

A Comprehensive Approach to Non-operative Rotator Cuff Rehabilitation

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Abstract One of the primary conditions targeted in rehabilitation of the shoulder is rotator cuff injury. Multiple non-operative rehabilitation protocols have been described for the treatment of the spectrum of rotator cuff injury. Most protocols are implemented under the pretense of treating areas local to the site of symptoms. However, a comprehensive approach aimed at identifying all possible contributing factors can aid the clinician in developing impairment directed programs, which address the local dysfunction in addition to the distal contributions of injury. This approach focuses on deficits distal to the site of symptoms and provides early intervention to rectifying the impairments found in the body segments, which provide the foundation of support for the proper function of the shoulder segment. Correction of the alterations following a kinetic chain and scapular-based program should be included as part of the comprehensive treatment plan for rotator cuff injuries.

Keywords Rotator Cuff · Rehabilitation · Non-operative management

Introduction

In the presence of tissue derangement such as labral and rotator cuff injuries, symptoms can be reduced and function can be improved with non-operative treatment methods [1•, 2, 3•, 4]. The implementation of activity restrictions, physical modalities, and/or therapeutic exercise can improve demonstrated deficits (muscle weakness, muscle tightness, capsular restriction, etc.) as these are the modifiable components. However, it should be understood that a non-operative approach is dedicated towards addressing demonstrated anatomical deficits and not healing the actual tissue derangement.

There is a high prevalence of rotator cuff injury with a large majority of shoulder complaints being related to either direct involvement of the rotator cuff muscles or subacromial bursa [5]. Epidemiological studies have reported that 13–51 % of people over the age of 50 likely have a tear of at least 1 rotator cuff muscle but without the manifestation of symptoms or loss of function, and it has been shown that the prevalence of rotator cuff tears increases with age [6•, 7, 8•]. Similarly, at least 36 % of symptomatic shoulders have been shown to have rotator cuff involvement [8•]. This information suggests that in the presence of symptoms, loss of function cannot be entirely attributed to an anatomical lesion in the rotator cuff nor does the presence of a visualized lesion necessarily suggest that therapeutic intervention is warranted due to the high rate of lesions found in asymptomatic shoulders. In the event that rotator cuff injury has been diagnostically confirmed and physical activity becomes altered (activities of daily living or work/athletic tasks), then therapeutic exercise may be beneficial for attempting to restore the lost function as long as all contributing factors have been considered. This paper will present a framework of

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rehabilitation, which describes proximal and distal contributions that are considered to drive the functional loss, and offer a comprehensive approach to non-operative treatment of dysfunction in the context of rotator cuff injury.

Pitfalls of the Rehabilitation Process

Successful rehabilitation of rotator cuff injury can be impeded by various potential pitfalls. The first potential pitfall resides within the pathological terminology. Rotator cuff injury can be broadly classified as either impingement or tendinopathy, or narrowly classified as a partial or full-thickness tear. This semantic issue is seen not only in rotator cuff injury, but also in other conditions such as shin splints and lateral epicondylitis. The broad diagnosis of “impingement” does not point to a specific lesion or cause. Impingement is the collective term for shoulder pain with active motion in the absence of demonstrable lesion. As is the case with shin splints and epicondylitis, impingement findings can be related to a multitude of specific diagnoses which can include various types of muscle dysfunction (poor posture, scapular dyskinesis), internal derangement (labral injury, rotator cuff tear), instability, and/or bony changes (spurs and arthrosis) [9].

The diagnosis should be specific in order to properly direct the treatment. The identification of a specific lesion or condition causing the impingement helps a clinician to select certain interventions instead of others. For example, if impingement is occurring as a result of AC joint arthrosis, conservative treatment may be ineffective as the calcification of the joint would not be eliminated through conservative measures; while impingement due to scapular dysfunction can be remedied with scapular based strengthening exercises. Tendinopathy (chronic tendon changes due to a failed healing response following exposure to compressive and/or tensile loads [10]) has historically been successfully treated with high demand, eccentric exercise. However, attempting to reverse the tendon changes by specifically treating the rotator cuff muscles with eccentric exercise would have less than favorable results due to the long lever design of traditional rotator cuff exercises [11–13] which can continue to cause pain in already irritated muscle(s). Rehabilitation clinicians rely on accurate diagnoses and descriptions from referring physicians in order to implement the proper treatment. Therefore, a more consistent and detailed pathological description would be necessary to improve the rehabilitation outcome.

The second potential pitfall is treating the site of symptoms rather than the cause of the dysfunction. The symptoms most commonly associated with rotator cuff injury include shoulder pain at rest and with movement,

stiffness within the joint and surrounding muscles limiting motion, and generalized weakness when attempting to use the arm. Traditional treatment measures have included modalities for pain control, stretching and manual therapy to improve motion [14], and exercises shown to activate the rotator cuff muscles to improve strength [11, 12, 15]. However, considering that a large proportion of rotator cuff tears are asymptomatic, the presence of a lesion does not necessarily indicate that attention should be directed at the site of symptoms. Deficits in areas distant from the shoulder should also be considered, as impairments in these areas have been implicated as contributors to shoulder dysfunction [16••]. These deficits include scapular muscle weakness and imbalance, hip and pelvic muscle weakness and tightness, and improper muscle activation patterns [16••, 17]. When no other impairments are present, multifactorial anatomical considerations may be helpful at predicting success in the rehabilitation setting. It has been demonstrated that the anatomical factors which predict success in patients with rotator cuff injury include: quality tendon integrity, limited atrophy, absence of impingement signs, and external rotation $>52^\circ$ [18•]. If 3 of the 4 factors are present, successful non-operative rehabilitation can be achieved [18•].

Various rehabilitation protocols [19–22] and general guidelines [2, 23••, 24, 25] have been reported for the treatment of the spectrum of rotator cuff injury. The protocols and guidelines described in the literature are comprised of logical, progressive rehabilitation treatment plans which promote the use of stretching, manual therapy, scapular exercises, and rotator cuff exercises as individual interventions or in combination. The third potential pitfall is that the protocol designs and details surrounding the intervention programs do not follow identical progressions and are not comprised of identical treatment measures, making it difficult to determine which designs are most effective. For example, there are protocols which exclusively address strengthening the rotator cuff muscles in addition to the larger global muscles surrounding the shoulder [19, 26] while other protocols focus on improving the strength of the scapular stabilizers [14, 27]. Placing an early focus on the scapula may be beneficial as the scapula is a critical link in shoulder function and has been shown to be involved in multiple manifestations of rotator cuff injury including rotator cuff weakness [28], rotator cuff tendinopathy or impingement [29–32], and rotator cuff tears [28, 33, 34].

In the absence of dysfunction, the scapula allows a congruent ball and socket arrangement through the full range of arm motion by keeping the alignment of the humerus and glenoid within physiologic limits which maximizes the concavity/compression capability of the joint [35]. Optimized concavity-compression creates

symmetrical joint compression around the glenoid allowing the labrum to decrease peak joint loads and spread compression effects [36•]. The scapula also creates a stable base for optimal activation of the scapular based muscles. Studies in asymptomatic subjects have documented that maximal rotator cuff strength can be developed when the scapula is stabilized in a position of neutral retraction, rather than in excessive protraction or retraction which decreases rotator cuff strength >10 % [37]. In symptomatic subjects, stabilization of the scapula in retraction has been shown to increase rotator cuff muscle strength by 24 % [38, 39]. These changes result from improved stability of the scapula and from the facilitation of rotator cuff activation by increased muscle activation. Therefore, a comprehensive protocol encompassing both rotator cuff and scapular components may be beneficial [23••].

Separate systematic reviews have determined that while the current best available evidence appears to support the use of therapeutic exercise as a viable treatment option, critical appraisal results have shown that the methodological quality of the evidence is not high enough to make a conclusive remark about the effectiveness of exercise [23••, 40]. The final pitfall is discounting or discrediting the effectiveness of therapeutic exercise as there have not been enough controlled studies reported to warrant a definitive conclusion [3•].

A Comprehensive Approach

Evaluation of the Shoulder

Sequential activation of specific muscle groups resulting in the performance of a specific dynamic action is known as kinetic chain function [16••]. Upper limb tasks are initiated in the lower limb with the energy traveling through a progressive series of anatomical links (legs, pelvis, trunk, and scapula) and terminating at the arm [41, 42]. When designing a rehabilitation program for the treatment of rotator cuff injury, clinicians should identify all associated impairments both proximal and distal to the site of symptoms as deficits in the kinetic chain links can affect shoulder specific outcomes. The traditional clinical examination of the shoulder is designed to detect potential impairments/deficits in multiple joints and muscles local to the shoulder. This method often begins with an observational assessment of position and posture from multiple views. Next, gross glenohumeral motion is assessed both passively and actively and this is followed by an assessment of joint mobility and translation (typically the glenohumeral joint, acromioclavicular joint and sternoclavicular joint). Muscle strength as determined by manual muscle testing procedures [43] is performed with

the intent of detecting weaknesses in specific groups. It is important to note that muscle testing cannot isolate a specific muscle. Finally, special testing of the shoulder is performed by taxing and stressing specific structures with the intent of ruling in or ruling out specific pathology. As part of the comprehensive approach, a segment of observations and maneuvers directed towards the scapula and kinetic chain segments, known as the non-shoulder shoulder examination, should be employed [44].

Similar to the traditional shoulder examination, the first phase of the non-shoulder shoulder examination is to observe the resting position of the scapula. The scapula should be exposed for complete visualization and resting posture should be checked for side-to-side asymmetry. Scapular malposition manifests as medial border and/or inferior angle prominence. Identifying and marking the anatomical landmarks of the superior border, spine of the scapula and inferior angle can be helpful in visualizing scapular asymmetry.

Dynamic scapular motions may be evaluated by having the patient move the arms in ascent and descent 3–5 times. This will usually bring out any weakness in the muscles and display any resulting scapular dyskinesis (abnormal scapular motion). Motion in forward flexion is most likely to demonstrate medial border prominence. The addition of 3–5 pound weights will highlight the weakness even more. Prominence of any part of the medial border is recorded in a “yes” (present) or “no” (absent) fashion [45–47].

Two maneuvers known to identify the scapula’s involvement in shoulder pain are the scapular assistance test (SAT) and scapular retraction test (SRT). These tests are not designed to detect specific pathology but instead provide information about the role of scapular dyskinesis in the total picture of dysfunction that accompanies shoulder injury. The SAT helps evaluate scapular contributions to impingement symptoms and rotator cuff strength, and the SRT evaluates contributions to rotator cuff strength. In the SAT, the examiner applies gentle pressure to assist scapular upward rotation and posterior tilt as the patient elevates the arm. 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 the supraspinatus muscle strength following standard manual muscle testing procedures. The clinician then places and stabilizes the scapula in a retracted position. A positive test occurs when the demonstrated supraspinatus strength improves with the addition of the scapular retraction [38, 39].

To demonstrate the potential involvement of selected kinetic chain segments, evaluation of the legs and trunk is performed by screening the low back for lumbar lordosis, the pelvis for pelvic tilt, and the hip for rotational abnormalities. A previously described screening examination for

leg and trunk strength is the single-leg stability series (Trendelenburg and single leg squat maneuvers) [17].

Treatment of the Shoulder

One of the limiting factors in rotator cuff injury is the loss of function due to pain. It has long been suspected that pain occurs from tissue injury, which initiates the inflammatory response. To combat excessive inflammation and resultant pain, physicians have historically administered different variations of corticosteroids via injection including beta-methasone [48], methylprednisone [49–51], and triamcinolone [52–55]. Investigations into the efficacy of such measures for the treatment of rotator cuff disease have had mixed results leading a recent systematic review to conclude that current evidence does not show corticosteroid injection to be efficacious for the treatment of rotator cuff disease [56]. The review noted that the variation in results appears to be due to multiple confounding variables not consistently accounted for, including differences in population demographics, size and type of the tissue lesion, type of steroid used, and location of the injection administration site [56]. If any effect occurs, it is short in duration and does not completely resolve the dysfunction. Therefore, until methodological consistency is achieved, attempts to improve function in treating rotator cuff injuries should begin with noninvasive measures such as the correction of physical factors that have been shown to contribute to shoulder dysfunction.

Treatment decisions should be designed to eliminate the dysfunction by correcting the causes. If a lesion is present, then the clinician should avoid prescribing measures that could potentially advance the tissue injury. Interventions should be administered with the intent of improving overall function by optimizing all musculoskeletal links. This is known as kinetic chain rehabilitation where an attempt is made to restore the logical sequential series of muscle activations within the kinetic chain [57, 58••]. The ideal principles for integrated functional kinetic chain rehabilitation which help assure optimal functioning of each segment are: (1) establish proper postural alignment; (2) establish proper motion at all involved segments; (3) facilitation of scapular motion via exaggeration of lower extremity/trunk movement; (4) exaggeration of scapular retraction in controlling excessive protraction; (5) utilize the closed chain exercise early; and (6) work in multiple planes [58••].

Most postural concerns can be addressed through the implementation of known stretching techniques and joint mobilizations. Dosage will vary based on the extent of the flexibility or motion deficit. Ideally, a clinician will work within a patient's pain tolerance limit while still addressing stability, mobility, and functional motor control. The

evaluation will help to determine the extent of the involved structures as well as identifying a potential starting point for the rehabilitation protocol. For example, a patient who has pain and motor restrictions below 90° of arm elevation with concurrent scapular dyskinesis and kinetic chain deficits (hip tightness and weakness) would not begin with traditional long lever strengthening exercises as these maneuvers would likely exacerbate the painful symptoms. Instead, the patient would begin with an integrated rehabilitation regimen where the larger muscles of the lower extremity and trunk are utilized during the treatment of the scapula and shoulder. The purpose of beginning with the distal structures is two-fold: (1) shifting attention away from the site of injury allows the painful symptoms to subside and (2) improving the function of the larger distal muscles will aid in restoring true kinetic chain function. Minimal stress is placed on the glenohumeral joint during hip and trunk extension which facilitate scapular retraction [58••]. All exercises are started with the feet on the ground and involve hip extension and pelvic control. The patterns of activation are both ipsilateral and contralateral [57].

The advantage of utilizing the larger muscles of the pelvis and trunk is that they produce the energy for upper limb tasks, which is then transferred to the arm through the scapula. If the strength and stability of these kinetic chain segments are optimized, then the terminal output performed by the arm is maximized. This concept reflects actual biomechanical function and can be clinically beneficial in the presence of rotator cuff injury, as improper loading will be diverted away from the scapula and shoulder, thereby decreasing risk for aggravating the original symptoms.

An emphasis on proper form and control of scapular compensations starts with little to no resistance, and progression through the rehabilitation program only occurs after appropriate scapular motion and control has been achieved. In this phase, the properly utilized distal kinetic chain segments would influence and direct proper scapular motion. This is described as the facilitation of motion and is rooted in neuromuscular re-education. Scapular muscle performance has been shown to be altered in the presence of scapular asymmetry with the serratus anterior and lower trapezius often affected [59, 60]. To properly facilitate scapular protraction, a clinician should encourage trunk and hip flexion (Fig. 1) while scapular retraction is facilitated through trunk and hip extension (Fig. 2) [57]. It is worth noting that while both protraction and retraction are necessary scapular motions that occur during normal scapulohumeral rhythm, positions of retraction have been shown to be beneficial for generating optimal rotator cuff strength [37–39]. Positions of excessive scapular protraction are associated with increased incidences of impingement symptoms and scapular dyskinesis [30, 61].

Therefore, when possible, a clinician should facilitate and re-educate the muscle activation patterns to include positions of scapular retraction.

Should a patient have motion above 90° but pain in the end range of motion, the focus should be on establishing scapular control at and above 90° of elevation. Initially, closed chain exercise at various levels of arm elevation would help initiate this task (Figs. 3, 4, 5). Axially loaded exercises are theorized to off-load the injured rotator cuff muscle(s) and encourage muscle activation in a safer manner [58, 62]. Progression from closed chain exercise would begin once scapular control is evident at all levels of arm elevation above 90° . Advancement to more challenging open chain exercises would also follow a logical progression beginning with short lever open chain exercises (Figs. 6, 7, 8) and then eventually progressing to long lever traditional rotator cuff strengthening exercises (Figs. 9, 10) [11, 12, 15].

There are multiple keys to developing a comprehensive rehabilitation program for treating rotator cuff injury. First, the rehabilitation program should be individualized based on the patient's response and current level of motor control. Second, early use of the trunk and lower limbs should be encouraged to facilitate scapular motion and mobility. Logically, core and scapular stability needs to be achieved in addition to motor control before advancing to open chain functional exercises. Finally, proper sequencing should be the global point of focus as kinetic chain sequencing will allow for facilitation of proper scapular kinematics and discouragement of deleterious compensations when performing arm elevation tasks.



Fig. 1 Flex the trunk and hips to facilitate protraction of the scapula



Fig. 2 Extend the trunk and hips to facilitate retraction of the scapula

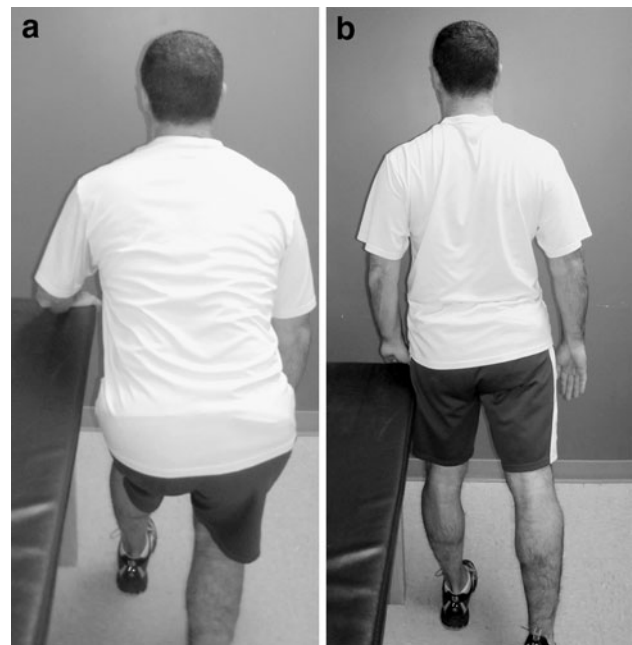


Fig. 3 The low row begins with (a) the patient's hand placed on the side of a firm surface and the feet staggered and knees slightly bent. The patient then extends the hips and trunk to achieve scapular retraction (b)



Fig. 4 The active inferior glide exercise requires active inferior depression of the arm and scapula in which helps depress the humerus and scapula

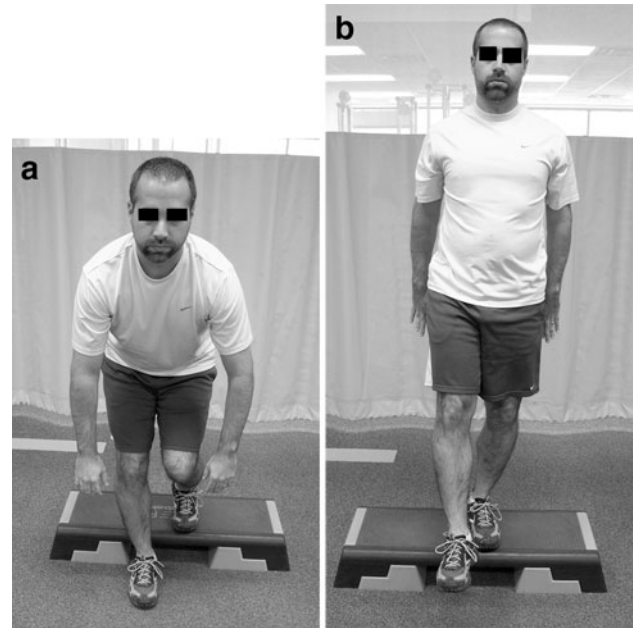


Fig. 6 The step back exercise requires utilization of a box or platform. The patient begins with one foot on the platform and one foot on the floor with the body flexed at the trunk and hips (a). The patient steps up and back on the platform while simultaneously retracting the scapulas (b)



Fig. 5 The wall wash exercise is closed chain by design where the patient begins (a) in a half or full squat position with the hand of the involved arm on a wall. The patient stands using the legs and trunk to drive the arm through various ranges and planes of motion (b)



Fig. 7 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 while the verbal cue is given to “place the elbows in the back pockets” (b)

Conclusion

The spectrum of rotator cuff injury can be difficult to treat. A comprehensive approach beginning with a thorough

Fig. 8 The fencing exercise begins with the arm elevated above 90° in the frontal plane (a) and is performed by side stepping and simultaneously retracting the scapula and adducting the arm (b)

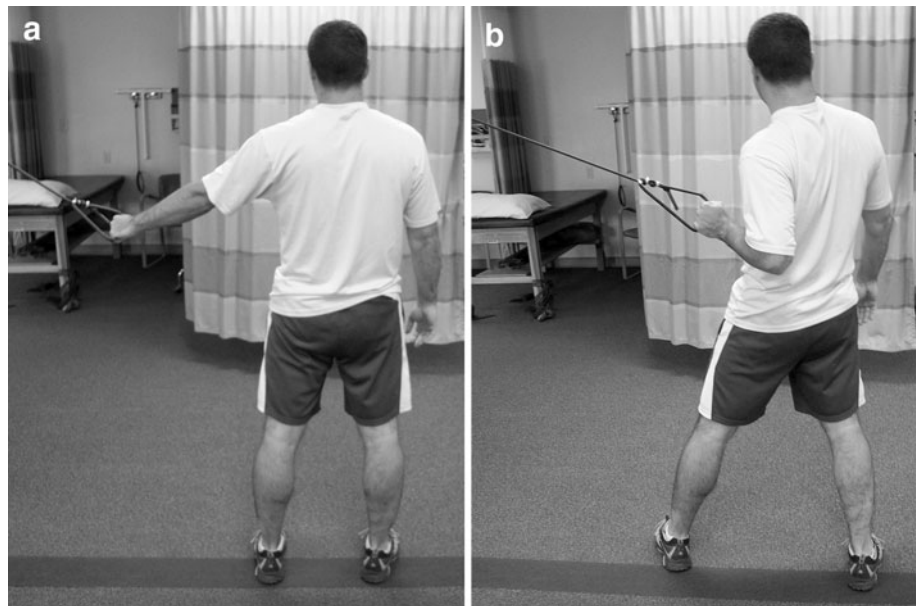


Fig. 9 External rotation exercise for strengthening the posterior rotator cuff. Adding a side step with the external rotation action is advocated to “off-load” the rotator cuff



Fig. 10 Scaption should be performed in the late phases of rehabilitation due to the high demand of the exercise

examination, which assesses all contributing factors at and beyond the site of injury can aid rehabilitation clinicians in designing the appropriate therapeutic regimen. The deleterious impact that kinetic chain deficits can have on the function of the rotator cuff suggest that rehabilitation programs should be created to encompass all kinetic chain segments with a logical progression beginning with distal segments and ending at the site of injury. This inclusive rehabilitation philosophy can be applied towards treating

the different manifestations of rotator cuff injury thereby improving the overall treatment of this common condition.

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- Of major importance

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