

Aaron Sciascia and W. Ben Kibler

---

## 14.1 Introduction

Dynamic upper extremity-dominant tasks such as throwing, hitting, and serving occur as the result of integrated, multi-segmented, sequential joint motion and muscle activation. In order for the tasks to be effective and efficient, optimal muscle flexibility, strength, proprioception, and endurance must exist as well as the ability to perform the task consistently on a repetitive basis. When a deficit exists within one or more of these functional components, increased load and stress may occur on the shoulder which can lead to pain or injury.

The scapula is one of many links within the kinetic chain. It has been recognized that the scapula serves many roles in shoulder function including serving as a stable base for muscle activation, precise concavity/compression ball and socket kinematics throughout the arm motion, optimal force and energy transfer from the core to the hand, and efficient work through the system of the shoulder, arm, and hand. The most effective scapular position to achieve these goals is retraction. Control of internal/external rotation, not allowing excessive internal rotation, and anterior/posterior tilting, not allowing anterior tilt, facilitate the control of retraction. The loss of retraction control

can be equated to having a faulty link in the system, i.e., weak link in the chain because the inability to obtain or maintain scapular retraction decreases the ability of the arm to optimally function. The loss of retraction can be caused by anatomical disruption (tissue derangement), anatomical impairment (tissue inflexibility, strength imbalance), or kinetic chain impairment (lower extremity inflexibility or weakness).

The focus for clinicians is to identify the cause(s) which led or contributed to the impairment. The clinician must then implement injury rehabilitation and prevention programs which will initially eliminate physical deficits followed by a focus on increasing an athlete's longevity while simultaneously decreasing the risk of injury. The purpose of this chapter is to describe normal scapular function, both in an isolated manner as well as in the kinetic chain of function, and the consequences of scapular dysfunction relative to the shoulder; provide a description of a routine scapular examination; and present a rehabilitation regimen for combating scapular dysfunction and restoring arm function.

---

## 14.2 Pathoanatomy/ Biomechanics/Preferred Classification

A kinetic chain is a coordinated sequencing of activation, mobilization, and stabilization of body segments to produce a dynamic activity [1].

---

A. Sciascia, MS, ATC, PES (✉) • W.B. Kibler, MD  
Lexington Clinic, Department of Shoulder Center  
of Kentucky, 1221 South Broadway, Lexington,  
KY 40504, USA  
e-mail: [ascia@lexclin.com](mailto:ascia@lexclin.com)  
<http://www.shouldercenterofky.com>

Many kinetic chains exhibit both closed- and open-chain activities. The concept of sequential force development throughout the segments of a kinetic chain is the best framework to understand the dynamics involved in upper extremity-dominant athletic activities. Optimal athletic function is the result of physiological motor activations creating specific biomechanical motions and positions using intact anatomical structures to generate forces and actions. Sports-specific function occurs when the activations, motions, and resultant forces are specific and efficient for the needs of that sport. For example, overhead athletic tasks such as throwing or striking a projectile require sequential muscle activation from both the upper and lower extremities, i.e., the links in the chain. The majority of force required to propel the projectile forward is developed in the larger muscles of the legs and trunk in a closed-chain fashion, is funneled through the smaller muscles of the scapulohumeral complex using closed-chain biomechanics, and is eventually transferred to the arm.

The scapula serves as a critical link in kinetic chain function because it serves as the bridge between the energy-producing muscles of the legs and trunk and the energy delivery muscles of the arm. Thus, scapular stability and optimized kinematics are an essential part of proper kinetic chain function.

The scapula performs rotary motion around three distinct axes and translations in two directions as part of the normal scapulohumeral rhythm [2]. The rotary motions are upward/downward rotation, which occur around an anterior/posterior axis perpendicular to the scapula, internal/external rotation around a vertical superior to inferior axis along the medial border, and anterior/posterior tilt around a horizontal medial to lateral axis along the scapular spine. The translations are upward/downward along the thorax and medial to lateral around the ellipsoid thorax. Scapular movement is complex and multidimensional, with the scapula rarely moving in only one of the motions and translations when accomplishing most scapular roles. However, loss of control of specific motions seems to alter glenohumeral kinematics and function more than oth-

ers. Loss of control of posterior tilting, allowing more anterior tilt, and loss of control of external rotation, allowing more internal rotation, appear to be most commonly associated with altered function or injury. Normal scapular resting position and active motion can be altered in overhead athletes due to the repetitive motions, with increases in posterior tilt and upward rotation being common alterations.

These alterations can be collectively termed scapular dyskinesis (dys=alteration of, kinesis=motion). Scapular dyskinesis refers to altered scapular motion and position that can be associated with shoulder symptoms. Because of the important but minimal bony stabilization of the scapula by the clavicle, dynamic muscle function is the major method by which the scapula is stabilized and purposefully moved to accomplish its roles. The predominant clinical finding demonstrating altered scapular motion or position is observation of prominence of the medial border of the scapula at rest or during motion. Scapular dyskinesis appears to be a nonspecific response to a painful condition in the shoulder rather than a specific response to certain glenohumeral pathology [3, 4]. This leads to excessive protraction of the scapula and depression of the acromioclavicular joint in all phases of motion which leads to increased symptoms of impingement. Scapular dyskinesis has multiple causative factors, both proximally (muscle weakness/imbalance, nerve injury) and distally (AC joint injury, superior labral tears, rotator cuff injury) based. The medial border prominence appears to be the result of abnormal muscle activations, either directly due to muscle involvement, such as inflexibility, weakness, and fatigue, or due to nerve injury, and is usually treated by rehabilitation.

The upper and lower trapezius muscles, which usually are activated independently, and the serratus anterior muscle contribute the most to scapular stability and mobility. Coupling of activation of these two muscles initiates upward rotation and posterior tilt. This force couple is especially active at the beginning of arm elevation and with arm elevation below 90°. As the arm elevation exceeds 90°, the lower trapezius is optimally

positioned to increase and maintain upward rotation through a direct line of pull. In this arm position, the serratus anterior works to stabilize the medial border against the thorax, acting as a regulator of scapular internal rotation. Lower trapezius activation is also important in the descent from maximum elevation, being activated eccentrically to control excessive anterior tilt. Other intrinsic muscles, the rhomboids and pectoralis minor, play important but not primary roles. Extrinsic muscles, mainly the latissimus dorsi and pectoralis major, create scapular motion through their effect as prime movers of the arm. Together the local and global muscles work together to provide concurrent stability and minimally constrained mobility. All muscles operate within the complex kinetic chain system where individual body segments or links have influence on multiple surrounding structures.

Tissue derangement both at or around the scapula and elsewhere within the kinetic chain can have deleterious effects on functional performance. Scapular dyskinesia has been found in association with almost every pathologic injury in the shoulder and arm in overhead athletes, including labral injury, impingement, instability, rotator cuff disease, acromioclavicular joint separations, and elbow MCL injury. The incidence varies, but dyskinesia can be identified in between 50 and 100 % of throwers with injuries. The dyskinesia is thought to be due to muscle inhibition caused by pain from the tissue derangement. It has also been hypothesized that lower extremity injury such as a history of ankle or knee injury can decrease shoulder function. It is suspected that alterations in the proximal links of the kinetic chain do not allow an athlete to achieve adequate stability prior to initiating force generation resulting in a reduction in the amount of energy being generated and transferred through the scapula and arm. Injury to any of the static restraints within the body may negatively affect arm function suggesting that surgical restoration of damaged tissue may need to be performed in order for scapular function to adequately return. Observed alterations in either the proximal or distal kinetic chain links should be initially treated conservatively with rehabilitation. However, if the alterations are addressed but

dysfunction continues to exist, the most appropriate surgical intervention should be considered as a viable treatment option.

Impairments at or around the scapula such as muscle tightness and/or weakness can produce increased loads on local structures creating injury and can also negatively impact the desired biomechanical output during athletic tasks. This has been illustrated in overhead athletics, specifically baseball and tennis. Biomechanical assessments tend to show that individuals with altered scapular position and changes in glenohumeral range of motion (ROM) also exhibit altered muscle performance. These results show that a thrower's dominant shoulder that is positioned more anterior, in addition to having forward scapular position, displays decreased lower trapezius and serratus anterior muscle performance. Additionally those with increased external rotation ROM display decreased posterior rotator cuff and lower trapezius muscle performance. This suggests that alterations in resting position and available ROM are strongly related to muscle performance. It is therefore recommended that any observed alterations be treated only if they are found in association with injury.

From a biomechanical perspective, dysfunction of a particular segment in the chain can result in either altered performance or injury to a more distal segment. For example, the muscles of the shoulder girdle are not capable of generating the substantial angular velocities seen at the shoulder during throwing; the force is largely generated by the more proximal segments of the lower extremities and trunk. The substantial forces that are transferred to and subsequently reabsorbed by the distal segments at the shoulder and arm during throwing leave these segments vulnerable to injury. In a closed system such as the kinetic chain, alteration in one area creates changes throughout the entire system. This is known as the "catch-up" phenomenon where the changes in the interactive moments alter the forces in the distal segments. The increased forces place extra stress on the distal segments such as the scapula or shoulder, which often result in the sensation of pain or actual anatomic injury.

### 14.3 Clinical Presentation and Essential P/E

Most scapular-related problems in throwing athletes can be traced to loss of control of normal resting scapular position and dynamic scapular motion, resulting in alterations in the position or motion that produce a position and motion of excessive protraction. This position and motion, in the face of functional demands of the throwing or overhead motion, can create inefficiencies and deficits in the kinematics of the shoulder which can decrease performance and increase injury risk.

The history is an important part of the evaluation. Specific questions should be asked regarding past or present trauma to the scapula, clavicle, or AC joint, chronic or acute spinal symptoms, recent or remote hip or leg injuries, or any surgical procedures. It is also important to establish if the patients have had physical therapy for any of these conditions or for a scapular condition, to document the exact extent of the therapy, and to document the results. Therapy that emphasizes modalities, early open-chain rotator cuff exercises with resistance, shoulder shrugs, and shoulder protraction exercises has not been found to be effective for scapular dyskinesis. The poor outcomes are thought to occur because (1) only the symptoms (pain, irritation) are being addressed; (2) the scapular positions known to be related with dysfunction are encouraged prior to reestablishing scapular control, i.e., protraction before retraction; or (3) the exercises are too demanding for the non-stabilized scapula (long-lever maneuvers such as traditional rotator cuff exercises being implemented before short-lever maneuvers have been mastered).

The goals of the physical exam of the scapula are to establish the presence or absence of scapular dyskinesis; to evaluate joint, muscle, and bone causative factors; and to employ dynamic corrective maneuvers to assess the effect of correction of dyskinesis on symptoms. The results of the exam will aid in establishing the complete diagnosis of all the elements of the dysfunction and will help guide treatment and rehabilitation.

Dynamic examination of scapular motion can be reliably performed by clinical observation of

the motion as the arm elevates and descends. This motion requires activation of the muscles to maintain the closed-chain mechanism of scapulo-humeral rhythm. Failure to maintain this rhythm can result in increased scapular internal rotation, with consequent medial border prominence. Clinical observation of medial border prominence in symptomatic patients has been correlated with biomechanically determined dyskinesis, and this method is clinically reliable enough to be used as the basis for determination of the presence or absence of dyskinesis [5–7]. The examination is conducted by having the patients raise the arms in forward flexion to maximum elevation and then lower them three to five times with a 3–5 lb weight in each hand. Prominence of any aspect of the medial scapular border on the symptomatic side is recorded as “yes” (prominence detected) or “no” (prominence not detected).

The scapular assistance test (SAT) and scapular retraction test (SRT) are corrective maneuvers that can alter the injury symptoms and provide information about the role of scapular dyskinesis in the total picture of dysfunction that accompanies shoulder injury and needs to be restored [8, 9]. The SAT helps evaluate scapular contributions to impingement and rotator cuff strength, and the SRT evaluates contributions to rotator cuff strength and labral symptoms. In the SAT, the examiner applies gentle pressure to assist scapular upward rotation and posterior tilt as the patient elevates the arm. The major biomechanical effect of the SAT is increasing scapular posterior tilt by 7–10° throughout the entire arc of arm elevation. This test has shown “acceptable” inter-rater reliability. A positive result occurs when the painful arc of impingement is relieved and the arc of motion is increased which would be expected with increased scapular upward rotation. In the SRT, the examiner first grades the supraspinatus muscle strength following standard manual muscle testing procedures. The examiner then places and manually stabilizes the scapula in a retracted position. The biomechanical effects are a combination of increased external rotation and posterior tilt. A positive test occurs when the demonstrated supraspinatus strength is increased or the symptoms of internal impingement are relieved in the retracted position.

Although these tests are not capable of diagnosing a specific form of shoulder pathology, a positive SAT or SRT shows that scapular dyskinesia is directly involved in producing the symptoms and indicates the need for inclusion of early scapular rehabilitation exercises to improve scapular control [1, 2].

Coracoid-based inflexibility can be assessed by palpation of the pectoralis minor and the short head of the biceps brachii at their insertion on the coracoid tip. The muscles will usually be tender to palpation, even if they are not symptomatic in use, can be traced to their insertions on the ribs as taut bands, and will create symptoms of soreness and stiffness when the scapulae are manually maximally retracted and the arm is slightly abducted to approximately 40–50°.

A major portion of the scapular exam is the evaluation of the proximal kinetic chain and distal glenohumeral joint structures that affect scapular position and motion. Kinetic chain screening can be accomplished by the one-leg stability series—a combination of a standing balance test which assesses static control and a single-leg squat test which assesses dynamic control of the body over the planted leg. In the standing balance test, the patient is asked to place their hands over their chest and stand on one leg with no other verbal cue. Deviations such as a Trendelenburg posture or internally or externally rotating the weight-bearing limb indicates inability to control the posture and has been found to correlate with proximal core weakness especially in the gluteus medius. The single-leg squat is the next progressive evaluation. Assuming the same starting point as the standing balance test, the patient is asked to do repetitive partial half squats going down and returning to the standing position with no other verbal cues. Similar deviations in the quality of the movement are assessed as in the standing balance test. A Trendelenburg posture which may not be noted on standing balance may be brought out with a single-leg squat. The patient may also use their arms for balance or may go into an exaggerated flexed or rotated posture—“corkscrewing”—in order to put the gluteal or short rotator muscles on greater tension to compensate for muscular weakness.

#### 14.4 Disease-Specific Clinical and Arthroscopic Pathology

The majority of scapular dyskinesia cases have root causes related to altered muscle function, i.e., strength imbalances, lack of flexibility, or altered muscle activation patterns. The kinematic alterations seen with scapular dyskinesia can also be due to neurological issues such as long thoracic or accessory nerve palsy which can be confirmed with diagnostic nerve conduction studies. Bony trauma such as a scapular fracture may be present which can be evaluated with standard radiographic imaging. Soft tissue injury involving the disruption of the rhomboids and/or lower trapezius from the scapular attachment sites has been recently described and labeled a scapular muscle detachment. Patients with this injury often have debilitating pain along the medial border of the scapula both at rest and during arm movement, limited use of arm function in forward elevation especially overhead motion, and pronounced scapular dysfunction similar to patients with neurological involvement. While tissue disruption is rare, it should be ruled out prior to making any treatment decisions.

More commonly, scapular alterations are due to inhibition of activation driven by pain from glenohumeral joint injury, strength imbalance among the scapular stabilizers, fatigue of muscle activation, or change in activation pattern. The serratus anterior and lower trapezius are often weak and display less activation intensity and increased latency, while the upper trapezius displays increased activation and decreased latency. This results in kinematic alterations of less posterior tilt, less external rotation, and less upward rotation motions, but increased elevation translation. These results have been found in athletes with impingement, instability, and labral tears.

Dyskinesia can also result from muscle or capsular stiffness caused by coracoid-based muscle inflexibility, i.e., pectoralis minor and short head of the biceps brachii. Tightness of these muscles decreases scapular posterior tilt, upward rotation, and external rotation. Similarly, pectoralis major and latissimus dorsi tightness can create dyskine-

sis through their action on the humerus. Glenohumeral internal rotation deficit, which is related to posterior muscle stiffness and capsular tightness, creates dyskinesia by producing a “windup” of the scapula into protraction as the arm rotates into follow-through.

Bony disruption such as clavicle fractures and high-grade acromioclavicular joint injuries may produce dyskinesia if the anatomy is not completely restored. Shortened malunions or non-unions decrease the length of the strut and alter the scapular position toward internal rotation and anterior tilt. In addition to changes in length, changes in clavicle curvature or rotation will affect scapular position or motion. Angulated fractures result in functional shortening and loss of rotation. The distal fragment in midshaft fractures often externally rotates, decreasing the obligatory clavicle posterior rotation and scapular posterior tilt during arm elevation. Acromioclavicular separations disrupt the strut function and allow a “third translation,” in which the scapula translates inferior to the clavicle and medial on the thorax.

---

## 14.5 Treatment Options

Since it is most frequently an alteration of muscle activation, scapular dyskinesia is traditionally treated with conservative efforts focusing primarily on restoration of muscle flexibility, strength, and restoration of activation patterns. Any surgically treatable conditions must be fixed as a precondition for scapular rehabilitation. Examples are scapular muscle detachment; high-grade acromioclavicular separations; shortened, rotated, or non-united clavicle fractures; acromioclavicular joint arthrosis; and intraarticular glenohumeral pathology, such as labral or biceps injury, or rotator cuff pathology. All of these problems create anatomic or physiologic limitations to normal scapular function. Treatment of scapular dyskinesia starts with optimized anatomy, locally around the scapula, distally in the glenohumeral and acromioclavicular joints and clavicle, and proximally in the kinetic chain. These alterations will have been discovered in the

evaluation process. Proximally, kinetic chain and core stability are key to optimal scapular kinematics. Most commonly, kinetic chain/core exercises are the first stage of scapular rehabilitation, followed by the restoration of scapular control, and end with strengthening of the rotator cuff and the larger muscles of the arm.

---

## 14.6 Rehabilitation

Functional tasks involving the scapula and shoulder most frequently are dependent upon appropriate functioning of the kinetic chain as a unit. This requires optimization of the individual kinetic chain segments and appropriate coordination of the individual segments. A typical progression to follow in order to assure each segment is optimized is (1) acquire flexibility of all segments involved, (2) establish core strength and stability, (3) facilitate critical kinetic chain links via sequential activation, (4) utilize a closed- to open-chain sequence of exercise, and (5) work in multiple planes. This progression has recently been described in detail [10]. A protocol template summarizing the appropriate exercises for each component is listed in Appendix A.

### 14.6.1 Acquire Flexibility

Flexibility of both the upper and lower extremity can be increased using various techniques and approaches with standard static, dynamic, and/or ballistic stretching being some of the options available to clinicians. Based on previous findings regarding flexibility deficits in upper extremity-dominant athletes, the hip extensor, flexor, and rotary muscle groups in addition to the knee flexor groups should be targeted for the lower extremity. Improving lower extremity muscle flexibility has been linked to improving lower body movement patterns and improving overall athletic performance. The muscles responsible for scapular stabilization and arm rotation specifically the pectoralis minor, latissimus dorsi, and posterior shoulder muscles should be the point of focus for the upper extremity.



### 14.6.2 Establish Core Strength

The local and global stabilizers of the trunk together provide optimal core stability. The larger global muscles (abdominal muscles, erector spinae, and hip abductors) are designed for power generation but also provide stability for upper extremity function. Core strengthening regimens have assisted clinicians in gaining strength of the pelvis and trunk muscles in patients with common ailments such as low back pain and shoulder impingement. In order to create a stable base, the rehabilitation protocols should focus on the local muscles (transverse abdominus, multifidi, abdominal obliques, and quadratus lumborum) which are responsible for segmental spinal stability and alignment. The core is the critical link between the development of and transfer of energy; therefore, an early focus on strength and stability is necessary for later stages of rehabilitation to be successful.

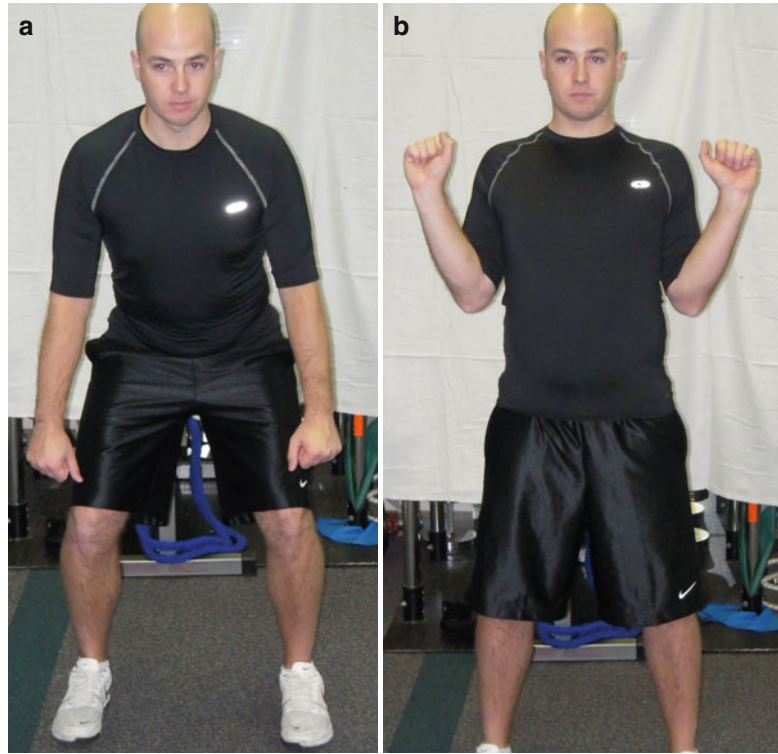
### 14.6.3 Facilitate Scapular Motion

Peri-scapular muscles such as the serratus anterior and lower trapezius should be a point of focus in early training and rehabilitation. Early training should incorporate the trunk and hip in order to facilitate proximal to distal sequencing of muscle activation. It is important to remember that scapular rotation is accessory in nature whereas scapular translation is physiologic or voluntary. Therefore, implementing exercises which attempt to isolate scapular rotation is not functional and should be discouraged. Utilizing the lower extremity in order to encourage scapular motion is ideal in that it mimics kinetic chain sequencing. Minimal stress is placed on the glenohumeral joint during hip and trunk extension which facilitates scapular retraction (Figs. 14.1 and 14.2). All exercises are started with the feet on the ground and involve hip extension and pel-



**Fig. 14.1** Sternal lift. This maneuver is performed standing with the trunk and knees slightly flexed (a). The patient is instructed to extend the hips and trunk and retract the scapulae without moving the glenohumeral joint (b)

**Fig. 14.2** Robbery exercise. The robbery maneuver begins with the knees and trunk flexed and the arms held away from the body (a). The patient is instructed to extend the hips and trunk and to “place the elbows in the back pockets,” holding this final position for 5 s (b)



vic control. The patterns of activation are both ipsilateral and contralateral [11]. Diagonal motions involving trunk rotation around a stable leg simulate the normal pattern of throwing (Fig. 14.3). As the shoulder heals and is ready for motion and loading in the intermediate or recovery stage of rehabilitation, the patterns can include arm movement as the final part of the exercise.

Excessive scapular protraction does not allow optimal rotator cuff activation to occur. Rotator cuff strength can increase when the scapula is stabilized and retracted. The muscles responsible for performing scapular retraction can help control scapular protraction through eccentric control. When optimized, these muscles can properly maintain scapular stability thus decreasing excessive protraction with arm movement. For this reason, the early phases of training should focus on scapular strengthening in an attempt to restore normal scapular kinematics rather than placing an early emphasis on rotator cuff strengthening as performed in more traditional rehabilitation protocols.

#### 14.6.4 Early Closed-Chain Implementation

Kinetic chain-based rehabilitation activities have been grouped into open and closed chain. Typically, when soft tissue is pathologic, closed-chain exercises are implemented early in the rehabilitation process. There are three components which make usage of closed kinetic chain exercise advantageous in early rehabilitation. First, the exercise environment can be controlled. This allows the focus to be taken away from the arm as an integrated unit with high dynamic demands and place it in a stable, axially loaded, static setting. Second, closed-chain exercise is ideal for working “at” specific ranges of motion compared to working “through” a range of motion. Finally, closed-chain exercise allows the rotator cuff and scapular musculature to be unloaded by decreasing the amount of force generated and stress applied to the involved soft tissue. These types of exercises are best suited for reestablishing the proximal stability and control in the links of the kinetic chain such as the pelvis



**Fig. 14.3** Lawn mower exercise. The lawn mower begins with the hips and trunk flexed and the arm slightly forward elevated (a). The patient is instructed to extend the hips and trunk, followed by rotation of the trunk to facilitate scapular retraction (b)



and trunk. Open-chain exercises, which generate greater loads in comparison to closed-chain activities, should be utilized later in rehabilitation programs due to their increased demand on the soft tissue due to the longer arm levers these exercises require.

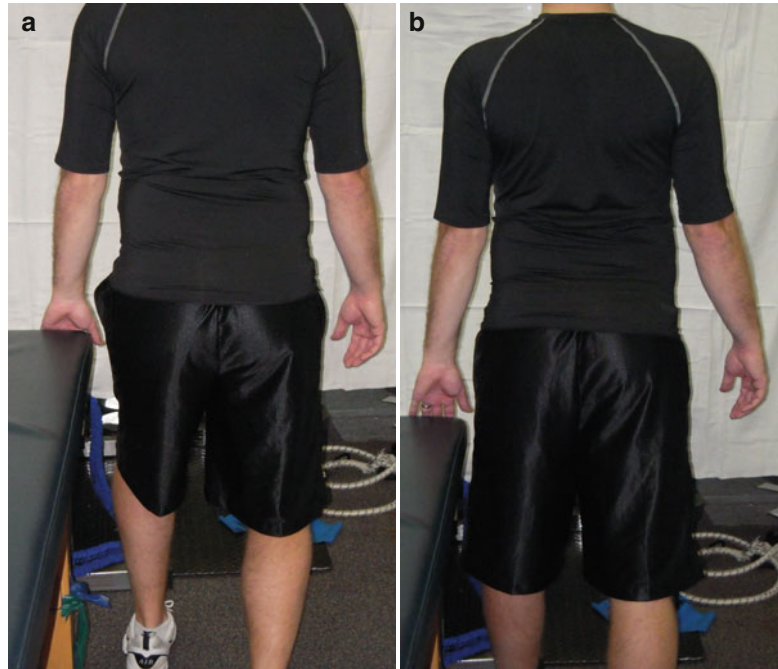
The rationale behind the closed-chain framework is to maximize the ability of the inhibited muscles to activate. This involves placing the extremity in a closed-chain position, emphasizing normal activation patterns, and focusing on the muscle of interest by deemphasizing compensatory muscle activation. For example, if a patient presents with shrugging during arm elevation, then it can be assumed that the lower trapezius and/or serratus anterior is not working effectively enough during the dynamic task. A closed-chain exercise such as the low row should be utilized

because the short-lever positioning in conjunction with the pelvis and trunk acting as the driver facilitates lower trapezius and serratus anterior co-activation which decreases the activation of the upper trapezius (Fig. 14.4). This is the normal muscle activation pattern for scapular retraction and depression. Once the normal activation pattern has been restored, then more challenging isolated exercises can be employed.

### 14.6.5 Work in Multiple Planes

Strengthening and stabilization should begin by emphasizing work in successful planes and then progress to deficient planes. Clinicians should avoid the use of single planar exercises which isolate specific muscles or specific joints. Greater

**Fig. 14.4** Low row exercise. The patient is positioned standing with the hand of the involved arm against the side of a firm surface and legs slightly flexed (**a**). The patient should be instructed to extend the hips and trunk to facilitate scapular retraction and hold the contraction for 5 s (**b**)



isolation should be utilized in the later stages of the rehabilitation protocol. During the early phases, emphasis should be placed on achieving successful positions, motions, and muscle activation sequences. In this manner, normal physiologic activations are restored, which lead to restoration of normal biomechanical motions.

Most activities, whether they are sports-related or normal daily movements, occur in the transverse plane. Therefore, the transverse plane should be exploited particularly in the early phases of rehabilitation. The protocol should progress to more unilateral planes as normal scapulohumeral kinematics are restored. Exploitation of the transverse plane and exaggeration of trunk motion help accentuate both scapular retraction and protraction. By forcing proximal stability, the hip and trunk muscle activations, which have been demonstrated to precede arm motion, will be more effective during a specified task (Fig. 14.5). In addition to generating and transferring energy to the distal segments, this component of rehabilitation allows the utilization of the stable base for arm motion and

forces the lower extremity and core to drive the arm (Figs. 14.6 and 14.7). Rehabilitation programs should attempt to encourage stimulation of proper proprioceptive feedback as well, so the patient can return to their desired level of function.

---

#### 14.7 Advantages/Pitfalls/Complications

The primary advantage of considering scapular function as a component of overall shoulder function is that scapular considerations allow the clinician to employ a comprehensive approach of assessment and treatment. Such an approach helps to eliminate placing sole focus on the site of symptoms and instead direct attention toward potential causes of symptoms and/or dysfunction. Adhering to the kinetic chain model of function is also helpful in appreciating the influence the scapula can have on arm function because of the understanding of segmental motion and energy transfer.

**Fig. 14.5** (a, b) Lawn mower with lateral step. By adding the step, the patient is forced to utilize the hip abductors making the exercise more functional



However, dyskinesia is nonspecific and as a result can be either overlooked as a potential impairment or mistakenly thought to be a pathologic entity. It is challenging to reestablish activation patterns and strength. To effectively re-create optimal muscle activation patterns, clinicians must have an intimate understanding of adequate scapular kinematics as well as an appreciation of kinetic chain function. This necessary knowledge has been absent for some time but has just recently become available through published consensus statements developed by experts in scapular function [3, 9]. Prior to these publications, clinical expertise in evaluating and managing the scapula had been lacking. In order to restore scapu-

lar stability, the serratus anterior and lower trapezius muscles should be addressed during rehabilitation. Strengthening these muscles will allow maximal rotator cuff strength to be achieved off a stabilized, retracted scapula. However, contrary to traditional rehabilitation philosophies, rotator cuff emphasis in rehabilitation should be after scapular control is achieved. Increase in impingement pain when doing open-chain rotator cuff exercises indicates the wrong emphasis at the wrong stage of the rehabilitation protocol. Additionally, muscle strength is typically developed over the span of 4–6 weeks, so adequate time must be allotted for regaining the necessary strength for functional scapular stabilization.

**Fig. 14.6** (a, b) Robbery exercise with posterior step. Utilizing the step allows the lower extremity to drive the upper extremity



## 14.8 Experience in Treatment of Athletes

Athletes tend to have scapular alterations often as a result of sports-specific demands. This has been shown repeatedly in overhead athletes involved in baseball, softball, tennis, and swimming. In some cases, these alterations can be considered positive adaptations such as the bony remodeling of the humerus in skeletally immature leading to increased external rotation in cocking which results in greater development of velocity. However, not all adaptations lead to positive results. Scapular dyskinesia can develop as a result of focusing exclusively on larger muscles during strengthening programs rather than comprehensive regimens. Additionally, the repetitious nature of overhead athletics has short- and long-term effects on the soft tissue of the shoulder with acute

decreases in glenohumeral internal rotation, horizontal adduction, and total range of motion. Loss of motion in one or more of these directions can affect scapular function and lead to future injury. Routine implementation of stretching and strengthening maneuvers which target the surrounding soft tissue of the scapula and glenohumeral joint, both preemptively and post-activity, can be effective at reducing the occurrence of injury.

Another consideration is that muscle endurance can be lacking in overhead athletes. General arm pain not generated by disrupted anatomy or kinetic chain deficit suggests that the extremity is not conditioned to handle the required repetitive tasks, is being used too often, or is being used incorrectly. Implementing conditioning programs which are designed to build muscle endurance, i.e., low-load, high-repetition programs, may help increase the necessary muscle endurance.



**Fig. 14.7** (a, b) Low row with posterior step. The posterior step back requires hip and trunk extension which facilitates scapular retraction and depression



However, even when muscle physiology has been optimized, excessive use without appropriate recovery time can lead to muscular fatigue which in turn decreases muscular activity and force production, subsequently causing biomechanical abnormalities (decreased cocking, dropped elbow), all of which can result in pain or soreness. Adequate rest and recovery should be allotted in order for muscular function to be less affected by the stress of physical activity. Finally, kinetic chain function should be integrated throughout all rehabilitation and conditioning programs. From the early phases of rehabilitation through the functional phases of sports-specific conditioning, utilization of the kinetic chain encourages adequate muscle activation, proper motor pattern development, and optimal performance output.

The scapula plays multiple key roles in normal scapulohumeral rhythm and shoulder func-

tion. Alterations of scapular resting position and dynamic motion, collectively termed scapular dyskinesia, are associated frequently with many shoulder injuries in throwing athletes. The clinical exam for presence or absence of scapular dyskinesia as well as physical impairments within the kinetic chain is best achieved through observational assessments. If scapular dyskinesia is present, corrective maneuvers may be used to determine the effect of dyskinesia on shoulder symptoms. If deficits within other segments of the kinetic chain exist, they should also be addressed as part of the comprehensive rehabilitation regimen for treating scapular dysfunction. Scapular control in a position of retraction, external rotation, and posterior tilt should be a key determinant of return-to-play status and should therefore be optimized prior to releasing athletes to their respective activities.

## 14.9 Appendix A: Kinetic Chain-Based Scapular Strengthening Guidelines

### 14.9.1 A.14.1 Phases of Rehabilitation

#### 14.9.1.1 A.14.1.1 Phase I: Acute Phase (Weeks 1–2)

##### Pearls

- Acquire flexibility
  - Upper extremity
    - Sleeper stretch (posterior shoulder muscles)
    - Open book stretch (pectoralis muscles)
    - Corner stretch (pectoralis muscles)
    - Door frame stretch (latissimus dorsi)
  - Lower extremity
    - Hip rotation
    - Hip extension
    - Hip flexors
    - Other maneuvers as needed
  - Manual joint mobilizations permitted as allowed by tissue integrity
- Establish core strength and stability
  - Lower extremity strengthening focusing on hip abduction and extension recommended
    - Lateral step
    - Step downs
    - Lunge progression
    - Physioball exercises

##### Goals

- No limitations of muscle or capsular tightness
- Establish trunk/hip motion and strength for quality scapular motion later

#### 14.9.1.2 A.14.1.2 Phase II: Recovery Phase (Weeks 3–5)

##### Pearls

- Facilitate critical kinetic chain links
  - Facilitate retraction
    - Lawn mower (Fig. 14.3)
    - Robbery (Fig. 14.2)
- Utilize closed- to open-chain exercise
  - Closed chain
    - Table slides (for integrated motion)
    - Low row (Fig. 14.4)
    - Inferior glide (Fig. 14.8)



**Fig. 14.8** Inferior glide. This maneuver encourages co-contraction of local and global muscles resulting in depression of the humeral head

- Open chain
  - Low row with step back (Fig. 14.7)
  - Lawn mower with step back (Fig. 14.5)
  - Robbery with step back (Fig. 14.6)

##### Goals

- Lower extremity driving upper extremity motion
- Full active range of motion
- Adequate scapular control to progress to longer-lever exercise maneuvers

#### 14.9.1.3 A.14.1.3 Phase III: Functional Activity Phase (Weeks 5±)

##### Pearls

- Work in multiple planes
  - Integrated motion
    - Punching
    - Power position (Fig. 14.9)
    - Power position with step back (Fig. 14.10)
  - Traditional rotator cuff exercises
    - Scaption
    - Horizontal abduction
    - Internal and external rotation

##### Goals

- Fine-tune scapular motion to alleviate all dyskinesia
- Increase strength and endurance of rotator cuff and scapular stabilizing muscles



**Fig. 14.9** Power position. The athlete is positioned standing with dominant arm in 90/90 position and forearm pronated (**a**). The athlete is instructed to rotate the trunk without moving the feet while maintaining the 90/90 position of the arm (**b**). The forearm should be allowed to supinate to imitate the act of the overhead throwing



**Fig. 14.10** (a, b) Power position with step back. This maneuver requires stability of the lower extremity in order for the upper extremity positioning to be achieved



## References

1. Kibler WB. The role of the scapula in athletic function. *Am J Sports Med.* 1998;26:325–37.
2. Kibler WB, Ludewig PM, McClure PW, Michener LA, Bak K, Sciascia AD. Clinical implications of scapular dyskinesis in shoulder injury: The 2013 consensus statement from the “scapula summit”. *Br J Sports Med.* 2013;47:877–85. doi:10.1136/bjsports-2013-092425.
3. Kibler WB, Ludewig PM, McClure PW, Uhl TL, Sciascia AD. Scapula summit 2009. *J Orthop Sports Phys Ther.* 2009;39(11):A1–13.
4. Kibler WB, Sciascia AD. Current concepts: scapular dyskinesis. *Br J Sports Med.* 2010;44(5):300–5. doi:10.1136/bjism.2009.058834.
5. McClure PW, Michener LA, Sennett BJ, Karduna AR. Direct 3-dimensional measurement of scapular kinematics during dynamic movements in vivo. *J Shoulder Elbow Surg.* 2001;10:269–77.
6. McClure PW, Tate AR, Kareha S, Irwin D, Zlupko E. A clinical method for identifying scapular dyskinesis: part 1: reliability. *J Athl Train.* 2009;44(2):160–4.
7. McMullen J, Uhl TL. A kinetic chain approach for shoulder rehabilitation. *J Athl Train.* 2000;35(3):329–37.
8. Sciascia A, Cromwell R. Kinetic chain rehabilitation: a theoretical framework. *Rehabil Res Pract.* 2012;2012:1–9.
9. Sciascia AD, Thigpen CA, Namdari S, Baldwin K. Kinetic chain abnormalities in the athletic shoulder. *Sports Med Arthrosc Rev.* 2012;20(1):16–21.
10. Tate AR, McClure PW, Kareha S, Irwin D, Barbe MF. A clinical method for identifying scapular dyskinesis: part 2: validity. *J Athl Train.* 2009;44(2):165–73.
11. Uhl TL, Kibler WB, Gecewich B, Tripp BL. Evaluation of clinical assessment methods for scapular dyskinesis. *Arthroscopy.* 2009;25(11):1240–8.