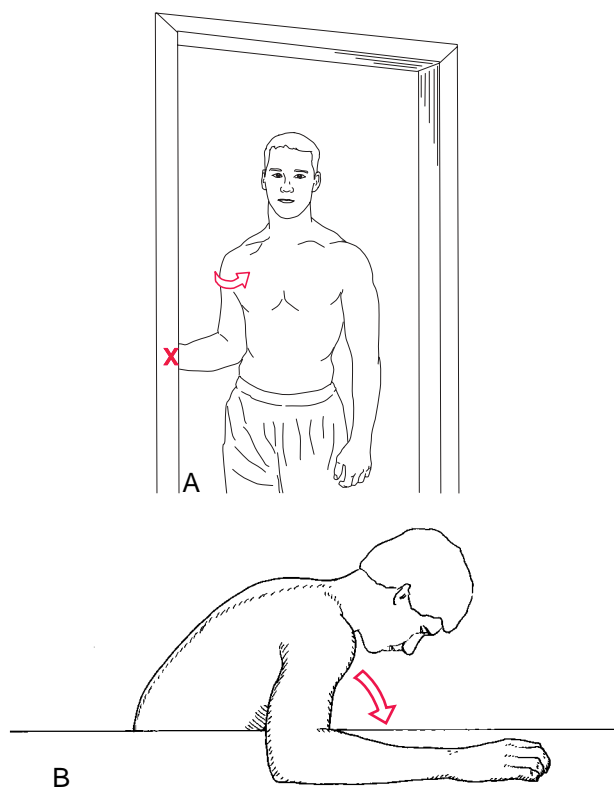


Figure 9–14 Self-stretching to increase lateral rotation of the shoulder (A) with the arm at the side using a doorframe and (B) with the arm in scaption, using a table to stabilize the forearm.

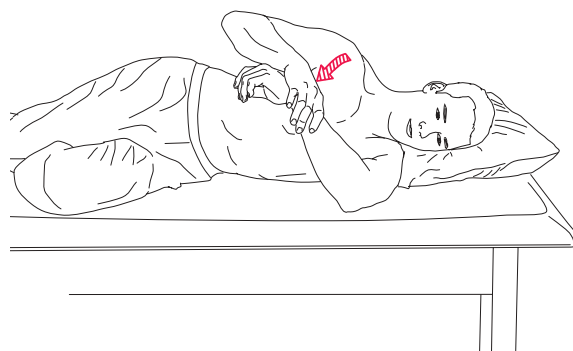


Figure 9–15 Self-stretching to increase internal rotation of the shoulder using a table to stabilize the humerus.

To Increase Internal Rotation

- Patient position and procedure: Standing facing a doorframe with the elbow flexed to 90 degrees and the back of the hand against the frame. Have the patient turn his or her trunk toward the fixed hand.
- Patient position and procedure: Side-lying on the affected side, with the shoulder and elbow each flexed to 90 degrees and arm internally rotated to end position. Have the patient then push the forearm toward the table with the opposite hand (Fig. 9–15).

To Increase Abduction and Elevation of the Arm

- Patient position and procedure: Sitting with the side next to a table, the forearm resting with palm up (supinated) on the table and pointing toward the opposite side of the table (Fig 9–16A). Have the patient slide his or her arm across the table as the head is brought down toward the arm and the thorax moves away from the table (Fig. 9–16B).
- Patient position and procedure: Same as above with a folded towel or belt placed across the proximal humerus and held in the opposite hand. Have the patient pull downward on the towel to cause a caudal slide of the humeral head when in the end-range stretch position of abduction.

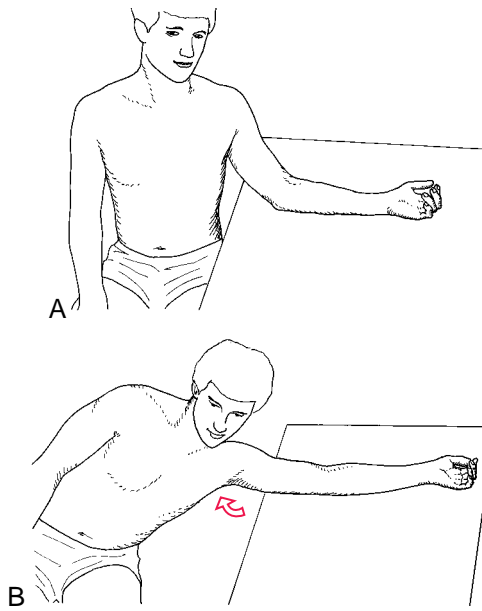


Figure 9-16 (A) Beginning and (B) end positions for self-stretching to increase shoulder abduction with elevation.

To Increase Extension of the Arm

Patient position and procedure: Standing with the back to the table, both hands grasping the edge with the fingers facing forward (Fig. 9-17A). Have the patient begin to squat while letting the elbows flex (Fig. 9-17B).

Precaution: If a patient is prone to anterior subluxation or dislocation, this stretching technique should not be done.

To Increase Internal Rotation, Extension and Scapular Tipping (Towel or Wand Stretch)

Patient position and procedure: Sitting or standing. Instruct the patient to hold each end of a towel (or wand) with one arm overhead and the arm to be stretched behind the lower back, and then pull up on the towel with the overhead hand (see Fig. 9-3).

Precaution: If a patient has anterior or multidirectional GH joint instability, or has had recent anterior stabilization surgery to correct a dislocated shoulder, this exercise should not be done because it forces the head of the humerus against the anterior capsule.

Note: This stretch is used to increase the ability to reach behind the back. It is a generalized stretch that does not isolate specific tight tissues. Before using it, each compo-

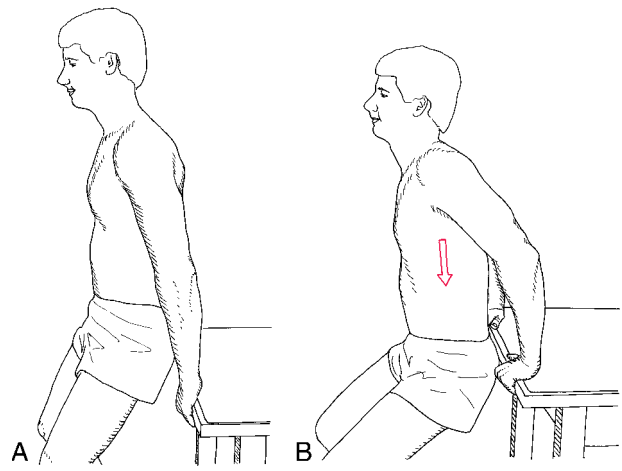


Figure 9-17 (A) Beginning and (B) end positions for self-stretching to increase shoulder extension.

nent of the motion should be stretched so that no one component becomes the “weak link” in the chain.

Manual and Self-Stretching Exercises for Specific Muscles

General manual stretching techniques to increase ROM were described and illustrated in Chapter 5. Specific multijoint muscles that affect alignment of the shoulder girdle that were not presented in Chapter 5 are presented in this section along with self-stretching techniques of these muscles.

To Stretch the *Latissimus Dorsi* Muscle

Manual Stretch

Patient position and procedure: Supine, with hips and knees flexed so the pelvis is stabilized in a posterior pelvic tilt. Provide additional stabilization to the pelvis with one hand, if necessary; with the other hand grasp the distal humerus and flex, laterally rotate, and partially abduct it to the end of the available range. Instruct the patient to contract into extension, adduction, and medial rotation while providing resistance for a hold-relax maneuver. During the relaxation phase, elongate the muscle.

Self-Stretch—Supine

Patient position and procedure: Hook-lying with the pelvis stabilized in a posterior pelvic tilt and the arms flexed, laterally rotated, and slightly abducted overhead as far as possible (thumbs pointing toward

floor). Allow gravity to provide the stretch force. Instruct the patient to not allow the back to arch.

Self-Stretch—Standing

Patient position and procedure: Standing with back to a wall and feet forward enough to allow the hips and knees to partially flex and flatten the low back against the wall, and the arms in a “hold-up” position (abducted 90 degrees and laterally rotated 90 degrees if possible). Tell the patient to slide the back of the hands up the wall as far as possible without allowing the back to arch.

Note: This exercise is also used to strengthen the lower trapezius and serratus anterior as they upwardly rotate and depress the scapulae during humeral abduction.

To Stretch the Pectoralis Major Muscles

Manual Stretch

Patient position and procedure: Sitting on a treatment table or mat, with the hands behind the head. Kneel behind the patient and grasp the patient’s elbows (Fig. 9–18). Have the patient breathe in as he or she brings the elbows out to the side (horizontal abduction and scapular adduction). Hold the elbows at this end-point as the patient breathes out. No forceful stretch is needed against the elbows, because the rib cage is elongating the proximal attachment of the pectoralis major muscles bilaterally. As the patient repeats the inhalation, again move the elbows up and out to the end of the available range, and hold as the patient breathes out. Repeat only three times in succession to avoid hyperventilation.

Note: Hyperventilation should not occur, because the breathing is slow and comfortable. If the patient does become dizzy, allow him or her to rest, then reinstruct for proper technique. Be sure the patient maintains the head and neck in the neutral position, not forward.

Corner Stretch

Patient position and procedure: Standing, facing a corner or open door, with the arms in a reverse T or a V against the wall (Fig. 9–19A and B). Have the patient lean the entire body forward from the ankles (knees slightly bent). The degree of stretch can be adjusted by the amount of forward movement.

Wand Exercises for Self-Stretch

Patient position and procedure: sitting or standing and grasping the wand with the forearms pronated

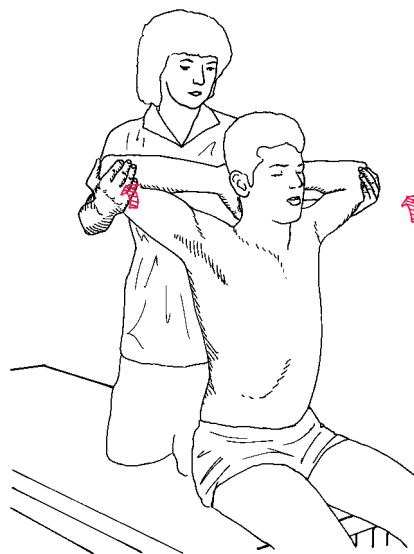


Figure 9–18 Active stretching of the pectoralis major muscle. The therapist holds the elbow at the end-point as the patient breathes out.

and elbows flexed 90 degrees. Have the patient then elevate the shoulders and bring the wand behind the head and shoulders (Fig. 9–20). The scapulae are adducted and the elbows are brought out to the side. Combine with breathing by having the patient inhale as he or she brings the wand into position behind the shoulders, then exhale while holding this stretched position.

To Stretch the Pectoralis Minor Muscle

Patient position and procedure: sitting, place one hand posterior on the scapula and the other hand anterior on the shoulder, just above the coracoid process (Fig. 9–21). As the patient breathes in, tip the scapula posteriorly by pressing up and back against the coracoid process while pressing downward against the inferior angle of the scapula, and then hold it at the end-position while the patient breathes out. Repeat, readjusting the end-position with each inhalation, and stabilizing as the patient exhales.

To Stretch the Levator Scapulae Muscle

Note: The muscle attaches to the superior angle of the scapula and causes it to rotate downward and elevate; it also attaches to the transverse processes of the upper cervical vertebrae and causes them to backward bend and rotate to the ipsilateral side. Because the muscle is attached to two movable structures, both ends must be stabilized opposite to the pull of the muscle.

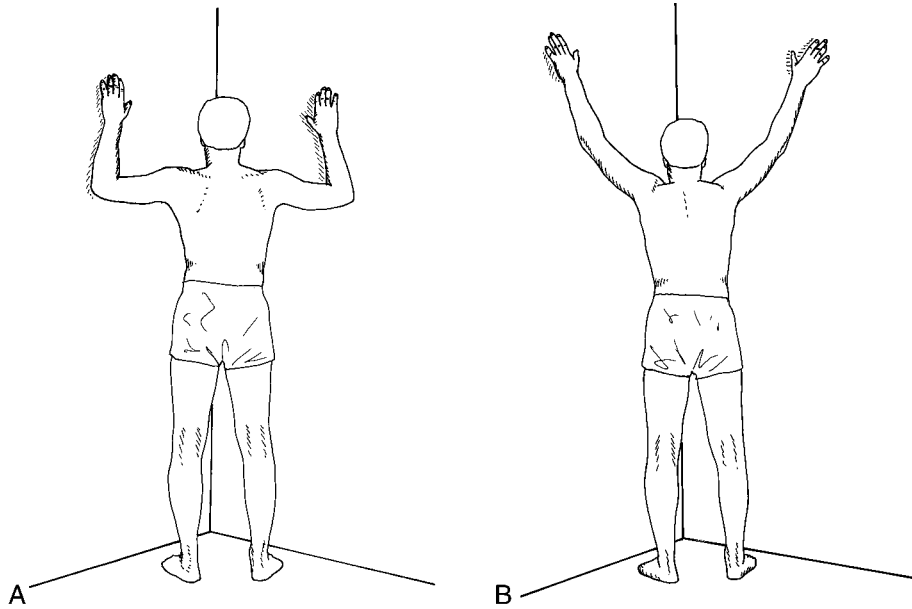


Figure 9-19 Self-stretching the pectoralis major muscle with the arms in a reverse T to stretch (A) the clavicular portion, and in a V to stretch (B) the sternal portion.

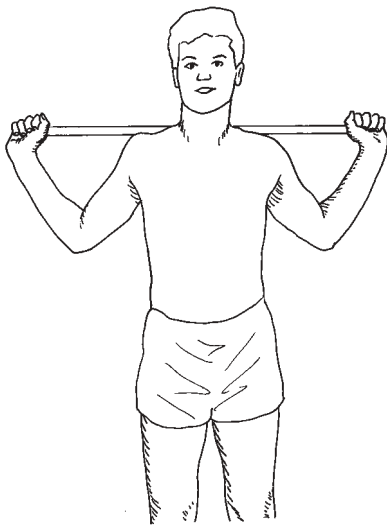


Figure 9-20 Wand exercises to stretch the pectoralis major muscle.

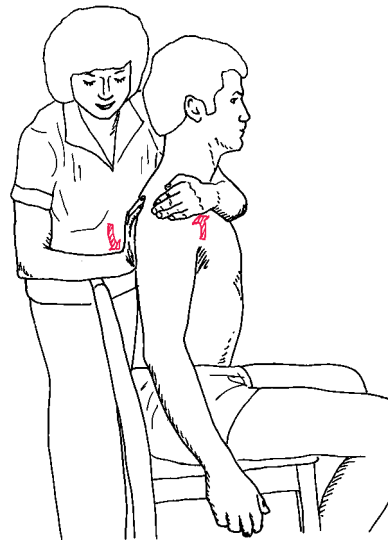


Figure 9-21 Active stretching of the pectoralis minor muscle. The therapist holds the scapular and coracoid process at the endpoint as the patient breathes out.

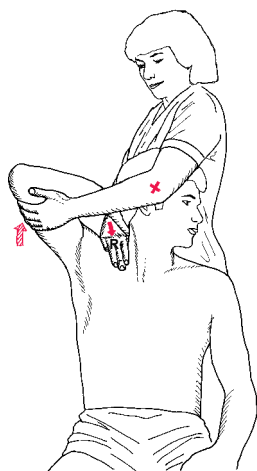


Figure 9-22 Active stretching of the levator scapulae muscle. The therapist stabilizes the head and scapula as the patient breathes in, contracting the muscle against the resistance. As the patient relaxes, the rib cage and scapula depress, which stretches the muscle.

Manual Stretch

Patient position and procedure: sitting with the head rotated opposite to side of tightness (looking away from the tight side) and forward bent until a slight pull is felt in the posterolateral aspect of the neck (in the levator muscle). The arm on the side of tightness is abducted and the hand is placed behind the head to help stabilize it in the rotated position. Stand behind the patient and stabilize his or her head with one arm, and place the other hand (same side as tight muscle) over the superior angle of the scapula (Fig. 9-22). With the muscle now in its stretched position, have the patient breathe in, then out. Hold the shoulder and scapula down to maintain the stretch as the patient breathes in again (he or she contracts the muscle against the resistance of the fixating hand). To increase the stretch, press down against the superior angle of the scapula. This is not a forceful stretch but a gentle hold-relax maneuver. Do not stretch the muscle by forcing rotation on the head and neck.

Self-Stretch

Patient position and procedure: Standing with the head side bent and rotated away from the tight side and bent elbow against a wall. The other hand can be placed across the forehead to stabilize the rotated head. Instruct the patient to slide the elbow up the wall as he or she takes in a breath, then hold the position while exhaling (Fig. 9-23A).

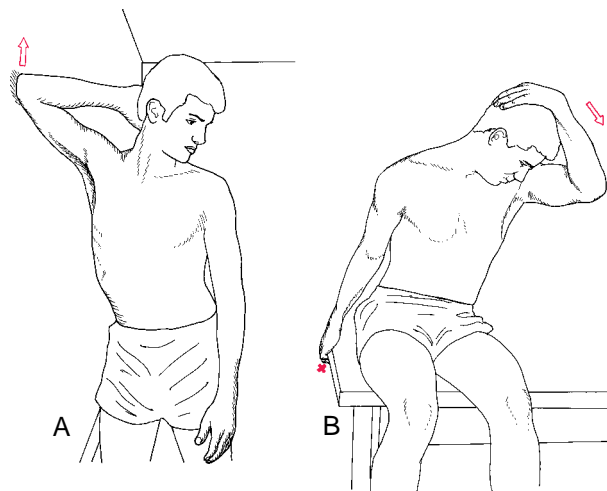


Figure 9-23 Self-stretching the levator scapulae muscle. (A) Using upward rotation of the scapula and (B) using depression of the scapula.

Self-Stretch

Patient position and procedure: Sitting with head side bent and rotated away from the tight side. To stabilize the scapula, have the patient reach down and back with the hand on the side of tightness and hold on to the seat of the chair. The other hand is placed on the head to gently pull it forward and to the side in an oblique direction opposite the line of pull of the tight muscle (Fig. 9-23B).

► Exercises to Develop and Improve Muscle Performance and Functional Control

Developing control of the scapula and glenohumeral joint musculature is fundamental to correcting faulty shoulder mechanics and for improving strength, muscle endurance, power, and performance of functional activities. During observation of scapular alignment and movement, if excessive tipping, winging, or poorly coordinated scapulohumeral rhythm during humeral elevation is identified, it is important to correct these faulty mechanics with properly chosen exercises. Poor stabilization and control of GH rotation and translation during humeral elevation likewise requires concentration on training the rotator cuff musculature. When designing an exercise program, the intensity and type of exercises must not exceed the capability of the healing tissues whether the cause of the impaired control is nerve injury, disuse, traumatic insult, overuse, instability, or surgery.

Box 9–9 Summary of Exercise Progressions for the Shoulder

- Develop awareness and control of weak or disused muscles.
- If weak, begin with minimal resistance, multiangle isometrics and active-assistive ROM, open- and closed-chain (pain-free ranges).
- Develop postural stability of scapula and glenohumeral joint with stabilization exercises in both open- and closed-chain.
- Provide just enough resistance and repetitions to challenge the muscles.
- Do not allow substitution with stronger muscles.
- When stabilizing control develops in the scapula and GH muscles, progress to dynamic exercises.
- First strengthen weak motions and weak muscles so that substitute actions do not dominate; emphasize scapular and rotator cuff muscle control in open- and closed-chain.
- Develop muscle endurance and control.
- Progress to patterns of motion and train muscle groups to function in a coordinated sequence of control and motion.
- Use simple functional activities.
- Progress to more complex and challenging activities.

The exercises described in the following sections begin at the simplest or least stressful level and progress to a more difficult level for each type of exercise. They also progress from uniplanar or isolated muscle activity to more complex and functional patterns. Initially, choose exercises that help the patient focus on utilizing correct muscles to counteract the identified impairments; then increase the challenge by utilizing patterns of exercises that will prepare the musculature to respond to functional demands.* No matter what the level of exercise, it is important to challenge patients at intensities they can meet so they can safely progress to more intense levels. Chapter 3 describes principles and techniques of resistance exercises; it is important that the reader understands and applies these principles, as well as the principles of tissue healing described in Chapter 8, and precautions for various pathologies as presented in this chapter before teaching exercises to patients. This section describes shoulder exercises; see also Chapter 16 for correction of cervical and thoracic postural problems that might underlie faulty shoulder girdle mechanics. Improvement of muscle performance is multifactorial; Box 9–9 summarizes a method of progressing an individual toward functional recovery.

Isometric Exercises

Isometric exercises are applied along a continuum of very gentle, to maximum contraction, and they are

applied at varying muscle lengths and joint angles. Choice of the intensity, muscle length, or joint angle and number or repetitions is based on strength, stage of recovery after injury or surgery, and/or pathomechanics of the region.

Scapular Motions

Patient position and procedure: Side-lying, prone-lying, or sitting, with the arm supported if necessary. Resist elevation, depression, protraction, or retraction with pressure directly on the scapula in the direction opposite the motion (Fig. 9–24).

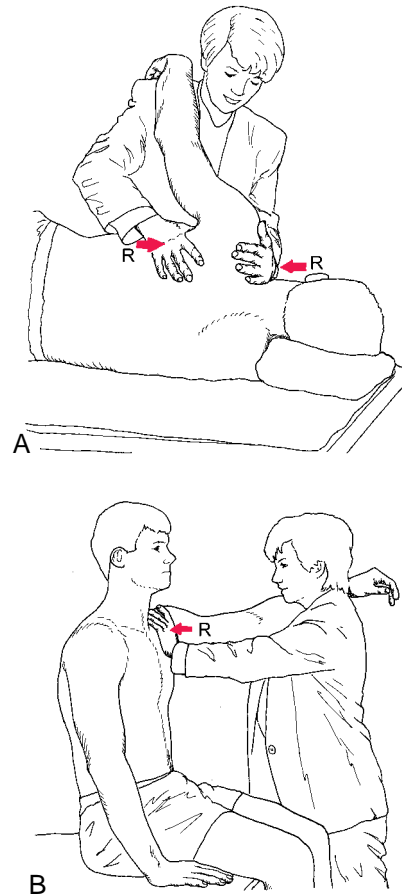


Figure 9–24 Isometric or dynamic manual resistance to scapular motions. (A) Resistance to elevation/depression. (B) Resistance to protraction/retraction. Direct the patient to reach across the therapist's shoulder to protract the scapula while the therapist resists against the coracoid and acromion process; the other hand is placed behind the scapula to resist retraction.

*See references 11, 20, 28, 44, 45, 82, 88, 90, 95, 101, 150, 171, 182.

Depression (lower trapezius). Activation of the lower trapezius is emphasized when there is forward tipping and delayed upward rotation often seen with impingement syndromes. Apply resistance against the inferior angle of the scapula (Fig. 9–24A).

Protraction (serratus anterior). Activation of the serratus anterior is emphasized when there is scapular winging or when there is delayed or incomplete upward rotation of the scapula with GH elevation. Apply resistance against the axillary border of the scapula or coracoid process, or indirectly against the humerus positioned in the plane of the scapula (Fig. 9–24B).

Retraction (rhomboids and trapezius). Activation of the rhomboids and trapezius muscle groups is emphasized when there the scapular posture is protracted (abducted). Apply resistance against the medial border of the scapula.

Multiple-Angle Isometrics to the GH Muscles

Patient position and procedure: Supine, sitting, or standing. During the protection and early motion phases of treatment when the tissue has symptoms of inflammation, use the supine position to provide scapular and trunk stability and manual resistance for the best control of position and intensity of resistance. If pain from joint compression occurs, apply a slight distractive force to the GH joint as the resistance is given.

Internal and external rotation. Position the humerus at the patient's side, in slight flexion, slight abduction, or scaption (plane of the scapula), and with the elbow flexed 90 degrees. Apply resistance against the forearm as if turning a crank (see Fig. 3–12A).

Abduction. Maintain the humerus neutral to rotation and resist abduction at 0, 30, 45, and 60 degrees. If there are no contraindications to motion above 90 degrees, reposition the humerus in external rotation before elevating the humerus and resisting above 90 degrees abduction.

Scaption. Position midway between flexion and abduction and resist at various ranges such as 30 and 60 degrees in the plane of the scapula (Fig. 9–25).

Extension. Position the humerus at the side or in various positions of flexion and apply resistance against the humerus.

Adduction. Position the humerus between 15 and 30 degrees abduction and apply resistance.

Elbow flexion with the forearm supinated. Position the humerus at the side and neutral to rotation. Apply resistance to the forearm, causing tension in the long head of the biceps (see Fig. 3–14). Change the position of shoulder rotation and repeat the isometric resistance to elbow flexion.

Self-Applied Multiple-Angle Isometrics

Teach the patient how to independently apply isometric resistance using positions and intensities consistent with therapeutic goals. The patient can use the opposite hand (Fig. 9–26) or a stationary object such as a wall or door frame (Fig. 9–27).

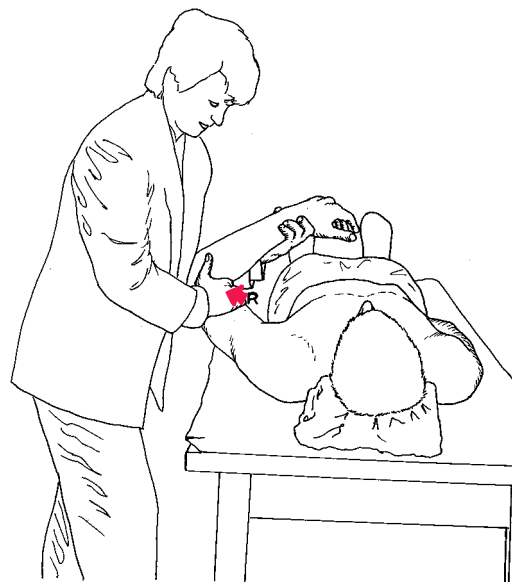


Figure 9–25 Isometric resistance in scaption. The shoulder is positioned between 30 and 60 degrees of scaption, and controlled manual resistance is applied against the humerus.

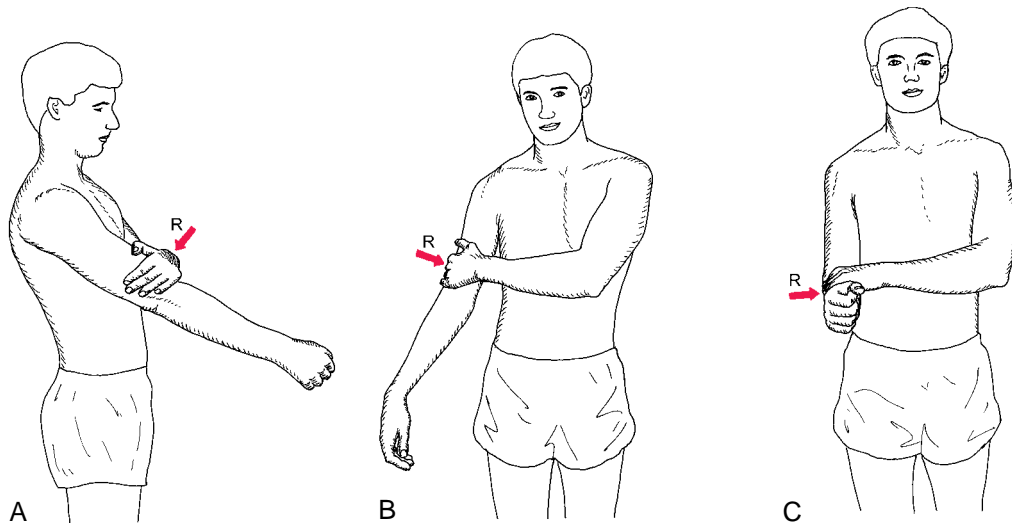


Figure 9-26 Self-resistance for isometric (A) shoulder flexion, (B) abduction, and (C) rotation.

Stabilization Exercises

The application of alternating isometrics and rhythmic stabilization techniques (described in Chapter 3) is designed to develop strength and stability of proximal muscle groups in response to shifting loads. The shoulder girdle functions in both open- and closed-chain activities, and therefore, the muscles should be trained to respond to both situations. Initially, apply the alternating resistance slowly and command the patient to “hold” against the resistance. At the beginning of training it may also be

necessary to tell the patient which way you are going to push to help the patient focus on the contracting muscles and alternating forces. As the patient learns to respond by contracting the proper muscles and stabilizing the joints, increase the rapidity of the shifting resistance and also decrease the verbal warning so that the muscles learn to respond accordingly.

Begin training the scapular muscles so that when the muscles of the GH joint need to contract they will have a stable base (scapular stability).

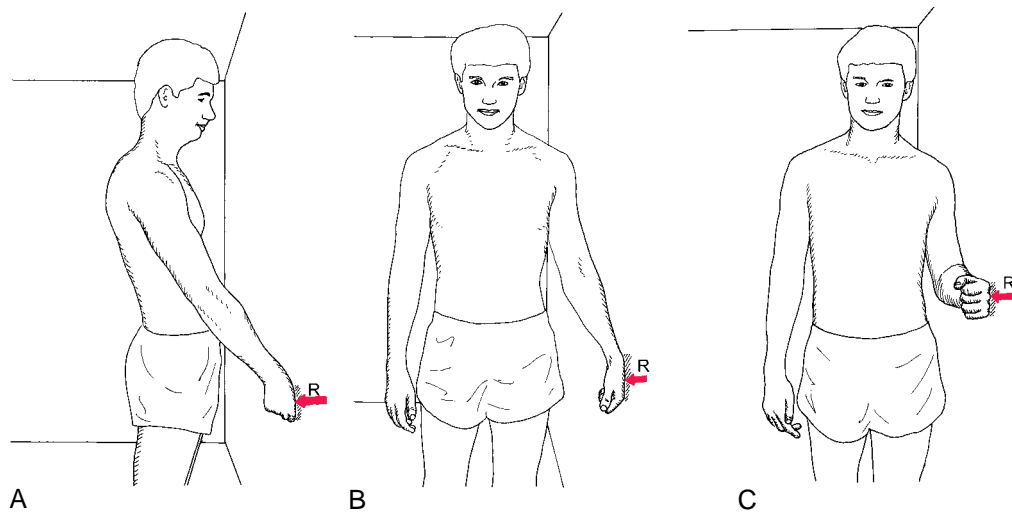


Figure 9-27 Using a wall to provide resistance for isometric (A) shoulder flexion, (B) abduction, or (C) rotation.

Open-Chain Stabilization Exercises for the Scapular Muscles

Begin with the patient side-lying, with the affected extremity up. Drape the forearm of the involved extremity over your shoulder. The degree of shoulder flexion, scaption, or abduction can be controlled by your stance and the relative position of the patient. Progress the patient to sitting with his or her arm draped over your shoulder; apply resistance to all scapular motions in the same manner as described previously.

Scapular elevation/depression. Place your top hand superiorly and the other hand inferiorly around the scapula to provide manual resistance (see Fig. 9-24A).

Scapular protraction/depression. Place your top hand along medial border and the other around the coracoid process to provide resistance (see Fig. 9-24B).

Scapular upward and downward rotation. Place one hand around the inferior angle and the other hand around the acromion and coracoid process to provide resistance.

Open-Chain Stabilization Exercises for the Shoulder Girdle

Patient position and procedure: Supine holding a rod or ball with elbows extended and shoulders flexed to 90 degrees. Stand at the patient's head and grasp the rod; instruct the patient to hold against or match the resistance you provide. Push, pull, and rotate the rod in various directions (Fig. 9-28). Resistance can also be applied directly against the arm or forearm.

- If too much assistance is being given by the normal extremity, apply the stabilization technique to just the involved extremity.
- As the patient gains control, progress to sitting and then standing, and have the patient hold the arm in various positions as the alternating resistance is applied. Observe the scapula to be sure there is good stabilization. If not, return to the exercises described above or decrease the intensity of resistance. Progress these exercises to functional patterns as strength and control improves.

Closed-Chain (Weight-Bearing) Stabilization Exercises

Weight bearing activates contraction of stabilizing muscles in proximal joints and may be a stimulus for improving fluid dynamics of the articular cartilage as described in Chapter 6. Early in the con-

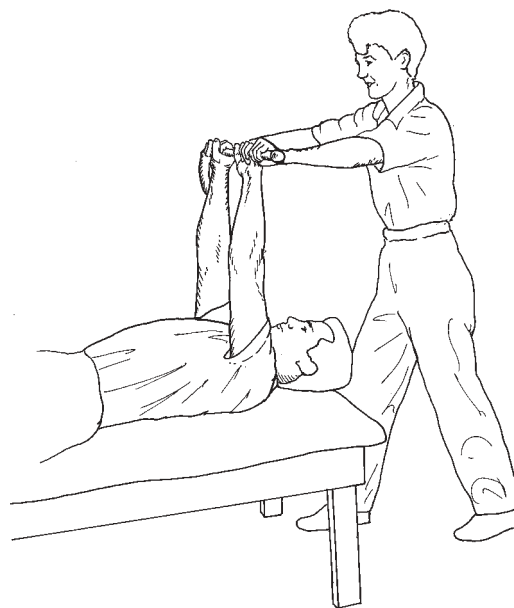


Figure 9-28 Stabilization exercises. The patient stabilizes with the shoulder girdle musculature (isometrically) against the resistance imposed by the therapist. Flexion/extension, abduction/adduction, and rotation resistance is applied in a rhythmic sequence.

trolled motion phase of treatment (subacute stage), if the healing tissues tolerate, it may be beneficial to initiate protected weight-bearing stabilization exercises. The amount and intensity of weight bearing and resistance is progressed as tissues heal.

Note: If scapular winging is observed when the patient is weight bearing, do not progress these exercises until there is enough strength to stabilize the scapula against the rib cage.

Scapular stabilization. Patient position and procedure: Side-lying on uninvolved side. Both the elbow and shoulder of the involved arm are flexed to 90 degrees with the hand placed on the table and bearing some weight. Resist the scapular motions of elevation/depression and retraction directly against the scapula; resist protraction by pushing against the elbow.

Protected weight bearing. Patient position and procedure: Sitting with forearms resting on thighs or a table, or standing with arms resting on a table. Apply a gentle resistance force against the shoulders and ask the patient to match the resistance and “hold.” Alternate from side to side and forward.

Closed-chain stabilization progressions. Patient position and procedure: Standing with shoulder at 90 degrees and one or both hands leaning against a wall or on a ball (Fig. 9–29). Additional, more advanced progressions include having the patient in the all-4s or quadruped position with hands on the floor, on a rocker or wobble board, or on a ball. The ball provides an unstable surface and requires greater neuromuscular control and balance reactions. Each of the positions can also be done with the patient supporting his or her weight on only the involved upper extremity. Apply alternating resistance against the patient's shoulders or trunk and ask him or her to "hold" against the force. Pressing forward against the trunk will increase the effect of the body weight and require the serratus anterior to stabilize more strongly against the additional force. As already noted, if the scapula wings, the resistance is too strong and should be reduced.

Closed-Chain (Weight-Bearing) Dynamic Stabilization

Dynamic stabilization requires the stabilizing muscles to maintain control of the scapula and GH joint while moving the body weight over the fixed extremity or extremities.

- Patient position and procedure: Standing with shoulders flexed 90 degrees and hands supported against a wall, leaning hands on a table, or quadruped (all 4s) position. Instruct the patient to shift his or her body weight from one extrem-

ity to the other (rock back and forth). Apply resistance against the shoulders (see Fig. 9–29).

- Progress by having the patient alternately lift one extremity, then the other, so that one extremity bears the body weight and stabilizes against the shifting load. Apply manual resistance to the shoulders or strap a weight around each wrist.
- When the muscles are able to control and stabilize, progress to using unstable surfaces (such as a rocker board, BAPS board, or ball). Suggestions for more vigorous closed-chain activities are described in the following section.

Dynamic Strengthening—Open- and Closed-Chain

It is imperative that the proximal stabilizing muscles of the thorax, neck, and scapula function properly before initiating dynamic strengthening of the muscles that move the glenohumeral joint through the ROM to avoid faulty mechanics. Strengthening exercises can be done in both open- and closed-chains. Progress exercises with repetitions and resistance that are within the mechanical limits of the involved tissues.

Initially utilize light resistance with multiple repetitions to develop dynamic control and muscular endurance. As control develops, progress to combined patterns of motion and training for muscle groups to function in a coordinated sequence. Begin

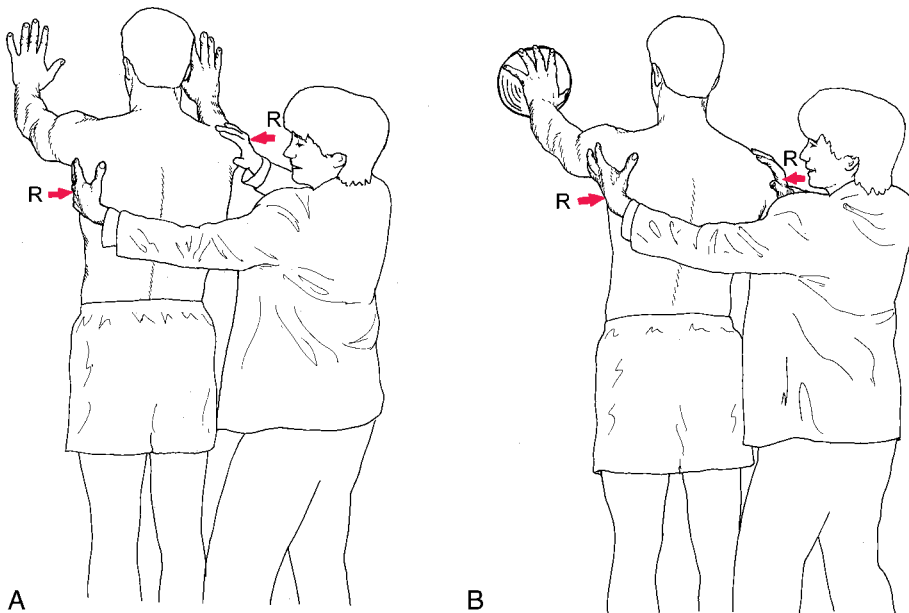


Figure 9–29 Closed-chain scapular and glenohumeral stabilization exercises. (A) Bilateral support in a minimal weight-bearing position with both hands against a wall. (B) Unilateral support on a less stable surface (ball). The therapist applies alternating resistance while the patient stabilizes against the resistance or the therapist applies resistance as the patient moves from side to side.

with simple functional activities and then more complex and challenging activities. Both muscular endurance and strength are necessary for postural and dynamic control of activities.

Scapular Retraction (Rhomboids and Middle Trapezius)

These exercises are designed to isolate scapular retraction; once the patient is able to retract the scapula against resistance, combine patterns with the GH joint to progress strength and functional patterns as described in the next sections.

- Patient position and procedure: Prone, sitting and standing. Instruct the patient to clasp the hands together behind the low back. This activity should cause scapular adduction. Draw attention to the adducted scapulae, and have the patient hold the adducted position of the scapulae while the arms are lowered to the sides. Have the patient repeat the activity without arm motion.
- Patient position and procedure: Prone with the arm over the edge of the table in a dependent position and a weight in the hand. Instruct the patient to pinch the scapulae together (Fig. 9–30). Progress this exercise to prone rowing and horizontal abduction against gravity described below.
- Patient position and procedure: Sitting or standing with the shoulder flexed to 90 degrees and elbows extended. Have the patient grasp each end

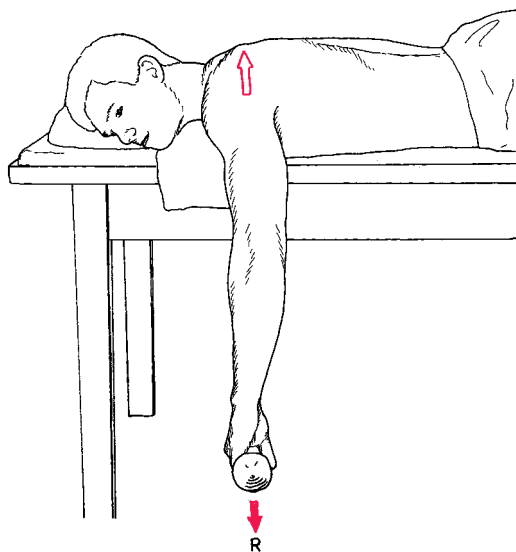


Figure 9–30 Scapular retraction against handheld resistance in the prone position.

of an elastic band or tubing that has been secured at shoulder level or a two-handed pulley that is at shoulder level, and pinch the scapulae together by pulling against the resistance.

Scapular Retraction Combined with Shoulder Horizontal Abduction/Extension (Rhomboids, Middle Trapezius, and Posterior Deltoid)

Prone and Sitting

Patient position and procedure: Prone with shoulders abducted 90 degrees, elbows flexed and forearms pointed vertically toward the floor. Instruct the patient to perform horizontal abduction with scapular retraction. This exercise can also be done with the elbows extended for greater resistance (Fig. 9–31). Progress this exercise by adding weights and then by having the patient perform the rowing motion standing or sitting in front of a length of elastic resistance that has been secured at shoulder level.

Corner Press-Outs

Patient position and procedure: Standing with his or her back toward a corner, shoulders are abducted 90 degrees, and elbows are flexed. Instruct the patient to press the elbows into the walls and push the body weight away from the corner (Fig. 9–32).

Scapular Retraction and Shoulder Horizontal Abduction Combined with External Rotation (Rhomboids, Trapezius, Posterior Deltoid, Infraspinatus, and Teres Minor)

- Patient position and procedure: Prone with shoulders abducted 90 degrees and externally rotated 90 degrees (90–90 position). The elbows can be flexed 90 degrees (easier position) or extended (more difficult position). Instruct the patient to lift

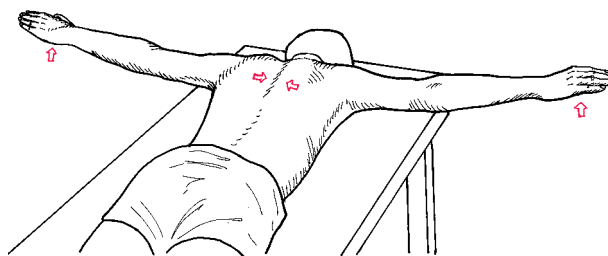


Figure 9–31 Horizontal abduction and scapular adduction exercises, with the arms positioned for maximal resistance from gravity. To progress the exercise further, weights can be placed in the patient's hands.

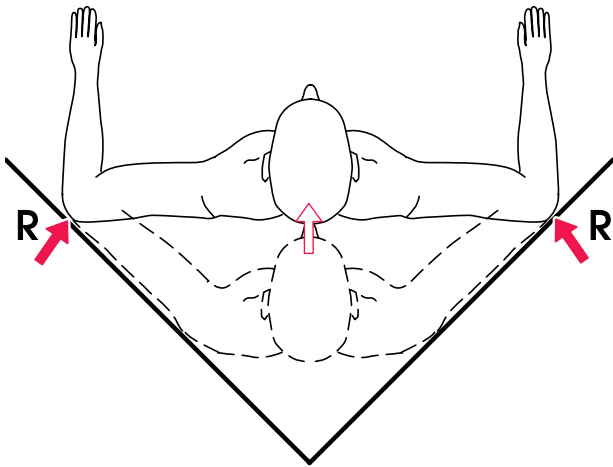


Figure 9-32 Corner press-outs to strengthen scapular retraction and shoulder horizontal abduction (view looking from above).

the arm a few degrees off the table. To do this correctly the scapulae must simultaneously adduct.

Note: Greater ROM can be used if these exercises are done on a narrow bench so that the arm can begin in a horizontally adducted position.

- **Patient position and procedure:** Sitting or standing with shoulders in the 90–90 position. Secure the middle of a piece of elastic resistance in front of the patient slightly above the shoulders, and have the patient grasp each end of the resistance. Then have the patient pull the hands and elbows back while simultaneously adducting the scapulae (Fig. 9-33).

Scapular Protraction (Serratus Anterior)

- **Patient position and procedure:** Sitting or standing with shoulder flexed around 90 degrees and elbow extended. Secure a piece of elastic resistance behind the patient at shoulder level (or use a pulley system). Instruct the patient to “push” outward against the resistance without rotating the body (Fig. 9-34).
- **Patient position and procedure:** Supine with the arm flexed 90 degrees and slightly abducted, and the elbow extended. Place a light weight in the hand if resistance is tolerated, and have the patient “push” the weight upward without rotating the body.
- **Push-ups with a “plus.”** Patient position and procedure: Standing with arms against a wall,

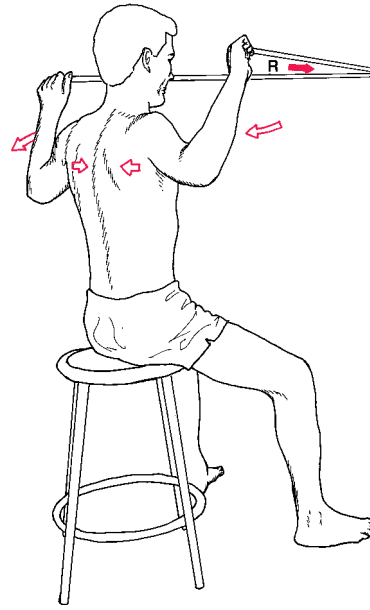


Figure 9-33 Combined scapular adduction with shoulder horizontal abduction and lateral rotation against resistance.

leaning on a table or lying prone. Have the patient place his or her hands directly in front or slightly to the side of his or her shoulders and push the trunk up (or away from the wall); once full GH range is reached, instruct the patient to “give an

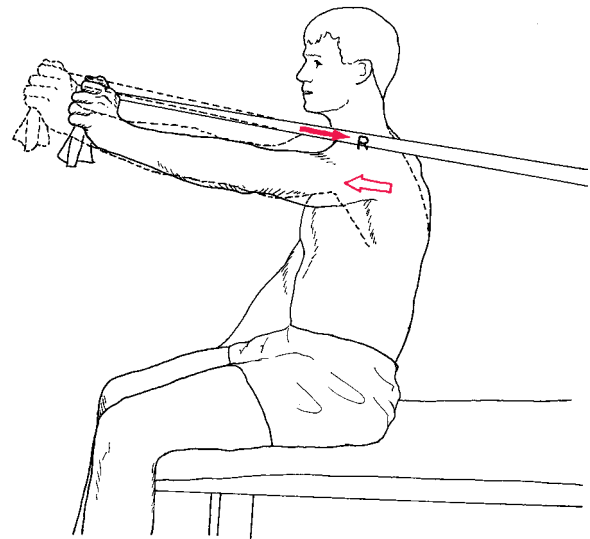


Figure 9-34 Scapular protraction; pushing against elastic resistance.

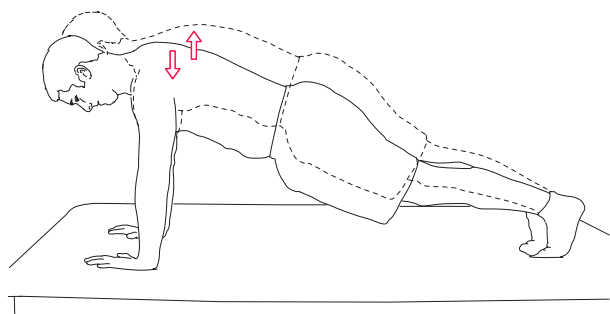


Figure 9-35 Push-ups with a “plus” to strengthen scapular protraction.

extra push” to protract the scapulae. Progress the wall push-ups to table push-ups then, prone push-ups with knees as a fulcrum, and finally prone-lying push-ups, lifting full body weight (Fig. 9-35). Add weight around the trunk if the patient is able to tolerate greater resistance.

Shoulder External Rotation (Infraspinatus and Teres Minor)

Position the arm at the patient’s side or in various positions of abduction, scaption, or flexion. Flex the elbow to 90 degrees and apply the resistive force through the hand at right angles to the forearm. Be sure the patient rotates the humerus and does not extend the elbow.

- Patient position and procedure: Sitting or standing, using elastic resistance or wall pulley in front

of the body at elbow level. Instruct the patient to grasp the elastic material or the pulley handle and rotate his or her arm outward (Fig. 9-36A).

- Patient position and procedure: Side-lying on normal side with involved shoulder upright and arm resting on the side of the thorax with a rolled towel under the axilla. Have the patient use a handheld weight, weight cuff, or elastic resistance and rotate the arm through the desired ROM.
- Patient position and procedure: Prone on a treatment table, upper arm resting on the table with shoulder at 90 degrees if possible, elbow flexed with forearm over the edge of the table. Lift the weight as far as possible by rotating the shoulder, not extending the elbow (Fig. 9-36B). It has been reported²⁰ that the activation of the infraspinatus and teres minor is maximized with this exercise.
- Patient position and procedure: Sitting with elbow flexed 90 degrees and supported on a table so the shoulder is in the resting position (scaption). The patient lifts the weight from the table by rotating the shoulder (Fig. 9-36C).

Shoulder Internal Rotation (Subscapularis)

Position the arm at the patient’s side or in various positions of flexion, scaption, or abduction. The elbow is flexed to 90 degrees and the resistive force is held in the hand.

- Patient position and procedure: Side-lying on involved side with the arm forward in partial flex-

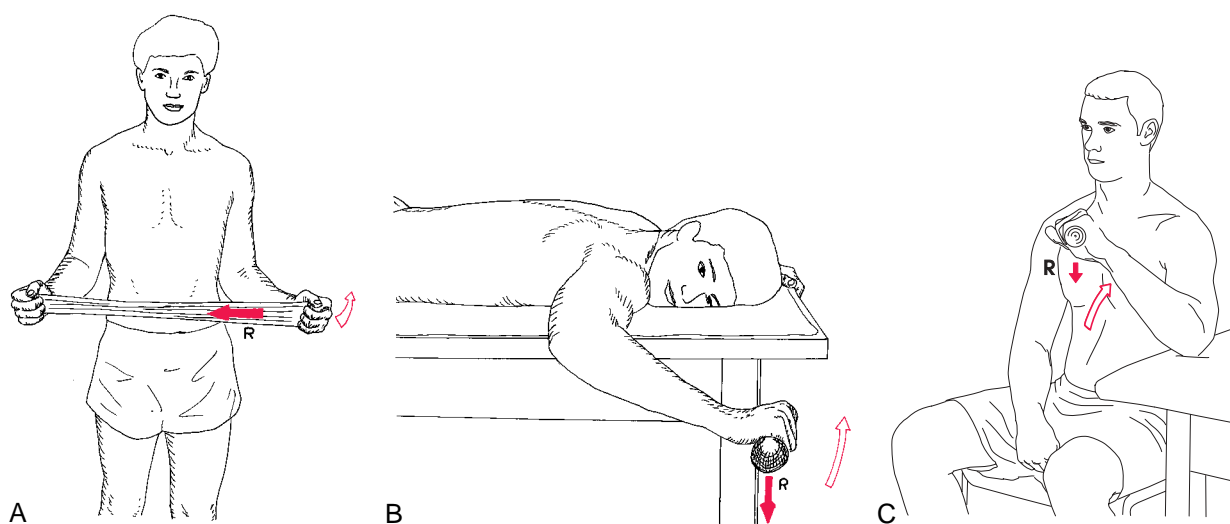


Figure 9-36 Strengthening external rotation with (A) the arm at the side using elastic resistance (B) prone with the arm at 90 degrees using a free weight, and (C) sitting with the shoulder in scaption using a free weight.

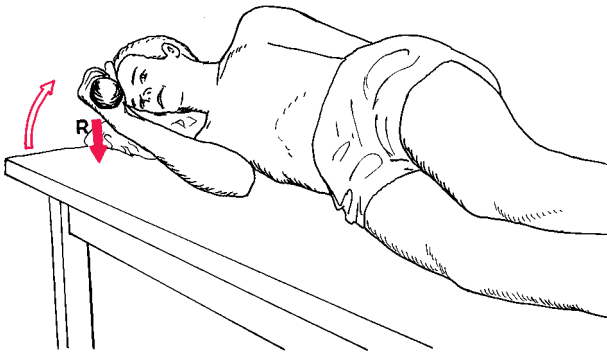


Figure 9-37 Resisted internal rotation of the shoulder using a handheld weight. To resist external rotation, place the weight in the patient's upper hand.

ion. Have the patient lift the weight upward off the table into internal rotation (Fig. 9-37).

- Patient position and procedure: Sitting or standing using an elastic material or pulley system with the line of force out to the side and at the level of the elbow. Have the patient pull across the front of the trunk into internal rotation.

Shoulder Abduction and Scaption (Deltoid and Supraspinatus)

Abduction exercises are classically done with the humerus moving in the frontal plane. It is commonly accepted that most functional activities occur with the humerus 30 to 45 degrees forward to the frontal plane where the arc of motion is more in line with the glenoid fossa of the scapula; this motion is called scaption. Many abduction exercises can be adapted to be performed in scaption.

Precaution: Teach the patient that whenever the shoulder elevates beyond 90 degrees, it must externally rotate to avoid impingement of the greater tubercle against the acromion.

"Military Press"

Patient position and procedure: Sitting, arm at the side in external rotation with elbow flexed and forearm supinated (thumb pointing posteriorly). Have the patient lift the weight straight up overhead (Fig. 9-38).

Abduction Against Gravity

- Patient position and procedure: Sitting or standing with a weight in hand. Have the patient abduct the arm to 90 degrees, then laterally rotate

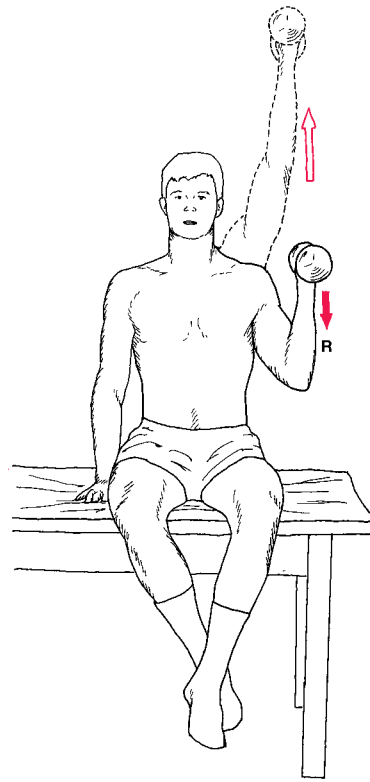


Figure 9-38 Military press-up. Beginning with the arm at the side in external rotation with elbow flexed and forearm supinated (thumb pointing posteriorward), the weight is lifted overhead.

and elevate the arm through the rest of the range. This same motion can be performed with elastic resistance secured under the patient's foot, but be cautious in that the greater the elastic stretch, the greater the resistance. The patient may not be able to complete the ROM because of the increased resistance at the end of the range.

- Patient position and procedure: Side-lying with involved arm uppermost. Have the patient lift a weight up to 90 degrees. The greatest effect of the resistance is at the beginning of the range. At 90 degrees, all of the force is through the long axis of the bone.

Full Can and Empty Can

Patient position and procedure: Standing with the humerus either externally rotated (full can) or internally rotated (empty can). Have the patient raise the arm away from the side in the plane of the scapula, halfway between abduction and flexion (Fig. 9-39). Performing scaption with the humerus in various positions of rotation has the value of emphasizing

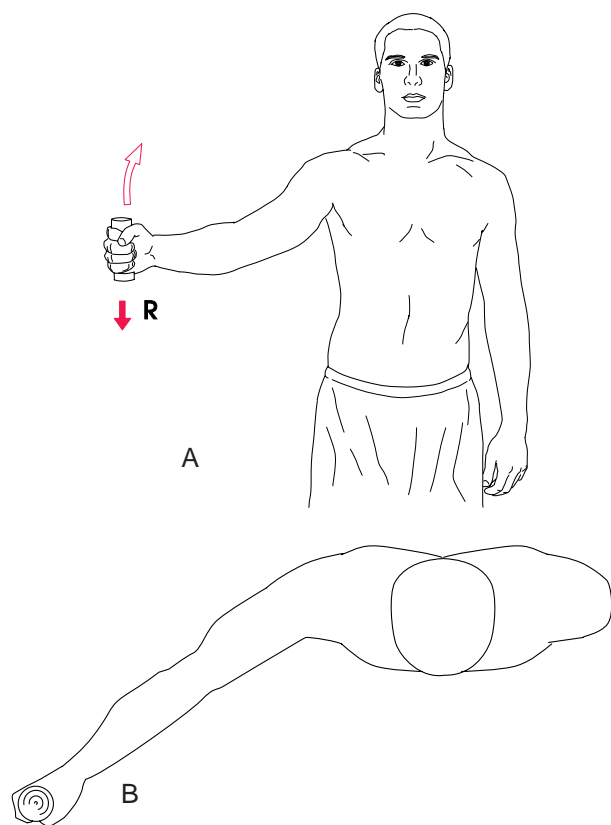


Figure 9-39 Abduction in the plane of the scapula (scaption). This is called the “full can” exercise because the shoulder is held in external rotation as if lifting a full can: (A) front view, (B) top view. If the shoulder is held in internal rotation it is called “empty can.”

each of the rotatory muscles of the cuff in their synergy with the supraspinatus and deltoid muscles.⁹⁹ Resistance is applied with a handheld weight or from elastic resistance secured under the patient’s foot.

Note: Recent EMG studies have confirmed that no one exercise isolates the action of the supraspinatus muscle from the other rotator cuff or deltoid muscles.^{100,171} The supraspinatus muscle is effectively activated in both the “empty can”^{82,182} and “full can” exercises.^{80,100,171} It also contracts strongly with the military press¹⁷¹ and horizontal abduction with external rotation exercises.^{20,100,191} These findings give the therapist several choices of exercises for strengthening the supraspinatus. Several authors^{45,78,80} as well as the authors of this text have suggested the “empty can” exercise (scaption with internal rotation of the humerus) should not be used in shoulder rehabilitation because it cause impingement of the suprahumeral tissues,

especially as the arm approaches and elevates above 90 degrees. The “full can” position (scaption with external rotation) does not cause impingement.^{45,80}

Shoulder Flexion (Anterior Deltoid, Rotator Cuff and Serratus Anterior)

Patient position and procedure: Sitting, standing, or supine. If a free weight is used when supine, the greatest resistive force is at the beginning of the range; during standing, the greatest resistive force is when the shoulder is flexed 90 degrees. An elastic resistive force also can be used if secured under the patient’s foot or solid object.

Shoulder Adduction (Pectoralis Major, Teres Major, and Latissimus Dorsi)

Patient position and procedure: Sitting or standing with the arm abducted. Have the patient pull down against a pulley force or elastic resistance tied overhead. The greatest resistance will be when the line of the resistive force is at right angles to the patient’s arm.

Shoulder Horizontal Adduction (Anterior Deltoid, Coracobrachialis, and Pectoralis Major)

Patient position and procedure: Supine, begin with one or both arms out to the side in horizontal abduction. Have the patient bring the arms forward into horizontal adduction until the arm or arms are vertical.

Shoulder Extension (Posterior Deltoid, Latissimus Dorsi and Rhomboids)

- Patient position and procedure: Prone with the arm over the side of the table in 90 degrees flexion. Have the patient lift the weight and extend the shoulder. Simultaneous elbow flexion while extending the shoulder is easiest (shortest lever arm); maintaining elbow extension while extending the shoulder is more difficult (longer lever arm).
- Patient position and procedure: Sitting or standing with the arm flexed; a pulley or elastic resistance is secured overhead. Have the patient pull down against the resistance into extension.

Scapular Depression (Lower Trapezius and Lower Serratus Anterior)

Shoulder Rolls

- Patient position and procedure: Sitting or standing. Ask the patient to roll the shoulders forward,

up, and then around to the back so that the scapulae are resting in the retracted and depressed position. Instruct the patient to do this frequently throughout the day as part of a posture correction activity (see Chapter 16).

- Patient position and procedure: Sitting with elbow flexed. Provide manual resistance in an upward direction under the patient's elbow, and ask him or her to push down into your hands. Caudal gliding of the humeral head may also occur (Fig. 9-40A).

Closed-Chain Scapular Push-Ups (Scapular Depression and Humeral Adduction)

Patient position and procedure: Sitting or standing with both hands on blocks, on the armrests of a chair, or on parallel bars. Have the patient push down on the hands and lift the body (Fig. 9-40B).

Scapular Upward Rotation with Depression (Lower Trapezius and Serratus Anterior)

This motion cannot be isolated. The upward rotation action of the lower trapezius and serratus anterior

require strengthening in coordination with humeral elevation. As noted elsewhere in this chapter, a patient may substitute with scapular elevation, primarily using the upper trapezius, so this exercise draws attention to maintaining the scapula in depression while upwardly rotating.

- **“Superman” motion.** Patient position and procedure: Prone, with humerus elevated overhead (if possible). Ask the patient to barely lift the arm off the table.
- Alternate position and procedure: Sitting or standing if the patient has a tight shoulder and cannot do the “superman motion” lying prone. Secure elastic resistance overhead and instruct the patient to move the shoulder into greater flexion with scapular depression. The scapular depression is most important; it may be necessary to use tactile cues on the lower trapezius to help the patient focus on the scapular depression, not scapular elevation (Fig. 9-40C).

Note: This is not a rowing motion; nor should trunk extension occur.

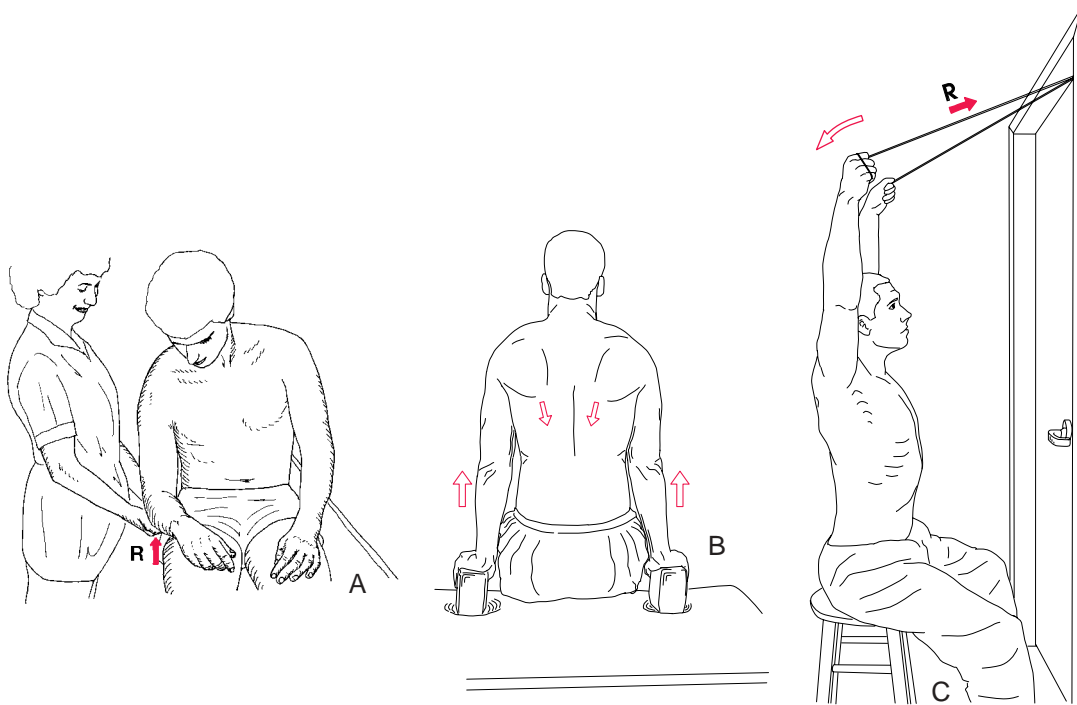


Figure 9-40 Exercises that emphasize the lower trapezius: (A) shoulder girdle depression against manual resistance, (B) closed-chain shoulder girdle depression using body weight for resistance, and (C) scapular depression with upward rotation of the scapula against elastic resistance.

- **Patient position and procedure:** Standing with back to the wall, heels away from the wall enough to be able to comfortably do a posterior pelvic tilt and maintain the back flat against the wall. Begin with arms slightly abducted and externally rotated and elbows flexed 90 degrees (back of hands should be against the wall). Instruct the patient to slide the hands and arms up the wall (abduction) as far as possible while maintaining the back flat against the wall.

Elbow Flexion (Biceps Brachii)

Biceps Curls

Patient position: Sitting or standing. Have the patient flex the elbow with a handheld weight while keeping the forearm supinated and the arm at the side or with the shoulder moving into slight extension (see Fig. 10–7).

Note: Since the biceps brachii is a two-joint muscle, the long head not only serves to flex the elbow as its primary function, it also assists the rotator cuff muscles by acting as an additional dynamic stabilizer of the GH joint by approximating the humeral head against the glenoid fossa and by depressing the head of the humerus as the arm elevates and the scapula upwardly rotates.⁹⁴ As such, the biceps brachii must be strengthened in a shoulder rehabilitation program.

PNF (Diagonal) Patterns

Note: PNF patterns as described in Chapter 3 utilize the entire upper extremity or address specific regions, such as the scapula. Apply resistance manually to emphasize specific muscles within the pattern by adjusting hand placement and resistance. Teach the patient exercises utilizing PNF patterns with weights or elastic resistance.

D₁ Flexion Pattern

Patient position and procedure: Standing. The arm begins in extension, internal rotation and slight abduction. Have the patient bring the arm into flexion, adduction, and external rotation while holding a weight or pulling against elastic resistance that is secured under the foot.

D₂ Flexion Pattern

Patient position and procedure: Standing. The arm begins in extension, internal rotation, and slight adduction. Have the patient bring the arm into flexion, abduction, and external rotation while holding a weight or pulling against elastic resistance (Fig. 9–41).

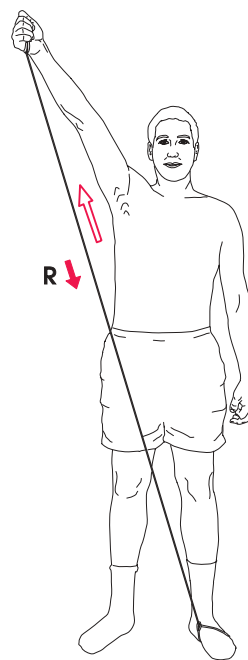


Figure 9–41 Elastic resistance to the D₂ flexion pattern, emphasizing shoulder flexion, abduction, and external rotation using elastic resistance.

D₁ Extension Pattern

Patient position and procedure: Supine, standing, or sitting. The arm begins in flexion, adduction, and external rotation. Have the patient pull against elastic resistance that is secured above the head or against an overhead cable attached to a weighted pulley system with a combined extension, abduction, and internal rotation motion.

D₂ Extension Pattern

Patient position: Supine, standing, or sitting. The arm begins in flexion, abduction, and external rotation. Have the patient pull against elastic resistance that is secured above the head with a combined extension, adduction, and internal rotation.

Isokinetic Training

Principles of isokinetic training are discussed in Chapter 3. Early in the exercise program have the patient use a submaximal effort at slow speeds. As tissues heal, have the patient perform maximum effort concentric and eccentric exercises at medium to high speeds. Simulate functional patterns of movement if the equipment setup allows.

Resisted Exercises Using Functional Patterns of Motion with Equipment

There are a variety of exercise devices that can be used or modified to use for shoulder girdle strengthening that require coordination between the stabilizing and dynamic functions of the scapula and humerus. Some are considered closed-chain in that the proximal segments move over the stabilized extremity, or there is pressure through the extremity causing approximation of the GH joint surfaces. The exercises may be used to accomplish several goals, such as improving strength, power, endurance (muscular and/or cardiovascular/pulmonary), balance, coordination, and skill.

Handwalking on a Treadmill

Patient position and procedure: Kneeling at the end of a treadmill. The surface can be moving forward or backward. Have the patient “walk” with his or her hands while bearing weight through the shoulders.

ProFitter™

Patient position and procedure: Kneeling with one or both hands on the movable platform. The hands slide the platform from side to side. Change the position of the unit to obtain different angles of motion (Fig. 9–42).

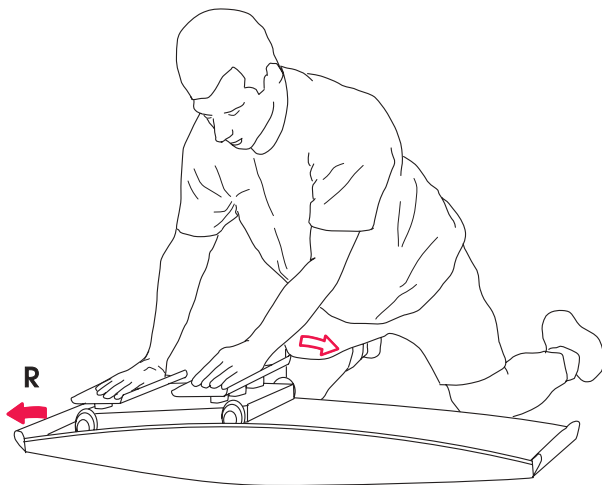


Figure 9–42 Advanced closed-chain exercise to resist the upper extremity using a ProFitter™ to provide an unstable, moving surface.

Stepping Machine

Patient position and procedure: Kneeling with each hand on a step of the unit. The upper extremities do the climbing. Encourage the patient to use scapular protraction/retraction rather than elbow flexion/extension.

Rowing Machine

Patient position and procedure: Long-sitting. Follow the instructions provided by the manufacturer if a commercial unit is used. Elastic resistance or cable system on a pulley can be used to simulate a commercial rowing machine. Have the patient secure the elastic resistance under the feet or around a solid object, grasp the ends of the resistance, and pull backward in a rowing action with the arms. Also have the patient long sit facing a cable system with the pulley at ground level. If there is just one cable, secure a bar to the cable, and have the patient pull the bar toward his or her trunk in a rowing action.

Lawnmower Pull

Patient position and procedure: Standing with hips partially flexed and holding onto a table or chair for balance with the hand of the sound upper extremity. Have the patient reach diagonally across the midline and grasp a piece of elastic resistance that is secured under the foot of the sound side or attached to the floor. Then have the patient pull upward on the resistance as if starting a lawnmower. This may also be simulated with a free weight (see Fig. 10–14).

Upper Body Ergometry

Patient position and procedure: Sitting or standing in front of an ergometer with hands on the handles. Determine arc of motion, and direction (forward or backward), speed, and time. This machine may be used for general warm-up, ROM, strengthening, or endurance training. Since tight or overused anterior structures and weak or underused posterior structures tend to be the pattern with shoulder impairments, place emphasis on backward (retro) motions of the ergometer.

Advanced Closed-Chain Stabilization and Balance Activities

Patient position and procedure: Quadruped on the floor with hands on an unstable surface such as BAPS board, rocker board, wobble board, foam roll, or 8- to 10-inch ball. Or have the patient assume a quadruped position with knees on a mat and hands

on a large gym ball on the floor next to the mat. A variety of activities can then be done. For example, have the patient perform the following activities.

- Maintain a balanced posture as resistance is applied to the shoulders or trunk to disturb balance.
- Shift body weight from one hand to the other using an alternating protraction/retraction motion of the scapulae.
- Alternately flex each upper extremity so that only one hand is balanced on the unstable surface.
- Perform push-ups and push-ups with a plus on the unstable surface.
- Increase speed of the above activities.

Functional Activities

As soon as the patient develops control of scapular and humeral motions and the basic components of the desired activities without exacerbating the symptoms, initiate specificity of training toward the desired functional outcome by progressing the strengthening exercises to maximum resistance concentrically and eccentrically. Use the actual patterns and type of contraction required in the desired outcome and progress to the desired speed first in a controlled manner, then with less control.

An individual who has a sedentary lifestyle may require postural adaptations and ergonomic analysis of his or her home environment or work station to change repetitive stress whereas an athlete or industrial worker may require high-intensity exercises that develop endurance, power, and skill. Functional exercises may begin simply by instructing the patient to unload a dishwasher and place the dishes on a low shelf using correct shoulder mechanics or washing windows using small circular motions. Body mechanics are incorporated into lifting, pushing, or pulling activities (Fig. 9–43). If catching and throwing or swinging a bat or golf club are necessary, total body patterns are practiced with the upper extremity exercises. Creativity in adapting exercises to meet progressive upper extremity challenges is a must. Basic principles to progress the patient during the return to function phase of therapy follow.

Endurance Training

Muscle and cardiovascular/pulmonary endurance is important for general health as well as to function throughout a workday. Utilize repetitive loading of each exercise from 3 to 5 minutes using patterns of motion that simulate work or functional activities. Principles of conditioning are discussed in Chapter

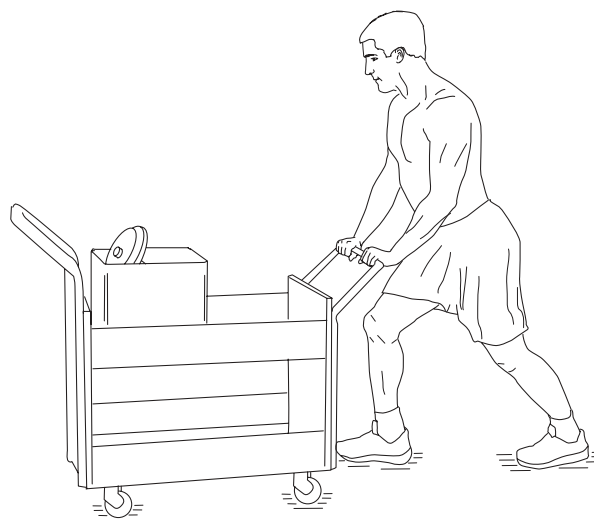


Figure 9–43 Functional exercise incorporating body mechanics

4. Have the patient maintain his or her target heart rate for 20 minutes with repetitive exercises.

Eccentric Training

Eccentric exercises are high-intensity exercises and may be used for specific training. Because eccentric contractions tolerate greater resistance than concentric, when loading resistance for eccentric training, the patient is taught to assist the arm to the end of the shortened range of the muscles to be stressed; then the muscles control the return motion. This can be performed with elastic resistance, pulleys, or free weights first in single-plane motions and then progressed to simulated functional patterns.

Plyometric Training

Initiate *stretch-shortening drills* in safe, controlled patterns with light resistance; then progress speed and resistance as tolerated.

Example. The therapist tosses a weighted ball such as a Plyoball® for the patient to reach for and catch and then immediately toss back using the reciprocal pattern (Fig. 9–44). Progress to total body patterns including step and throw and overhead pass activities. Spring-loaded rebounders or elastic tubing is commercially available so the patient can do the activity independently once the drills are learned.^{181–183}

Total Body Training

Increase *speed* with superimposed stresses to tolerance while simulating the desired activity. Assess

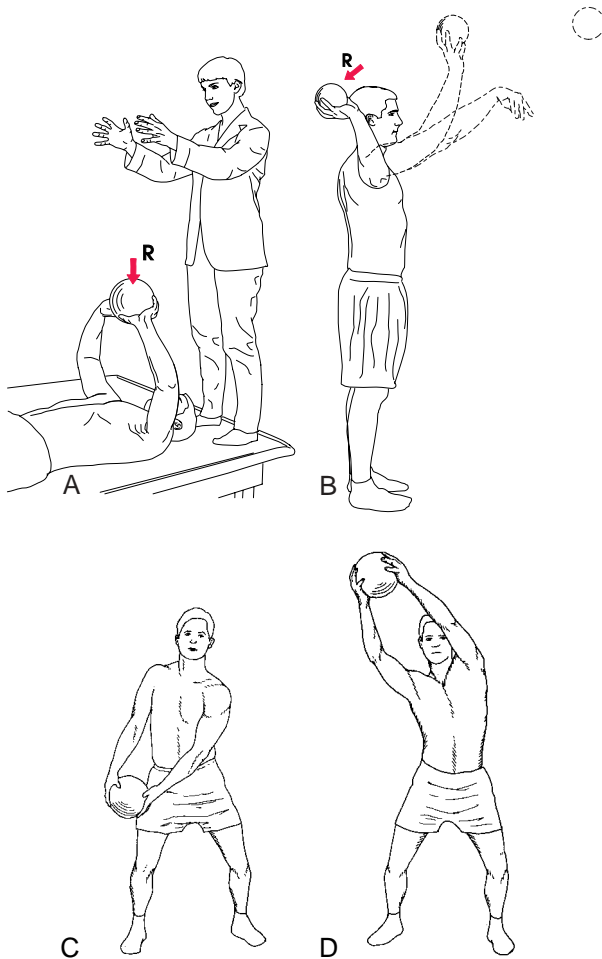


Figure 9-44 Plyometric activities catching and throwing a weighted ball (A) in a stable supine position, (B) in a standing position, (C) in a diagonal extension pattern, and (D) in a diagonal flexion pattern

the total-body function while the desired activity is being carried out. Develop timing and sequencing of events that are consistent with the functional activity.

Independent Learning Activities

CRITICAL THINKING AND DISCUSSION

1. Describe the functions and inter-relationships of the scapulothoracic and glenohumeral musculature as dynamic stabilizers of the shoulder.
2. Which structures can restrict normal upward rotation of the scapula, and how does inadequate

passive or active upward rotation of the scapula adversely affect elevation of the arm?

3. How does sitting or standing in a slumped posture (excessive thoracic kyphosis and forward head) with scapular abduction versus an erect posture with scapular adduction alter ROM of the shoulder?
4. Which mechanisms and structures could be sources of pain in primary impingement syndrome?
5. How are impingement and instability related to each other in secondary impingement syndrome?
6. A patient experienced a traumatic shoulder injury, falling down five cement steps 2 weeks ago. She now has a capsular pattern, decreased joint play, and muscle guarding with passive glenohumeral motions. She does not actively use the extremity because of pain. You observe edema in the hand. What potential complications could develop if left untreated? Design an exercise program for this patient at her present level of involvement. What would you teach the patient about her symptoms, impairments, and parameters for recovery?
7. An individual with a history of diabetes has developed a frozen shoulder. She has had shoulder discomfort for several months, but she did not seek treatment until 1 week ago when she was unable to wash or fix her hair with her left hand. Identify your intervention plan and instructions for this patient.
8. A new patient describes experiencing episodes of numbness and tingling in the hand with occasional periods of “puffiness.” She reports it is particularly annoying because it happens whenever she carries her briefcase or heavy purse with a shoulder strap. She also experiences pain at night and wakes up with her hand “having fallen asleep.” What shoulder girdle problems could cause these symptoms? What is the probable cause of the symptoms? Create a scenario of objective findings, identify impairment and functional goals, and a plan of intervention. What precautions are related to nerve pathologies?
9. In the early and middle stages of a rehabilitation program, what types of functional activities (ADL, work-related, or sport-related) should initially be avoided or modified for patients with a history of recurrent anterior dislocation of the GH joint? With recurrent posterior dislocation of the GH joint?

10. What criteria should patients with each of the following shoulder diagnoses meet before progressing to *overhead* exercises and functional activities: primary impingement syndrome; anterior GH instability; frozen shoulder; S/P rotator cuff repair?

LABORATORY PRACTICE

1. With your partner, review and practice key tests and measurements that you might need to do to determine what is causing shoulder pain and/or diminished upper extremity function. What do each of those tests indicate?
2. Mobilize the scapula with manual techniques.
3. Mobilize the glenohumeral joint capsule with manual techniques.
4. Teach your partner a series of self-mobilization techniques for the GH joint capsule.
5. Using appropriate stabilization manually stretch all major muscle groups of the shoulder.
6. Teach your partner effective self-stretching techniques for each of these muscle groups.
7. Practice a sequence of exercises to strengthen the muscles of the scapula using manual resistance (applied by the therapist). Use open-chain and closed-chain positions.
8. Teach your partner a progressive sequence of strengthening exercises that he or she could do in a home exercise program to develop stability and dynamic control of the scapula.
9. Teach your partner a progressive sequence of strengthening exercises that he or she could do in a home exercise program to develop strength, stability, and endurance of the GH muscles. Have your patient perform each exercise for a specified number of repetitions and at a specified level of resistance. Correct any faulty postures or motions as your partner executes each exercise. Watch for and teach your partner signs of fatigue and poor exercise technique.
10. Develop a series of functional activities to complement the self-stretching and self-strengthening exercise you have taught your partner.

CASE STUDIES

1. A patient referral states: evaluate and treat shoulder pain S/P MVI. The patient describes shoulder pain whenever reaching overhead. She is a nurse and finds symptoms worsen whenever

placing solutions on an IV pole, a frequent activity for her. She was the driver of the car in a head-on collision. Examination reveals painful resisted scapular protraction, elbow extension, and shoulder extension with pain on palpation of the long head of the triceps near its insertion on the inferior glenoid, and pain in the serratus anterior in the axilla. Other impairments include weak rhomboids and lower trapezius muscles (4-/5).

- Explain why these muscles would be injured in this type of accident.
 - Explain why this patient's job would perpetuate these symptoms.
 - Outline a treatment plan to manage the acute symptoms and initiate a therapeutic exercise program.
 - Identify a measurable functional outcome goal and interventions you would use to reach the goal.
 - As the patient's symptoms subside, how would you progress her exercise program?
2. Your patient describes pain whenever reaching overhead. He likes to play volleyball in a weekend league, but otherwise has a sedentary lifestyle. On examination, you observe moderate atrophy in the infraspinous fossa, protracted scapula, and a thoracic kyphosis with forward head. You have him assume the quadruped position in anticipation of instruction in closed-chain rhythmic stabilization and scapular protraction exercises and note significant winging of the scapula.
 - Describe what muscles probably test weak with these observations.
 - How would you change the quadruped exercise to develop control and strength in the involved muscles at a safe resistance level?
 - Based on your assumptions of muscle involvement, develop an intervention plan for this patient that includes a home exercise program. Indicate parameters (frequency, repetitions), positions, safety, and progressions.
 3. You have received a referral to "evaluate and treat" a 62-year-old patient who had a total shoulder arthroplasty for osteoarthritis 2 weeks ago. The patient has been wearing a sling to support and protect the operated shoulder but has been allowed to remove the sling only for daily pendulum exercises and active ROM of the elbow, wrist, and hand.

- Prior to initiating your examination and developing an exercise program, what additional information would you like to find out from the surgeon?
- What information will you want to gather from the patient?
- What examination procedures would you wish to perform during the patient's initial visit?
- The patient's insurance, most likely, will initially approve 6 visits. Develop, implement, and teach and then progress a series of exercises over a period of 6 visits with the patient.

4. Six months ago your patient underwent surgery for repair of a Bankart lesion and stabilization of the anterior capsule (capsular shift) after a traumatic anterior dislocation of the GH joint. The patient now has full ROM and 90% strength in the shoulder after a program of rehabilitation. Your patient wants to return to recreational sports, such as tennis, softball, and volleyball but is apprehensive that the shoulder will dislocate during these activities. Design an advanced rehabilitation program to gradually return the patient to the desired recreational activities.

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