Managing Scapular Dyskinesis

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KEYWORDS

• Scapula • Rehabilitation • Kinetic chain • Motor control

KEY POINTS

- The scapula plays significant roles in developing task-specific kinematics for optimal shoulder and arm function.
- Scapular dyskinesis, defined as an alteration of scapular position at rest or upon dynamic motion, is not a specific diagnosis or an injury by itself, but an impairment of normal kinematics, and can be observed in association with most shoulder injuries.
- Scapular dyskinesis has multiple pathoanatomical and pathophysiological causative factors, all of which can be evaluated by standard clinical testing through a step-wise evaluation process.
- It is recommended clinicians allow the examination to guide the treatment. Addressing impairments such as immobility and decreased strength may be necessary, but motor control enhancement should be considered as well.

INTRODUCTION

The scapula is an integral segment in the proximal to distal kinetic chain system that creates task-specific positions and motions for shoulder and arm function. Recent studies have produced information that more precisely characterizes normal and abnormal scapular mechanics, develops more effective methods of clinical evaluation, better categorizes the causative factors of abnormal scapular kinematics, and outlines more efficacious intervention protocols that will guide functional rehabilitation. This article provides an overview of the information and highlight clinical applications.

BACKGROUND

Scapular Function

Optimal scapular function is a key component of all shoulder and arm sports, work, and everyday activities. Normal scapular position and motion are foundational for

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the achievement of its roles. The overall purposes of scapular motion are to optimize the dynamic task-specific balance between scapular stability and scapular mobility.[1] Scapular stability provides a stable base for optimal activation of the scapular-based muscles, a stable fulcrum for arm function as a first-class and third-class lever, and stability against the loads and momentum of arm motion. Scapular mobility provides a dynamic socket for optimal glenohumeral (GH) joint ball and socket kinematics, creating maximal concavity/compression and dynamic GH stability throughout the whole arm motion, results in positioning the arm and hand in three-dimensional space for function, and moves the acromion for optimal arm elevation.

Scapulohumeral rhythm (SHR) is the mechanism for optimal shoulder and arm function. Efficient SHR underlies efficient arm function, whereas alterations in SHR affect effective arm function and increase injury risk. The coupled motion is a ratio between individual scapular and humeral motions during arm movement in elevation. The average ratio between scapular rotation and humeral rotation over the whole arm motion up to maximal elevation is 1:2 but will vary from 1:1 to 1:4 depending upon the phases of scapular and arm motion.

Coupled motions create all SHR and arm functions[2] There are four phases of scapular motion with arm motion. Phase 1 involves setting the scapula and occurs during 0° to 30° of arm elevation. This creates the initial placement of the scapula on the thorax to optimize further and later arm motions. The primary muscle activation for motion is the serratus anterior. The SHR ratio is 1:4.

Phase 2 involves scapular rotation and occurs during 30° to 100° of arm elevation. This results in mainly upward rotation in three-dimensional task-specific patterns. The primary muscle activation for mobilization is the serratus anterior, and for control and stabilization is the trapezius. The instant center of rotation is at the medial scapular spine. The SHR ratio is 1:1.

Phase 3 involves scapular rotation at or above 100° arm elevation. This results in mainly rotation along the long axis of clavicle. The muscle activations to produce this rotation are the serratus anterior and trapezius. The force transducers to produce this rotation are the coracoclavicular (CC) and acromioclavicular (AC) ligaments. The instant center of rotation moves along the clavicle to the AC joint. There is little SHR rotation. This phase mainly positions the scapula to act as a base for GH function.

Phase 4 is characterized by controlled dynamic scapular stability at or above 100°. The exact position is dependent upon the required tasks and demands for function. The scapula performs as a stable base for GH function, optimizing concavity/compression and muscle activation. At this level, the most effective single scapular position and motion for arm function is stabilized retraction, consisting of external rotation, posterior tilt, and upward rotation. For dynamic overhead, activities-controlled protraction is also required to respond to the eccentric activities experienced during throwing.

Scapular Dysfunction (Dyskinesis)

Most scapula-related shoulder dysfunction can be traced to the loss of control of the normal resting scapular position and dynamic scapular motion, which results in alterations in position or motion that produce a position and motion of excessive protraction.[3] The altered scapular position at rest has been described as the *S*capula malposition–*I*nferior medial border prominence–coracoid pain–scapular dyskinesis (SICK) scapula.[4] Altered dynamic motion is called scapular dyskinesis (the term combines *dys* [alteration of] and *kinesis* [motion]). Scapular dyskinesis is characterized by medial or inferomedial scapular border prominence, early scapular elevation or shrugging when the arm is elevated, and rapid downward rotation when the arm is lowered.[3–5] The salient clinical manifestation of the dyskinetic scapula is protraction.

Dyskinesis represents an alteration of scapular position and/or motion that may create an impairment of the ability to achieve the scapular roles. It is not a specific injury or a musculoskeletal diagnosis. Dyskinesis may be a clinically insignificant finding, with as many as 27% of identified alterations of kinematics not associated with clinical symptoms.[6] However, it is considered clinically significant when it is identified in association with symptoms and arm dysfunction.[5,7] Whether associated with symptoms or not, protraction is an unfavorable position for almost all shoulder functions and may increase the risk for subsequent injury. If it is shown on exam in the symptomatic patient or in someone who anticipates high loads during overhead activities, one of the goals of treatment or conditioning should be regaining static and dynamic retraction capability.

Multiple causative factors have been identified that can affect the static position or dynamic motion control and result in the observation of dyskinesis. These can be grouped into alterations in anatomy (pathoanatomy) or alterations in muscle activation, flexibility, or strength (pathophysiology).

Pathoanatomical causative factors include:

- Clavicle fracture
- Scapular body, glenoid fracture
- AC joint injury
- GH joint internal derangement (labral injury, GH instability, biceps tendon injury, GH arthritis, adhesive capsulitis)
- Rotator cuff injury
- Post-traumatic scapular muscle injury
- Snapping scapula
- Neurologic injury (long thoracic nerve, spinal accessory nerve, dorsal scapular nerve, cervical radiculopathy)

Pathophysiological causative factors include:

- Soft tissue tightness (pectoralis minor, upper trapezius, latissimus dorsi, biceps, posterior GH capsule, posterior shoulder muscles
- Muscle weakness, inhibition-common by themselves or associated with pain generators (serratus anterior-weak, inhibited-develops early in scapular injury, lower trapezius-weak, altered activation, rotator cuff-impingement, weakness, imbalance, core weakness-seen in as many as 50% of cases of dyskinesis, loss of voluntary control-altered activation-seen early in patients with periscapular pain of any origin).

Frequently dyskinesis related to a pathoanatomical cause will have elements of pathophysiology that will need to be addressed in addition to restoring the anatomy.

PREVALENCE/INCIDENCE

The exact incidence of clinically significant scapular dyskinesis is not known. There are many reasons for this deficit, including different methods of definition and evaluation of dyskinesis, differences in targeted populations, and reliance on clinical methods of qualitative observational examination, which may lead to variable measurements. Most studies point to a high incidence of dyskinesis in populations that require repetitive overhead motions in their activities.[8] Sports including baseball, tennis, swimming, volleyball, cricket, kayaking, and surfing have shown an incidence of

30% to 70% dyskinesis.[9–15] Studies in symptomatic patients reveal an incidence between 64% and 100% depending on the anatomic diagnosis.[16]

PATIENT EVALUATION OVERVIEW

Because of the complexity of the possible scapular positions and motions in function and dysfunction, the scapula's role in the kinetic chain, and the multiple possible causative factors for dyskinesis, the clinical evaluation will need to be a step-wise, comprehensive process, using screening tests and maneuvers and employing more in-depth examination to evaluate the deficits identified by the screening tests. It should evaluate not only for the pathoanatomy, but also for the pathophysiology. It is a three-step process (**Fig. 1**). The first is the establishment of the presence or absence of dyskinesis, using the scapular dyskinesis test.[17,18] The second is establishing the relationship between the observed dyskinesis and the clinical symptoms using the corrective maneuvers, the Scapular Assistance Test (SAT) and the Scapular Retraction Test (SRT) and the Low Row maneuver.[5,7,19] The third is the evaluation of the possible causative factors, using standard testing.

Determination of the presence or absence of dyskinesis can be accomplished through observational evaluation of resting and dynamic scapular motion and position.[20] The patient's resting posture should be checked for side-to-side asymmetry and especially for evidence of a SICK position or inferomedial or medial border prominence. Clinical testing is performed by visual observation of static position at rest with arms at the side and dynamic arm motion using the Scapular Dyskinesis Test (SDT) (**Fig. 2**).[17,18] The exam is conducted by having the patients raise the arms in forward

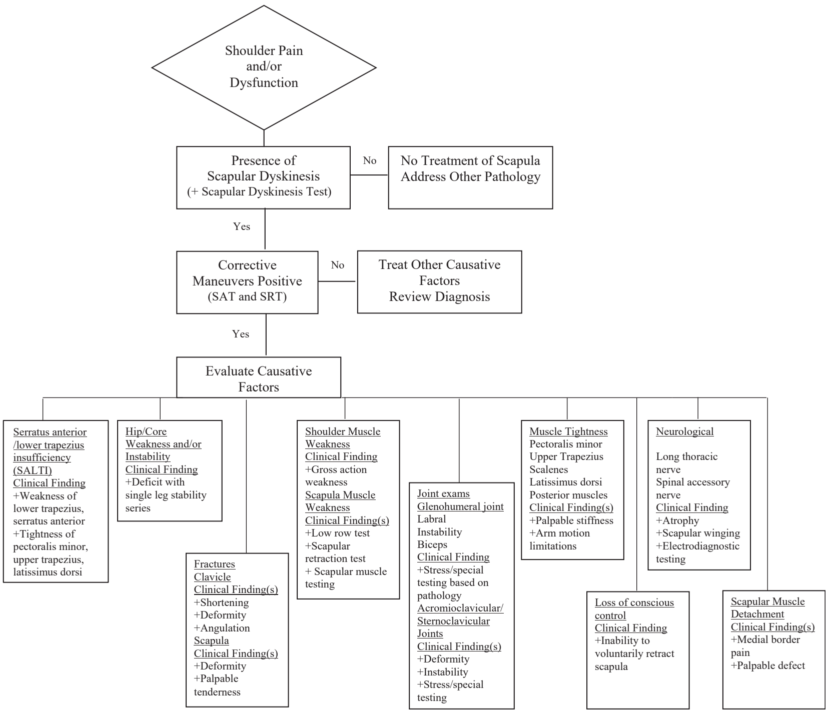

Fig. 1. Scapular examination algorithm.

flexion to maximum elevation, and then lower them three to five times. If the clinician is unsure the movement is altered or asymmetric, placing 3- to 5-pound weights in each hand can help accentuate possible alterations of motion.[17,18] Prominence of any aspect of the medial scapular border or inferior angle on the symptomatic side is recorded as “yes” (prominence detected) or “no” (prominence not detected).[20] The relationship of the dyskinesis to the clinical symptoms can be assessed through the scapular correctives maneuvers, the SAT, the SRT, and the Low Row Test.

In the SAT, the examiner applies gentle pressure to assist scapular upward rotation and posterior tilt as the patient elevates the arm (**Fig. 3**). A positive result occurs when the painful arc of impingement symptoms is relieved, and the arc of motion is increased. In the SRT, the examiner grades flexion strength using standard manual muscle testing procedures or evaluates labral injury in association with the modified dynamic labral shear test.[21] The examiner then places and manually stabilizes the scapula in a retracted position (**Fig. 4**). A positive test occurs when demonstrated flexion strength is increased or the symptoms of internal impingement related to possible labral injury are relieved in the retracted position. The Low Row Test can be used to assess the integrity of the lower trapezius and serratus anterior muscles.[22] To perform this maneuver, the patient is standing with the involved arm resting at the side with the palm facing posteriorly. The patient is instructed to extend their trunk and push their hand maximally against an examiner’s resistance in the direction of shoulder extension and instructed to retract and depress the scapula (**Fig. 5**). This maneuver assesses both muscles’ ability to actively stabilize the scapula while providing the examiner a visual depiction of lower trapezius muscle contraction. Although a positive SAT, SRT, or Low Row is not diagnostic for a specific form of shoulder pathology, it shows that scapular dyskinesis is involved in producing the symptoms, and that more detailed evaluations should be done to discover the causative factor(s) and indicates the need for early scapular rehabilitation exercises to improve scapular control.

The evaluation for the causative factors uses standard physical exam testing procedures. A general guide would include:

- Screening evaluation for hip/core stability and strength, using one leg stance and one leg squat evaluation
- Observation and palpation for medial scapula border tenderness and/or muscle defect
- Testing for periscapular and shoulder muscle voluntary activation and strength and ability to fully retract the scapula, using standard clinical tests
- Flexibility testing for commonly tight muscles including pectoralis minor, upper trapezius, and latissimus dorsi
- GH joint testing, including alteration of internal and external and horizontal adduction/abduction range of motion, anterior and posterior instability, labral injury, biceps injury, and rotator cuff disease, using standard exam techniques
- Clavicle, AC, and sternoclavicular joint evaluation for joint stability and bone shortening, angulation, or malrotation
- Neurological evaluation

The patient evaluation pathway can identify the pathoanatomical and pathophysiological factors underlying the observed alterations of position and motion. An unpublished study of 462 consecutive patients with shoulder pain who met the algorithm stage 1 and stage 2 criteria revealed that 35% of the patients had a pathoanatomical basis for their dyskinesis, whereas 65% had a pathophysiological basis. These findings suggest two-part outcomes result for patients with observed scapular dyskinesis that can be linked to the clinical symptoms. Treatment for those patients whose

Fig. 2. Example of scapular dyskinesis with medial border and inferior angle prominence.

dyskinesis is secondary to identified pathoanatomy may include rehabilitation but frequently will require surgical means of restoration of the anatomy. Those whose dyskinesis is secondary to pathophysiology will need a comprehensive evaluation process to understand the muscular alterations that will serve as the basis for treatment.

SURGICAL TREATMENT

Many dyskinesis cases resulting from pathoanatomical causative factors may need restoration of the optimal anatomy to help create the proper mechanics. In addition, criteria for return to play or work should include the demonstration that normal scapular kinematics are present.

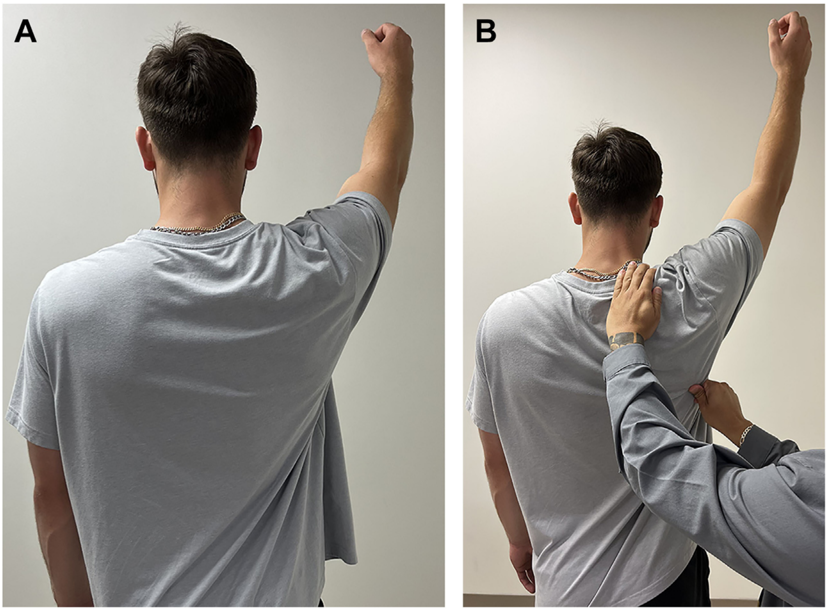

Fig. 3. Scapular Assistance Test (SAT)—The patient actively elevates the arm (*A*) then the scapula is stabilized with one hand and the other hand "assists" the scapula through its correct motion plane (*B*).

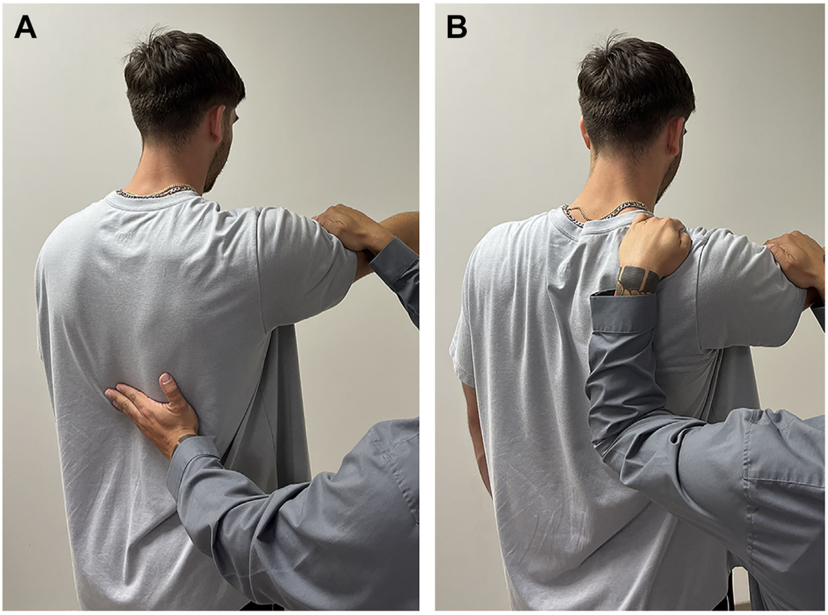

Fig. 4. Scapular Retraction Test (SRT)—The examiner first performs a traditional flexion manual strength test (*A*). The examiner stabilizes the medial border of the scapula and repeats the test; if the impingement symptoms are relieved and strength improved, the test is positive (*B*).

Neurologically Based

Surgery may be indicated for a patient with long thoracic nerve palsy after 1 year of symptoms and functional deficits, with no sign of recovery. Transfer of the sternocostal head of the pectoralis major has been the most successful procedure, with generally favorable results.[23] The selected portion of the tendon is reflected from its insertion on the humerus, tunneled ventral to the scapula, and attached to the inferior angle of the scapula by one of several techniques. The tendon length generally requires augmentation with fascia lata or other graft for length. Surgery for spinal accessory nerve palsy surgery can be considered if nonsurgical management is unsuccessful. In the Eden-Lange transfer, which is intended to provide a dynamic medial and superior restraint, the levator scapula and rhomboids are transferred approximately 5 cm laterally and secured through drill holes to improve mechanical advantage and a substitute for trapezius function.[24] A recent modification of the Eden Lange transfer, which involves a more superior transfer of the rhomboids and more closely replicates the direction of pull of the lower trapezius, has been shown to have superior outcomes.[25]

Snapping Scapula

Snapping scapula is a descriptive term for painful crepitus along the medial scapular border during arm motion. Alterations in normal SHR underlie most incidences of snapping scapula.[26,27] but through creating increased compressive pressure along the medial border can produce pathoanatomy that contributes to the symptoms. Surgery may be indicated for a patient who has undergone a thorough but unsuccessful program of nonsurgical management. Good success rates have been reported with both open and arthroscopic techniques despite wide variance in techniques.[23,26]

Fig. 5. In the Low Row Test, the arm is slightly extended and first tested without gluteal contraction then followed up with re-testing with gluteal contraction.

INTRA-ARTICULAR INJURIES AND ROTATOR CUFF INJURIES

Glenoid labral, biceps, and GH instability cases, and rotator cuff injuries, should be addressed by standard surgical techniques. The restoration of the anatomy may result in restoration of the normal kinematics, but more frequently rehabilitation will be required to restore the normal muscle activation patterns that will restore the kinematics. In nontraumatic GH injuries, especially labral injuries, the dyskinesis that has been found in association with a large percentage of the cases will need to be addressed so that the altered kinematics will not result in subsequent re-injury.

ACROMIOCLAVICULAR JOINT INSTABILITY AND CLAVICLE OR SCAPULAR FRACTURES

Surgical treatment should be designed to reconstruct and re-establish the strut function of the clavicle and the coupled AC ligamentous structures that stabilize joint function and control scapular motion. Multiple techniques have been advocated, but the procedure of choice should address and restore the clavicular shortening and/or malrotation and the ligament integrity that creates three-dimensional AC pathomechanics resulting from the injury that can affect scapular kinematics. Restoration of the scapular position and motion should be one of the outcomes of the treatment.[28]

Post-Traumatic Scapular Muscle Injury (Scapular Muscle Detachment)

Scapular muscle detachment is an uncommon but very painful and debilitating injury that results from a tensile load on the scapular supporting muscles, mainly involving the lower trapezius and the rhomboids. Early recognition of this injury can result in early treatment which can minimize the deleterious effects of the chronic pain on patient outcomes.[29,30] If patients have failed an appropriate scapular rehabilitation program, surgical reattachment is indicated. This is accomplished by direct reattachment through pairs of drill holes in the medial scapular border and scapular spine.[29,31] The detached and scarred rhomboids are mobilized and reattached onto the dorsal aspect of the scapula approximately 1 cm from the medial edge. The lower trapezius is mobilized and reattached along the proximal scapular spine.

NONSURGICAL TREATMENT

Is This Nerve Related?

Scapular dysfunction accompanied by moderate to severe pain with overt scapular dyskinesis and limited use of the arm can be due to multiple factors. The most typical factors are neurological damage (long thoracic or spinal accessory nerve palsies), traumatic injury (detachment of one or more scapular muscles), or chronic adaptations from unresolved injury, impairment, or soft tissue dysfunction. In cases of scapular dysfunction with neurologically rooted causes, rehabilitation can be performed to restore some level of arm function. Conservative treatment is recommended as most cases of long thoracic nerve injury are neuropraxic and will recover spontaneously. Because the nerve is so long, however, the recovery may be up to two years. It is for this reason that standardized protocols are difficult to develop and recommend. A general guideline would be (1) Verify neurological injury with electrodiagnostic testing; (2) If electrodiagnostic evidence exists that nerve injury is present, modify activity for 2 to 3 months to reduce movements that would tax or traction the affected nerve(s) and only consider immobilization if the patient has the potential to be noncompliant with activity restrictions; (3) Perform follow-up electrodiagnostic testing to determine if the nerve injury is improving (Recovery can be followed clinically, or via serial electromyography studies conducted no more frequently than every 3 months); and (4) Begin rehabilitation cautiously taking care not to use long lever arm movements in the early phases of treatment. Approximately 80% of patients do well in the long term with resolution of the winging and normal flexion and abduction, however many patients still have pain at long-term follow-up.[32] However, if the conservative measures fail, surgical options, such as muscle transfers may need to be considered.

Is This Soft Tissue Related?

Detecting musculoskeletal impairments requires clinicians to use multiple examination components and results to compile a clinical profile for the identification of scapular dyskinesis. Clinicians are recommended to follow the philosophy that the examination should guide the treatment.[33,34] For example, if altered scapular motion is identified via the SDT, the clinician should initially identify the specific observable components (ie, medial border prominence and scapular body positioning) and simultaneously consider what is the likely cause of the alteration (ie, deficiencies in mobility, strength, and/or motor control versus overt anatomical injury). The additional examination components of the corrective maneuvers, mobility testing, strength testing, and kinetic chain testing would help the clinician better identify the contributing cause. Once the cause is identified, the treatment plan can be optimized to target the cause(s). Let’s consider the following case: A patient with shoulder pain has been noted to have scapular dyskinesis. The clinician observes the involved arm has a visible limitation of arm elevation (approximately 30° difference from the non-involved arm) and there is observed medial border and inferior angle prominence during the descent of the arm from the elevated position. The remainder of the examination reveals: palpable rigidity of the pectoralis minor, scapular movement during manual muscle testing of the serratus anterior and middle/lower trapezius both graded as 4/5, and negative special testing for all GH joint pathology. The combination of limited motion and a demonstrable strength decrease lead the clinician to suggest a treatment program focused on improving mobility and strength which based on the examination results would be an appropriate treatment pathway. However, the “how-to” of the treatment pathway should be considered.

Using this case as a guide, it would be common for interventions such as stretching, massage, and/or joint mobilization to be employed for addressing the mobility deficit while therapeutic exercises that have been shown to elicit high levels of muscle activity in specific muscles[35–37] to be used for addressing the strength deficit. However, various reports have noted that mobility and strength enhancement interventions have little influence on the scapular motion itself.[38–41] One point to consider is that mobility alterations are rarely acute in the scapula and/or shoulder. Although an acute decrease in GH rotation is common in overhead athletes following a throwing episode/exposure,[42–47] this phenomenon does not occur as often in the general population. Mobility deficits tend to manifest over time as it takes many weeks/months to create bony adaptations, capsular thickening, and various types of tendon responses to loading.[48] Although immediate gains in motion have been reported following the application of manual therapy interventions, the gains have not been shown to be long lasting.[49–57] The consensus within the literature is that these interventions positively impact pain and self-reported function which is more likely rooted in the neurophysiological effects related to endogenous pain control.[54] Thus, clinicians should educate patients that mobility interventions will likely be most effective when employed across multiple weeks and treatment sessions, and any immediate gains are likely not due to tissue correction/restoration.

When discussing therapeutic exercise selection, therapeutic exercises designed to target the specific shoulder and scapular muscles have been well described but these targeted exercises were primarily determined with electromyographic methodologies.[35–37,58–61] Although electromyography has helped identify which positions and maneuvers bias specific muscles, a common misconception from these results is that muscles can be isolated in rehabilitation. The complexities of shoulder/scapular architecture and movement do not allow any one muscle to be isolated during times of examination or treatment. Furthermore, various works have helped illustrate the summation of the activation phenomenon known as the kinetic chain which refutes the occurrence of isolated muscle activation.[62–70] Finally, the identified maneuvers were often performed in an isolated manner with the body in vertical or horizontal (prone or supine) stationary positions. These positions could lead to a less-than-optimal rehabilitation outcome likely due to the encouragement of inefficient or improper motor patterns.[7,71–75]

If mobility and strength are to be addressed during rehabilitation, there are additional guidelines to consider. A kinetic chain rehabilitation framework for shoulder dysfunction describes a rehabilitation approach that addresses mobility and strength but focuses on three critical characteristics.[76] First, patients perform exercises in upright positions rather than supine or prone positions to simulate functional demands. Second, the lever arm on the shoulder and trunk is shortened to reduce the load and torque on the injured arm. The exercises shown to elicit high amounts of muscle activity require the arm to be

Table 1
Nonoperative rehabilitation guidelines

Guideline	Key Points
Begin incorporating therapeutic exercise for addressing proximal segment control	Use exercises designed for leg and trunk/core strengthening Re-evaluate every few weeks to determine if strength is advancing
Employ exercises for scapular and shoulder mobility and/or lower extremity mobility as needed	Mobility can be addressed simultaneously with proximal segment control interventions Employ conscious correction (Fig. 6) with an appropriate type of feedback (visual, auditory, and/or kinesthetic)
Progress to short-lever interventions beginning with maneuvers that use trunk and leg motion to facilitate more optimal scapular positioning and mobility	These maneuvers will be performed sitting or standing and with the arm close to the trunk Examples: Low row (Fig. 7), Lawnmower with arm close to body (Fig. 8), Robbery (Fig. 9) Progress to the next guideline with visually observed improved scapular control and when patient can complete without early fatigue or symptom exacerbation
Phase out short-lever interventions and phase in long-lever maneuvers	Begin with maneuvers requiring the arm to be slightly flexed or abducted (approximately 30° to 45°) (Figs. 10 and 11) then transition to maneuvers with the arm at or above shoulder height (Fig. 12)

maintained in a set position throughout a range of motion and involve the arm to be further away from the body (also known as long lever exercises) thus increasing the demands on the muscles, that is, increased force output and torque generation.[61] Conversely, exercises that are performed with the elbow in 90° of flexion and/or with the arm close to the body (ie, short lever exercises) elicit lower levels of muscle activity and have decreased demands on the muscles.[22,77] Either long lever or short lever exercises are acceptable to use in rehabilitation however, the timing of implementation may cause different outcomes. Owing to the physical demands of long lever exercises, patients may experience irritation or soreness during or after the performance of the maneuvers when they are employed early in the rehabilitation process. In addition, it is also assumed that the greater demands require more effort be exerted to perform the exercises which may conflict with a patient attempting to establish scapular control. This could potentially create a situation where the patient becomes fatigued early in treatment sessions which in turn could cause the patient to use compensatory movement patterns during exercise performance. This would be counter-intuitive to the goal of establishing scapular control. Short lever exercises allow patients to focus on the stability function of the scapula and can often be performed with greater ease compared with long lever exercises. Finally, arm motions should be initiated using the legs and trunk to facilitate activation of the scapula and shoulder muscles, which is a typical motor pattern of motion. This framework has been previously described to include a set of progressive goals:[78] (1) establish proper postural alignment and motion; (2) facilitation of scapular motion via exaggeration of lower extremity/trunk movement; (3) exaggeration of scapular retraction in controlling excessive protraction; (4) use the closed chain exercise early; and (5) work in multiple planes.

Fig. 6. Conscious correction of scapula begins with the patient standing and being instructed to actively "squeeze your shoulder blades together." Utilization of mirrors or mobile devices can assist patients with visualizing correct scapular positioning.

The complexity of scapular motion and the integrated relationship between the scapula, humerus, trunk, and legs suggest a need to develop rehabilitation programs that involve all segments working as a unit rather than isolated components. Obtaining mobility early in the rehabilitation would in turn allow for more fluid, task-specific movements to occur. Furthermore, integrating the legs and trunk more often in the rehabilitation process (as allowed by the patient's impairments and/or injury) would closely mimic activities of daily living, sports, and work tasks. The integrated approach expands the traditional focus of mobility and strength to also include enhancements in motor control thus improving rehabilitation outcomes.

TREATMENT RESISTANCE/COMPLICATIONS

Consider a Motor Control Approach

The aforementioned treatment approach that centers on mobility and strength improvement has been described based on the concept of scapular dyskinesis being the result of soft-tissue deficiencies.[7,22,38,39,41,76–87] However, various reports have noted that mobility and strength enhancement interventions have little influence on the scapular motion itself.[38–41] In addition to the concerns of chronicity of tissue alterations and the immediate false-positive effects of manual therapy on mobility as well

Fig. 7. For the low row, 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*).

as using muscle activity studies as the sole evidence for selecting exercises for rehabilitation, a recent clinical review suggested motor control has been lacking as a point of focus in scapular-based rehabilitation programs with the motor control principle of feedback being overlooked most often.[33]

The type and amount of feedback a person receives during task performance can positively influence the outcome of the task.[75,88–90] In most upper extremity tasks, visual feedback is used for joint positioning and error correction. However, because the posteriorly positioned scapula cannot be visualized, it is possible that the lack of visual feedback leads to the alterations in motion that manifests as scapular dyskinesis. Previous reports have shown intentional attempts at repositioning the scapula before elevating and/or rotating the humerus, called conscious correction/scapular squeezing/scapular setting, increases scapular muscle activity and enhances scapular kinematics.[71,73,75] Most clinicians have used "scapular squeezing" as an exercise but experience has shown that little instruction beyond "squeeze your shoulder blades together" is rarely conveyed to the patient. It is quite common for patients to "shrug" or simply be unable to perform this maneuver correctly, forcing clinicians to closely

Fig. 8. Lawnmower with the arm close to body requires the patient to begin with the hips and trunk flexed and the arm held secure to the body (*A*). The patient is instructed to extend the hips and trunk, maintain the arm position next to the body, and followed by rotation of the trunk to facilitate scapular retraction (*B*).

monitor the motion for potential errant movements. It is possible that patients struggle with performing conscious scapular correction properly not only because of the scapula's posterior placement, but also because scapular motion is mostly characterized as accessory motion (ie, involuntary motion). Visual acuity is the strongest type of feedback humans use for knowledge of results, knowledge of performance, and overall motor control. Although non-adolescent patients can benefit from verbal external feedback provided by the clinician, there is a balance between too little and too much feedback that must be defined. Too little feedback does not inform the patient of occurring motion errors while too much feedback creates a dependency of the patient on the verbal feedback not allowing learning to occur.

In regard to scapular function, visual feedback,[91–95] auditory feedback,[91,92] and kinesthetic feedback[91,92] have been shown to positively influence scapular muscle activity and positioning. Considering the scapula as a "link" within the kinetic chain, the feedback approach may be better suited for re-establishing scapular control compared with the traditional mobility and strength focus as feedback relates to the

Fig. 9. Robbery maneuver begins with the knees and trunk slightly flexed (*A*) and is performed by instructing the patient to "place the elbows in the back pockets" (*B*).

sequential activation within the kinetic chain. Combining the kinetic chain approach described earlier with feedback serves as an integrated approach where the patient is required to perform exercises from a sitting or standing position to perform (and learn) the necessary motor patterns that require integrated use of the majority of the kinetic chain segments (ie, using the legs and trunk to facilitate scapular and shoulder movement and muscle activation).[22,77,96–99] However, there are no empirical reports or randomized control trials that have compared a motor control/kinetic chain focused program against a program that does not use this approach. To date, general guidelines for program development have been suggested including[33]:

- Short lever progression beginning with the arm close to the body and then progressively advancing the arm to angles further away from the body
- Sitting and standing preferred over prone or supine exercises
- Target impairments in the order of mobility, motor control, strength, and endurance but allow the examination to guide the treatment
- Use longer lever maneuvers later in the rehabilitation program
- Advance to plyometric-based maneuvers just before discharge

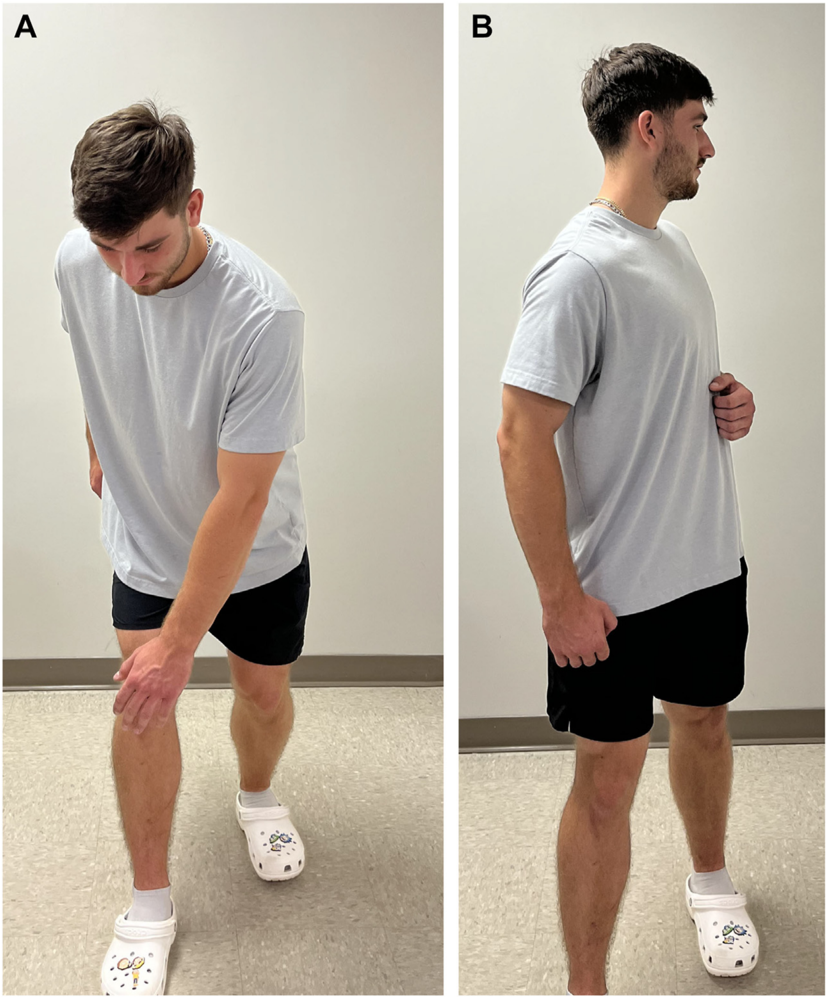

Fig. 10. Lawnmower begins with the hips and trunk flexed and the arm slightly forward elevated (*A*). The patient is instructed to extend the hips and trunk, followed by rotation of the trunk to facilitate scapular retraction (*B*).

A sample program has been provided in **Table 1**. Dosage recommendations include beginning with 1 to 2 sets of 5 to 10 repetitions with no external resistance. Additional sets and repetitions can be added based on symptoms and exercise tolerance, with a goal of 5 to 6 sets of 10 repetitions being able to be performed without an increase in symptoms before adding resistance. Resistance may be added next beginning with light free weights (2 to 3 pounds maximum) and then progressing to elastic resistance. The stability of free weights allows those devices to be used before elastic resistance because elastic resistance, although effective at increasing scapular muscle activity,[98] has high variability when used by patients, especially when arm position is progressed throughout a treatment program.[100] If elastic resistance were to be used, it can be adequately monitored and progressed using perceived exertion scales.[101] Feedback may be incorporated throughout the treatment program but there is not an exclusive

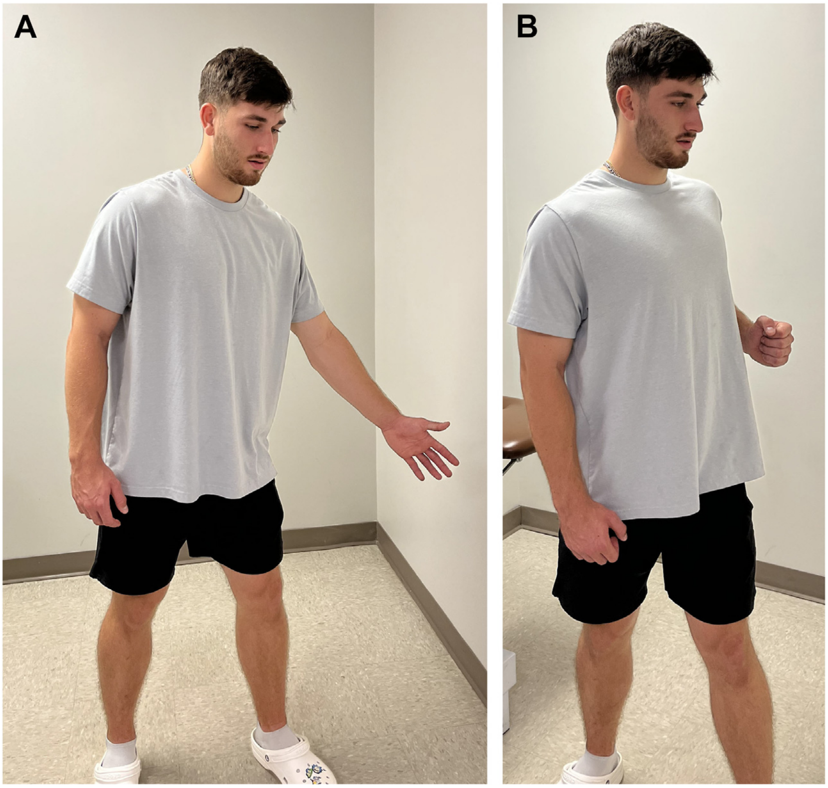

Fig. 11. Fencing maneuver begins in a standing position with the patient grasping resistance bands or tubing (*A*). It uses multiple kinetic chain segments to enhance proper muscle scapular muscle activation through activation of the legs, trunk, scapula, and arm (*B*).

type to recommend considering various forms of feedback have been shown to have positive clinical influence.[91–95] However, it should be noted that too much feedback can be detrimental to learning as the patient becomes reliant on the knowledge of performance.[88]

NEW DEVELOPMENTS

Although clinicians can become well trained at distinguishing between clinically significant and benign scapular dyskinesis,[17,18] the inherent flaw with observational analysis is the natural subjectivity of the assessment method. Multiple methods of quantitative analysis have been proposed but have not been found to be clinically useful due to lack of consistent reliability,[102,103] limitation of data to one scapular kinematic component,[104–107] large error of the data in relation to actual bone motion,[108–110] or inability to use the assessment method(s) in a clinical setting due to inconveniences of cost and set-up (bone pins, electromagnetic tracking, computed tomography scans).[111–114] As a result, even with the known limitations,[115,116] the visual observational method is still the most frequently selected by clinicians to identify the presence or absence of dyskinesis in the evaluation of the patient,[117] and to make generalized assessments of change during the treatment process. Precise and effective quantitative assessment of scapular motion in the clinical setting that encompasses all

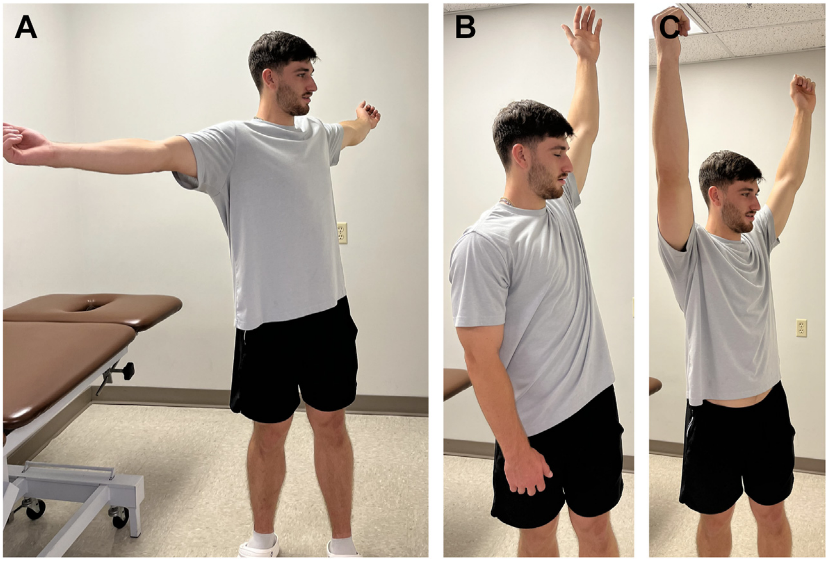

Fig. 12. T's, I's, and Y's with trunk rotation are standing rotator cuff exercises that begin with the patient in an upright position with the arms transitioning through abduction (*A*), forward elevation (*B*), and elevation in the plane of the scapula (*C*) while simultaneously performing trunk rotation.

scapular kinematic components of three-dimensional motion by a device that contains gyroscopic technology and/or a system of wearable sensors are currently being developed[118–123]; however, although psychometrics have been reported as being at acceptable levels, the novelty of the systems have not allowed for rigorous clinical testing to provide clinically useful recommendations at this time.

SUMMARY/DISCUSSION/FUTURE DIRECTIONS

Scapular dyskinesis is an impairment that has causative factors, and those factors should be discerned from a comprehensive physical examination. The examination should not exclude assessments related to identifying pathoanatomical causes but the pathoanatomical approach should not be the primary focus of the examination. Using clinician experience and the best available evidence, a qualitative examination for determining the presence or absence of a scapular contribution to shoulder dysfunction is currently the best option widely available to clinicians. Future investigations should attempt to standardize methodological approaches to perform better comparisons between studies and generate higher quality results. Finally, rehabilitation approaches should be reconsidered where enhancing motor control becomes the primary focus rather than primarily increasing mobility and strength.

CLINICS CARE POINTS

- Make the comprehensive diagnosis-rule in or rule out scapular dyskinesis in patients with shoulder or arm pain.
- Use the clinical pathway to develop the information needed to initiate the first treatment steps.

- Only one-third of the patients with demonstrated dyskinesis have a pathoanatomical cause for the dyskinesis. Pathophysiological causes, which can also create the altered kinematics need to be evaluated as well.
- Understand that demonstrated peri scapular muscle weakness may be secondary to inhibition rather than strictly a strength deficit.
- The complexity of scapular motion and the integrated relationship between the scapula, humerus, trunk, and legs suggest a need to develop rehabilitation programs that involve all segments working as a unit rather than isolated components.
- Addressing deficits in mobility and strength may be necessary but including motor control enhancement should also be considered.

DISCLOSURE

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