[ CASE REPORT ]

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# Comprehensive Impairment-Based Exercise and Manual Therapy Intervention for Patients With Subacromial Impingement Syndrome: A Case Series

Shoulder pain affects approximately 16% to 21% of the population and is second only to low back pain in prevalence[72,73,85] of musculoskeletal conditions. Subacromial impingement syndrome (SAIS) accounts for 44% to 60% of all conditions that cause shoulder pain and is reported to be the most frequent cause of visits to a physician's office.[86,87] Impingement syndrome involves degeneration and/or mechanical compression of the subacromial structures on the anterior undersurface of the acromion, coracoacromial ligament, and the acromioclavicular joint.[67] The structures involved include the rotator cuff tendons, the long head of the biceps, and subacromial bursa. The etiology of SAIS is considered multifactorial and related to exposure and biomechanical factors. Repetitive work at or above shoulder level and participation in athletic activities involving frequent overhead use are both associated with a high incidence of shoulder pain.[13,46,64] Biomechanical factors include degenerative changes in the bones and soft tissues of the glenohumeral joint,[67] variations in acromial morphology,[22] poor posture,[26,37,56] rotator cuff and scapular muscular

SUPPLEMENTAL VIDEO ONLINE

• **STUDY DESIGN:** Case series.

• **BACKGROUND:** Few studies have defined the dosage and specific techniques of manual therapy and exercise for rehabilitation for patients with subacromial impingement syndrome. This case series describes a standardized treatment program for subacromial impingement syndrome and the time course and outcomes over a 12-week period.

• **CASE DESCRIPTION:** Ten patients (age range, 19-70 years) with subacromial impingement syndrome defined by inclusion and exclusion criteria were treated with a standardized protocol for 10 visits over 6 to 8 weeks. The protocol included a 3-phase progressive strengthening program, manual stretching, thrust and nonthrust manipulation to the shoulder and spine, patient education, activity modification, and a daily home exercise program of stretching and strengthening. Patients completed a history and measures of impairments and functional disability at 2, 4, 6, and 12 weeks.

• **OUTCOMES:** Treatment success was defined as both a 50% improvement on the Disabilities of the Arm, Shoulder, and Hand (DASH) score and a global rating of change of at least "moderately better." At 6 weeks, 6 of 10 patients had a successful (mean ± SD) DASH outcome score (initial, 33.9 ± 16.2; 6 weeks, 8.1 ± 9.2). At 12 weeks, 8 of 10 patients had a successful DASH outcome score (initial, 33.1 ± 14; 12 weeks, 8.3 ± 6.4). As a group, the largest improvement was in the first 2 weeks. The most common impairments for all 10 patients were rotator cuff and trapezius muscle weakness (10 of 10 patients), limited shoulder internal rotation motion (8 of 10 patients), and reduced kyphosis of the midthoracic area (7 of 10 patients).

• **DISCUSSION:** A program aimed at strengthening rotator cuff and scapular muscles, with stretching and manual therapy aimed at thoracic spine and the posterior and inferior soft-tissue structures of the glenohumeral joint appeared to be successful in the majority of patients. This case series describes a comprehensive impairment-based treatment which resulted in symptomatic and functional improvement in 8 of 10 patients in 6 to 12 weeks.

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• **KEY WORDS:** *manipulation, pain, rotator cuff, shoulder, supraspinatus*

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weakness and imbalance,[24,76] limited flexibility of the posterior shoulder structures and other soft tissue restrictions,[11,89] and altered scapular kinematics.[55,58,90]

Treatment options for those with SAIS to address the aforementioned factors include rehabilitation and surgical decompression of the subacromial space. Although some patients undergo surgery, nonsurgical rehabilitation is a viable option. A randomized controlled trial[9] found that arthroscopic subacromial decompression and supervised nonsurgical rehabilitation equally resulted in decreased pain and increased function compared to placebo at 6 months in those with SAIS. Although 22% of those randomized to the exercise group eventually elected to have surgery within the 2.5-year follow-up period, the majority of patients in that study had satisfactory results.[8] In a similar randomized clinical trial comparing exercise to arthroscopic decompression for patients with SAIS, Haahr[29] found equally good results in both treatment groups at 12-month follow-up, as measured by the Constant score functional outcome measure. McClure et al[61] used a progressive 6-week intervention program consisting of strengthening, flexibility, posture instruction, and education on 39 patients with SAIS and reported a mean ± SD functional improvement from 63.3 ± 13.6 to 83.3 ± 16.9 using the Penn Shoulder Score. Additional studies and systematic reviews clearly support the use of exercise to treat pain and disability in persons with SAIS,[3,17,45,53,54,64,78,80] with 3 of these studies and 2 systematic reviews[45,64] demonstrating superior improvements in either function,[3,78] pain,[3,17,78] range of motion,[78] and/or strength[3] when thrust and nonthrust manipulation and manual stretching were added to an exercise-based program. Unfortunately, each of these studies either did not adequately describe or standardize the manual therapy and exercise components of the intervention programs,[3,78] use validated outcome measures,[3,17] or provide data beyond the intervention period.[17] Because the addition of spinal thrust and nonthrust manipulative techniques to standard therapeutic exercise interventions for patients with shoulder pain has produced superior outcomes at both short-term (2-3 sessions, 12 weeks) and long-term (52 weeks) follow-up,[5,7,65] studies are needed which incorporate specific manual therapy techniques into a comprehensive program with follow-up beyond the intervention period. The purpose of this case series was to provide a detailed description of a standardized progressive exercise and manual therapy intervention program for SAIS that includes thoracic thrust and nonthrust techniques and to describe outcomes at patient discharge (6 weeks) and follow-up (12 weeks), using validated functional outcome measures.

## CASE DESCRIPTION

Consecutive patients (n = 10) presenting to rehabilitation clinics with shoulder pain were evaluated and treated by 1 of 8 participating physical therapists. The subjects described here were the initial 10 subjects in a larger study designed to develop a clinical prediction rule for response to nonsurgical intervention for SAIS. The inclusion criteria used to establish a diagnosis of SAIS were (1) a positive Hawkins or Neer test, (2) a positive painful arc, (3) pain or weakness with either the Jobe "empty-can" test or resisted shoulder external rotation with the arm at the side, (4) a pain rating of less than or equal to 7/10 at rest, and (5) being between 14 and 80 years of age. Patients could also have a concurrent secondary diagnosis of instability, rotator cuff tear, or labral tear. Exclusion criteria were shoulder surgery on the symptomatic side, previous shoulder rehabilitation for this episode of shoulder pain, a positive Spurling test, traumatic shoulder dislocation or instability in the past 3 months, reproduction of shoulder pain with active or passive cervical range of motion, or a clinical presentation of adhesive capsulitis defined as a loss in passive shoulder range of motion greater than 50% as compared to the uninvolved side in at least 2 shoulder movements. Patients had to meet all 5 inclusion and no exclusion criteria to participate.

There were 5 females and 5 males in this case series. Demographic and other descriptive information from the history are presented in **TABLE 1**. All patients provided written consent for participation, and the rights of the subjects were protected. This study was approved by the Institutional Review Boards of Virginia Commonwealth University and Arcadia University.

### Outcome Measures

The outcome measures included pain intensity, the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, and the Global Rating of Change (GRC) question. Pain was assessed using the 3 pain subscale questions of the Penn Shoulder Scale,[48] which rates pain at rest, with normal activities (eating, dressing, bathing), and with strenuous activities (reaching, lifting, pushing, pulling, throwing), using a numeric pain rating scale with anchors of 0 (no pain) and 10 (worst pain). Pain was then represented by the sum of the scores under the 3 conditions, with scores ranging from 0 to 30 and higher scores representing more pain. The pain subscale has demonstrated excellent reliability (intraclass correlation coefficient [ICC] = 0.88).[48] Shoulder function was measured with the DASH,[34] which is a 30-question region-specific self-report outcome for upper extremity disability. The DASH score ranges from 0 to 100 points, with 0 reflecting no disability. The DASH has demonstrated excellent reliability (ICC = 0.92, 0.96)[4,34] and responsiveness.[4,44,28,77] The GRC[36] is a 13-point scale, ranging from −6 (a very great deal worse) to 0 (about the same) to +6 (a very great deal better), allowing the patient to rate the perceived change in their shoulder condition since their first visit.

### Examination

Patients underwent a physical examination by a physical therapist who par-

ticipated in a 5-hour training module provided by the primary author, which included didactic and laboratory training. All examination procedures and manual techniques were practiced. Adequate interrater reliability was demonstrated for 13 of the 17 examination measures (percent agreement, >80%; $ICC_{2,1}$>0.75) among participating clinicians during the training session prior to data collection. For 4 examination measures, initial reliability was not satisfactory, so these techniques were subsequently reviewed at an additional training session and rechecked for accuracy. Clinicians were also given

**TABLE 4** Descriptive Information and Outcomes for All Patients (Ranked by Outcome)

| | Patient ID | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Descriptive Information | | | | | | | | | | |
| Gender | M | M | M | F | F | F | M | F | F | M |
| Age (y) | 26 | 52 | 26 | 19 | 42 | 48 | 54 | 67 | 46 | 73 |
| BMI (kg/m$^2$) | 24.0 | 22.5 | 24.1 | 22.9 | 18.6 | 29.4 | 36.3 | 24.4 | 27.5 | 32.3 |
| Side | ND | D | ND | D | D | D | D | ND | ND | ND |
| Onset | NT | NT | NT | T | T | NT | NT | NT | T | NT |
| Duration of symptoms (mo) | 61.4 | 5.4 | 36.9 | 16.2 | 1.0 | 5.0 | 6.4 | 6.2 | 1.1 | 3.0 |
| Atrophy* | N | N | N | N | N | N | Y | Y | Y | N |
| FTRCT† | N | N | N | N | N | N | Y | Y | N | N |
| Labral tear‡ | N | N | N | Y | Y | N | Y | N | Y | Y |
| PROM elevation (°)§ | 0 | 10 | 10 | 26 | 0 | 15 | 10 | 12 | 0 | 10 |
| Elevation lag (°)‖ | 10 | 14 | 10 | 10 | 26 | –2 | 10 | 13 | 0 | 20 |
| PROM IR 90° (°)¶ | 20 | 7 | 15 | 8 | –1 | 2 | 25 | 5 | 17 | 15 |
| ROM IR 0° (vertebral levels)# | 5 | 0 | 3 | 5 | 2 | 10 | 7 | –2 | 12 | 6 |
| PROM ER 90° (°)** | 50 | –1 | 20 | 0 | –35 | –40 | 20 | 0 | –20 | 15 |
| Outcomes | | | | | | | | | | |
| Pain 0 wk (IE)†† | 9 | 7 | 21 | 19 | 6 | 10 | 10 | 10 | 16 | 18 |
| Pain 6 wk (DC)†† | 0 | 2 | 4 | 8 | 1 | 7 | 7 | 7 | 8 | 8 |
| Pain 12 wk†† | 0 | 2 | 13 | 3 | 1 | 3 | 7 | 6 | 9 | 23 |
| DASH 0 wk (IE)‡‡ | 14.2 | 13.3 | 40.8 | 52.5 | 42.5 | 40 | 26.7 | 35 | 35.8 | 39.8 |
| DASH 6 wk (DC)‡‡ | 0.0 | 3.3 | 3.3 | 11.7 | 16.7 | 13.3 | 22.5 | 25.0 | 16.7 | 29.2 |
| DASH 12 wk‡‡ | 0.0 | 0.8 | 17.5 | 7.5 | 8.3 | 9.5 | 5.8 | 16.7 | 26.7 | 27.5 |
| GROC 6 wk (DC)§§ | 6 | 6 | 5 | 5 | 6 | 3 | 4 | 0 | 2 | 5 |
| GROC 12 wk§§ | 6 | 6 | 4 | 6 | 6 | 4 | 5 | 5 | 1 | 0 |
| Success‖‖ | 6 and 12 wk | 6 and 12 wk | 6 and 12 wk | 6 and 12 wk | 6 and 12 wk | 6 and 12 wk | 12 wk | 12 wk | Fail | Fail |

*Abbreviations: BMI, body mass index; D, dominant; DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; ER, external rotation; FTRCT, full-thickness rotator cuff tear; GROC, global rating of change; IR, internal rotation; ND, nondominant; NT, nontraumatic; PROM, passive range of motion; T, traumatic.*

* *Supraspinatus atrophy based on inspection.*

† *Any sign of full-thickness rotator cuff tear (drop arm test, external rotation lag sign, weakness on empty-can or external rotation).*

‡ *Any sign of labral injury (tests: biceps I or II, crank test, anterior slide test).*

§ *Passive range-of-motion deficit in elevation in degrees (uninvolved-involved, positive number means less on involved side).*

‖ *Elevation lag in degrees (passive elevation-active elevation on involved side, positive number represents less active motion).*

¶ *Passive range-of-motion deficit in degrees in glenohumeral internal rotation with arm abducted 90° (uninvolved-involved, positive number means less on involved side).*

# *Glenohumeral internal rotation deficit assessed by placing hand behind back to highest vertebral level (positive number represents number of vertebral levels less on involved side).*

** *Passive range-of-motion deficit in glenohumeral external rotation in degrees, assessed with arm abducted 90° (uninvolved-involved, positive number means less on involved side).*

†† *Pain score at baseline, 6 weeks, and 12 weeks. Values range from 0 to 30, where 0 equals no pain.*

‡‡ *DASH scores at baseline, 6 weeks, and 12 weeks. Values range from 0 to 100, where 0 equals no disability.*

§§ *Global rating of change scores at 6 weeks and 12 weeks. Values range from +6 to –6, where +6 is a very great deal better and –6 is a very great deal worse.*

‖‖ *Success criteria were 50% improvement on DASH score and GROC. Greater than or equal to 3, moderately better; 6 wk, success at 6 weeks; 12 wk, success at 12 weeks; fail, success not achieved.*

online access to the training materials that contained embedded video footage of manual intervention and examination procedures to refer to during the course of the case series.

An upper-quarter screen was performed including assessment of cervical active range of motion and evaluation of myotomes, dermatomes, and muscle stretch reflexes.[88] Responses were classified as normal or abnormal, with the latter designating myotomal weakness, hypoesthesia or hyperesthesia, with light-touch testing of the upper extremity dermatomes, or a reflex found to be increased, decreased, or absent compared to the contralateral extremity. Posture was observed from both the posterior and lateral views. From the posterior view, the supraspinatus and infraspinatus were observed and recorded as either normal muscle bulk or having obvious atrophy, identified visually as significant muscle wasting (flattening or hollowing) in the supraspinous or infraspinous fossa. The height of the involved shoulder was observed at the acromion and recorded as either greater than 1 cm higher, equal to, or greater than 1 cm lower, as compared to the contralateral side. The patient was then observed from the lateral view and the contour of the cervicothoracic junction (C7-T2), middle thoracic (T3-T5), and lower thoracic spine (T6-T10) were classified as normal, excessive kyphosis, or reduced kyphosis, as described by Kendall et al.[40] The presence of shoulder protraction was noted and defined by the acromion being anterior to the apex of the lumbar spine. Cleland et al[14] reported good to excellent reliability (percent agreement, 82%-95%; kappa, 0.58-0.90) using clinicians' qualitative judgments of thoracic postural assessment.

Spring testing was performed using posterior-to-anterior pressure applied over each of the C7 to T9 spinous processes, with the patient in a prone position and the head in neutral. Each segment was assessed for pain provocation and judged as hypomobile, normal, or hypermobile, based on the therapist's perception of normal motion, as well as mobility of the tested segment relative to adjacent segments.[14,59] Active shoulder range of motion was measured with the subject standing. A standard goniometer was used to measure forward elevation, abduction (coronal plane), and external rotation with the arm by the side.[68] Composite glenohumeral and scapulothoracic internal rotation mobility was assessed using the thumb to highest spinous process behind the back method.[25,33] Passive shoulder range-of-motion measures for flexion, abduction (coronal plane), and external rotation, with the arm in neutral and at 90° abduction, were taken with the patient supine. Passive glenohumeral internal rotation was measured goniometrically with the humerus in 90° of abduction. The clinicians were instructed to record the measurement when the scapula began to lift from the plinth, as observed visually.[2]

Manual muscle testing was performed in the seated position, using 3 strength tests that have demonstrated high activity of the rotator cuff muscles: (1) shoulder external rotation in neutral rotation at 0° elevation (teres minor and infraspinatus), (2) shoulder internal rotation in neutral at 0° elevation (subscapularis), and (3) shoulder abduction at 90° elevation and 40° anterior to the frontal plane and internal shoulder rotation (supraspinatus "empty-can test").[39,81] During the empty-can test, patients were asked to give a verbal numeric pain rating from 0 (no pain) to 10 (worst possible pain). The arm was then passively lowered and the therapist performed the scapula reposition test[83] by grasping the scapula medial to the acromion, with the forearm angled obliquely across the inferior scapular angle. A moderate force to posteriorly tilt and externally rotate the scapula (ie, approximate the scapula towards the thorax) was applied while the arm was passively returned to empty-can position. The empty-can test was performed again, and patients were again asked to report a numeric pain rating.

Three scapular muscle tests were performed, as described by Kendall et al.[40] Middle and lower trapezius muscles were tested with the subject prone, resisting shoulder horizontal abduction at 90° and 145°, respectively, with the thumb pointing superiorly. The therapist applied a downward force proximal to the olecranon and monitored the medial border of the scapula, grading the muscle on its ability to maintain scapular retraction.[21] The serratus anterior was tested in the seated position, with the shoulder flexed to 125°. The therapist applied an inferiorly directed force to the arm proximal to the olecranon and graded the muscle based on its ability to maintain scapular upward rotation. High corresponding muscle activity has been demonstrated with electromyography for each test.[21,63] The serratus anterior, lower trapezius, and middle trapezius were tested because they have been reported to be weak in patients with SAIS.[49,55] Each muscle test was rated as "normal," "reduced," or "markedly reduced." Normal was defined as strong, with equal resistance applied as compared contralaterally; reduced indicated that only mild to moderate resistance could be applied as compared contralaterally; and markedly reduced was defined as a significant deficit, with little to no resistance applied as compared contralaterally.[88] Shoulder pain was recorded, if present, during each test.

Patients were then observed from a posterior view and scapular motion patterns were assessed using the scapula dyskinesis test.[60,82] Patients performed 5 repetitions of flexion with weight, using 2.3 kg for patients weighing 68.0 kg or greater and 1.4 kg for patients weighing less than 68.0 kg. If the patient was highly symptomatic, motions were performed without weight. Patients were rated as having normal scapular motion, subtle abnormalities, or obvious abnormalities, with the abnormalities being winging or dysrhythmia.[60,82] Special tests were performed for impingement (Neer's,[67] Hawkin's,[31] empty-can[35]), labral tears (crank test,[51] biceps I,[43] biceps II,[42] anterior slide[41]), instability

(apprehension,[52] sulcus test[50]), upper-limb neural tension,[88] and full-thickness rotator cuff tears (drop arm,[12] external rotation lag,[32] lift off,[32]external rotation resistance test[70]).

## Intervention Program

The intervention program consisted of manual techniques, a 3-phase progressive exercise program, and patient education (**TABLE 2**). Detailed descriptions of the intervention program are provided in **APPENDICES A** through **D**. Patients were seen for a maximum of 10 visits over 6 weeks, extending up to 8 weeks if needed, at which time the patient was discharged. If patients met all goals prior to 10 visits, they were discharged earlier, and the discharge examination and self-report measures were done on the final visit. Status at 12 weeks was determined by self-report surveys mailed to participants.

**Manual Therapy Techniques** Manual therapy consisted of thrust and nonthrust manipulation techniques and manual stretching aimed at addressing dysfunction in the following 3 areas: the thoracic spine, posterior shoulder, and inferior glenohumeral capsule. Clinicians were instructed to perform manual techniques for a total of 10 to 15 minutes and were required to use at least 1 technique for each of the 3 areas. Nonthrust manipulation of acromioclavicular joint was optional. Clinicians were permitted to choose between techniques based on examination findings and patient history. For example, glenohumeral low-grade nonthrust manipulation in a pain-free range of motion could be used for pain-dominant, highly irritable shoulders, whereas high-grade nonthrust manipulation at end ranges could be used for stiffness-dominant or low-irritability shoulders.[38] Manual therapy, including glenohumeral nonthrust manipulation techniques, has been used in conjunction with an exercise program, and superior outcomes have been reported in comparison to use of an exercise program alone.[3,17,78] In addition to techniques for the glenohumeral joint, thrust and nonthrust manipulation procedures for the thoracic spine were utilized, as greater thoracic extension has been shown to promote greater range of shoulder elevation and increased abduction strength compared to the positions of increased thoracic flexion.[10,37] Clinicians were encouraged to use thrust manipulation techniques for the thoracic spine unless contraindications were present.

**TABLE 2** Standardized Treatment for All Patients

Manual Therapy

*Performed at all phases, 10-15 min total duration per visit, at least 1 thoracic, posterior shoulder, and inferior shoulder technique required each visit*

Thoracic spine:
1. PA pressure in prone
2. PA pressure seated
3. Thrust in prone
4. Thrust in supine
5. Distraction thrust seated

Posterior shoulder:
1. GH posterior glide
2. GH posterior glide with active elevation (MWM)
3. Cross-body posterior shoulder stretch
4. Internal rotation passive stretching

Inferior shoulder:
1. GH inferior glide

AC joint (optional):
1. Anterior-inferior glide of clavicle (seated or supine)

Stretching

*Performed at all phases, 30 s, 3 repetitions*
1. Thoracic extension towel stretch supine
2. Doorway pectoral stretch
3. Cross-body stretch
4. Shoulder external rotation cane stretch
5. Shoulder internal rotation towel stretch
6. Shoulder flexion stretch; phase 1, supine cane flexion; phases 2 and 3, standing wall stretch

Motor Control/Strengthening

*2-3 sets of 10 repetitions, progressing from the yellow to red to green to the blue band*

Phase 1:
1. Resisted shoulder external rotation
2. Resisted shoulder internal rotation
3. Resisted scapular retraction
4. Resisted shoulder extension
5. Resisted scapular protraction in supine
6. Active elevation with upper trapezius relaxation
7. Chin tuck with scapular retraction

Phase 2:
1. Resisted shoulder abduction in scapular plane
2. Resisted shoulder external rotation with abduction
3. Resisted shoulder internal rotation with abduction
4. Quadruped push-up plus "camel"
5. Prone scapular retraction and shoulder elevation "Y"
6. Prone shoulder elevation in ER with scapular retraction "T"

Phase 3:

Continue phase 2 and add:
1. Bodyblade below 60°
2. Bodyblade above 60°
3. Lawnmower pull
4. Protraction plank

Home Exercise Program

*To be done once daily using same resistance and repetitions as in clinic*

Phase 1:
1. Resisted shoulder external rotation
2. Resisted shoulder internal rotation
3. Resisted scapular retraction
4. Upper thoracic extension stretch
5. Cross-body stretch
6. Other stretches optional

Phase 2:
1. Resisted shoulder abduction in scapular plane
2. Resisted shoulder external rotation with abduction
3. Quadruped push-up plus "camel"
4. Prone scapular retraction and shoulder elevation "Y"
5. Upper thoracic extension stretch
6. Cross-body stretch
7. Other stretches optional

Phase 3:
1. Shoulder abduction in scapular plane
2. Prone scapular retraction and shoulder elevation "Y"
3. Prone shoulder elevation in ER with scapular retraction "T"
4. Lawnmower pull
5. Protraction plank
6. Cross-body stretch
7. Other stretches optional

*Abbreviations: AC, acromioclavicular; GH, glenohumeral; MWM, mobilization with movement; PA, posterior to anterior.*

**Exercise Program** The exercise program was divided into 3 phases, with each phase consisting of strengthening/muscle re-education exercises for the scapula stabilizers and the rotator cuff in addition to flexibility exercises. Patients were also instructed to perform a chin tuck, with scapular retraction to promote cervical retraction and an erect posture. A slouched posture is associated with reduced arm elevation strength[37] and a reduction in the dimension of the subacromial space.[79]

Strengthening exercises were performed with 2 to 3 sets of 10 repetitions, using a 120-cm-long precut section of latex-free Thera-Band (Hygenic Corporation, Akron, OH). Patients began exercising using the nonlatex yellow band at mild tension and when able to perform 3 sets of 10 repetitions without significant pain or fatigue, they were progressed to the next color resistive band in the sequence: yellow, red, green, and blue. Phase 1 emphasized strengthening of the rotator cuff with the humerus in a neutral position in an effort to improve the depressor function of the rotator cuff to center the humeral head in the glenoid and prevent excessive superior humeral head translation from the deltoid.[61,71] Increased upper trapezius activity and reduced serratus anterior activation have been reported in those with impingement[57]; therefore, motor control training during elevation, with avoidance of excessive upper trapezius activity and serratus strengthening, were begun in phase 1. When subjects had adequate rotator cuff strength, as identified by the ability to perform exercises with the red nonlatex color Thera-Band (approximately equal to green latex Thera-Band), shoulder elevation exercises were added, as were progressive strengthening exercises for the serratus anterior and trapezius in phase 2. To advance to phase 3, the subject was required to perform the exercises in phase 2 for 1 week without an increase in symptoms. In phase 3, the subject was instructed to continue the exercises from phase 2 in addition to the new exercises listed in **TABLE 2**. Phase 3 provided higher-level strengthening and control exercises that incorporated trunk strengthening in the lawnmower and protraction plank exercises, and endurance training at multiple levels of elevation using the Bodyblade (Mad Dogg Athletics, Venice, CA). If any prescribed exercise produced lasting or significant symptoms, it was avoided or modified.

Stretching exercises were designed to increase the flexibility of the glenohumeral capsule and other soft tissues, as well as the pectoral muscles and thoracic spine. The stretching exercises were performed for 3 repetitions held for 30 seconds each. A standardized home exercise program was given, consisting of strengthening and flexibility exercises, as described in **TABLE 2**.

**Patient Education** In addition to exercise, all patients received education regarding posture and body mechanics. They were instructed on preferred positioning of the shoulder during sleeping, daily activities, and strenuous work or sport performance. Ergonomic goals emphasized lightening the amount of load carried, using arm below shoulder level, keeping the load close to the body, and using hip and lumbar spine extension when lifting overhead. In general, the patient education provided guidelines aimed at avoiding use of the involved shoulder in positions likely to provoke impingement.

## OUTCOME

**TABLE 1** shows descriptive information and outcome scores for all patients. The mean ± SD DASH initial score was 34.1 ± 12.0 and the 6-week and 12-week scores were 14.2 ± 9.8 and 12.0 ± 9.7, respectively. Total pain scores improved from 12.6 ± 5.4 out of 30 on initial evaluation to 5.2 ± 3.2 out of 30 at 6-week discharge. At 12-week follow-up, the mean pain score was 6.7 ± 7.0 points. These changes exceed the minimal detectable change score of 5.4.[48] From 6 to 12 weeks, there was a slight increase in the mean pain score, which was attributable to 1 subject whose pain went from 8/30 at 6 weeks to 23/30 at 12 weeks. We classified patients as either success or failure. Success was defined as a 50% improvement in DASH score and a GRC score rated as "moderately better" (+3) or higher. Patients were classified as failure if the change on the GRC was "somewhat better" (+2) or at any level below this or if there was not a 50% improvement in the DASH. Using these criteria, 6 of the 10 patients were classified as having successful outcomes at discharge and 8 of the 10 patients had successful outcomes at the 12-week follow-up. The time course of change in DASH for subgroups is shown in the **FIGURE**.

## DISCUSSION

A successful outcome, based on an improvement of greater than 50% on the DASH and a rating of "moderately better" or higher on the GRC score, was achieved in 6 of 10 patients who went through the exercise and manual therapy intervention program at 6-week discharge. The outcome for these patients remained successful at 12-week follow-up, and an additional 2 patients achieved a successful outcome by 12 weeks, resulting in a successful outcome in 8 of 10 cases. This is somewhat higher than the rates reported by Morrison and colleagues,[66] who had a successful outcome in 67% of cases at follow-up, which averaged 27 months (range, 6-81 months). Looking at conservative management using injection and physical therapy, Cummins et al[19] reported that 79% of their 100 patients did not require surgery at 2-year follow-up, although 23% had persistent pain. Other studies report improvements in function and/or pain[3,61,78] but did not rate cases as success or failure.

Our findings are consistent with those reported by both Cummins[19] and McClure,[61] who found improvements in pain and function within the first 6 weeks, with slow but continued improvement at selected intervals postdischarge from

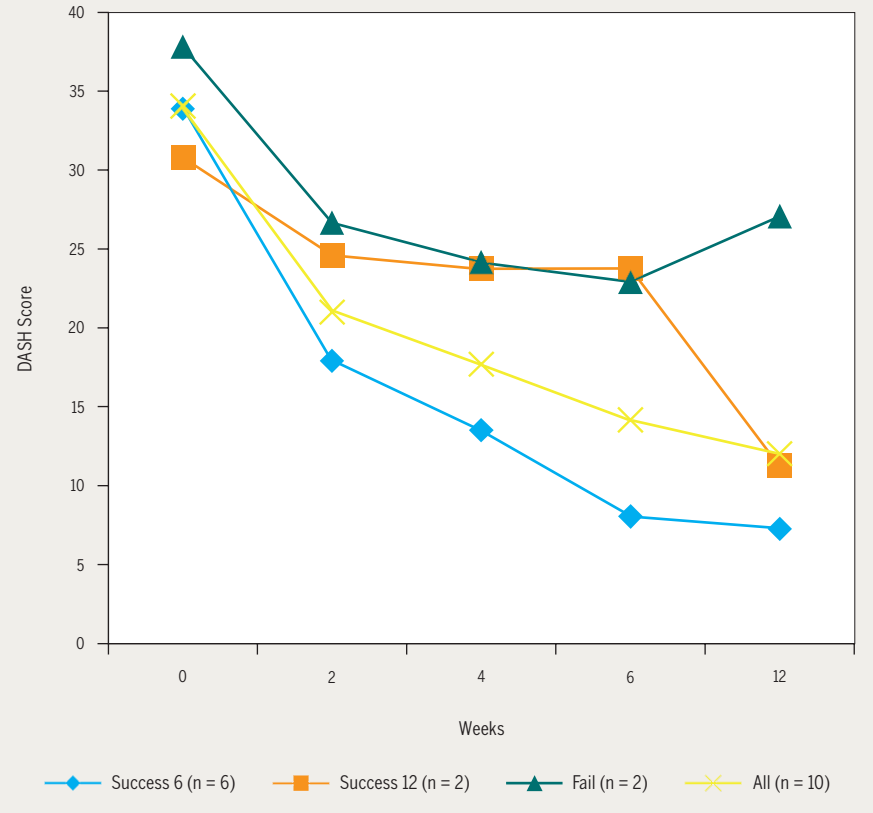


**FIGURE.** DASH scores versus time in subgroups of patients based on outcome. Success was defined as a 50% improvement in DASH score and a GRC score rated as "moderately better" (+3) or higher. The DASH scored from 0 to 100, with 0 indicating no disability. Abbreviations: DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; GRC, global rating of change scale; success 6, patients meeting criteria at 6 weeks; success 12, patients meeting criteria at 12 weeks; fail, patients not meeting criteria.

rehabilitation. In our series, the greatest rate of improvement on the DASH occurred in the first 2 weeks. This might be attributable to education on avoidance of provocative activities and medication usage, as well as neural adaptations associated with short-term exercise training.[6,20,27] Only 5 of 10 patients were taking nonprescription medications such as acetaminophen or nonsteroidal anti-inflammatory drugs. In contrast, structural changes to muscle (ie, hypertrophy) in response to training[23] may explain the improvements seen at the 12-week period for the 2 additional patients in this case series and in others' studies.[19,61] Increases in muscle cross-sectional area and muscle volume with concomitant strength gains have been measured within 12 weeks of starting resistive training.[1,74,84]

## Examination Findings

The most common impairments found in patients were rotator cuff and trapezius weakness (10 of 10 patients), limited shoulder internal rotation range of motion (8 of 10 patients), and reduced midthoracic kyphosis (7 of 10 patients). Seven of 10 patients were rated as having a reduced kyphosis in the midthoracic region and hypomobility of at least 1 thoracic segment was found in the same number of patients. Although reduced thoracic kyphosis in the T3-T5 segment was one of the predictors of success using thoracic manipulation for patients with cervical pain,[15,16] the relationship between kyphosis and success with manipulation for shoulder pain has not yet been investigated.

Passive shoulder elevation was decreased compared to the uninvolved side by at least 10° in 7 patients, and 8 of 10 patients demonstrated a deficit of at least 10° in active compared to passive elevation on the involved side. Posterior and inferior capsular or soft tissue restrictions would explain reduced passive elevation, while muscle activation deficits, perhaps related to pain or compression of subacromial tissue, could decrease active motion. As reflected in **TABLE 1**, most patients (8 of 10) had reduced shoulder internal rotation motion compared to the uninvolved side measured by vertebral level reached in standing and in 90° abduction in supine. Harryman[30] found increased anterior and superior translation of the humeral head with posterior capsule shortening, so this may be a relevant finding in SAIS. McClure and colleagues[61] found that gains in shoulder internal rotation range of motion, measured by vertebral level, in response to a 6-week exercise program were positively associated with functional improvement ($r = -0.54$, $P = .001$) for patients with SAIS.

Weaknesses of both the rotator cuff and scapular muscles were evident. Weakness was found in the serratus anterior in 6 patients, in the middle trapezius in 9 patients, and in the lower trapezius in 8 patients. These are the primary muscles responsible for controlling scapulothoracic motion. Consistent with these findings, 9 of the 10 patients demonstrated subtle or obvious dyskinesis on the affected side, based on a visual rating with demonstrated reliability and validity.[60,82] Half of the patients in this study reported 2 points or greater reduction in pain (on a 0-to-10 scale) during the Jobe empty-can testing with the scapula repositioned compared to standard Jobe testing, indicating that altering the scapula position positively affected symptoms. Our intervention program contains progressive exercises designed to increase the strength and motor control of the scapulothoracic articulation, with the intent to provide a stable base for the rotator cuff muscles. Half of the patients exhibited shoulder internal rotation weakness, while 9 of 10 exhibited shoulder external rotation and elevation

weakness on initial examination. Exercises to strengthen and facilitate motor control of the rotator cuff muscles were used to address these impairments and prevent pain that may be, in part, caused by excessive superior humeral head translation demonstrated in those with rotator cuff tears as well as with fatigue.[18,69,75]

Full-thickness rotator cuff tears and labral tears may be reasons that rehabilitation alone might fail. Patients in this series had not undergone MRI testing, so there was no definitive evidence of these pathologies. Two patients had clinical signs consistent with rotator cuff tears (weakness with empty-can resisted elevation test and positive lift-off test), and, interestingly, both of these patients achieved success at 12 weeks but not at 6 weeks. There were 5 patients who had clinical signs associated with labral tears, with 2 of these cases rated as failures.

### Intervention Program

Our protocol consisted of 8 to 10 supervised physical therapy visits over 6 weeks, which is comparable to current recommendations,[45] and other studies that report using between 6 and 12 sessions over 3 to 6 weeks.[3,19,61,78] The optimal dosage of supervised visits for SAIS has not yet been determined, as comparisons of results among these studies are not possible due to varying outcome measures and follow-up times. However, our results support previously suggested continued use of a home exercise program over a period extending beyond our 6-week intervention, as continued benefit may be derived. This pattern of continued improvement over time concurs with the temporal outcomes of conservative care reported by Cummins.[19]

Our intervention program included use of thoracic spinal manipulation (thrust and nonthrust procedures). Boyles and colleagues[7] have reported on outcomes 2 days after a single session of manipulative therapy in patients with SAIS. The use of thoracic spine thrust manipulation resulted in small but statistically significant improvements in shoulder pain and function.[7] Meurer et al[62] have found reductions in thoracic flexibility in the coronal, sagittal, and transverse plane in those with SAIS compared to those with healthy shoulders. It is not known whether these findings result from or may contribute to the etiology of SAIS; but manipulative procedures were included in our program to enhance thoracic flexibility and may be 1 mechanism responsible for the short-term reduction in shoulder pain in our patients.[5,7] Although therapists were permitted to provide local application of heat or cold, they did not use electrical or deep thermal modalities such as ultrasound, the addition of which has not been shown to provide benefit for patients with SAIS.[47,64]

## CONCLUSION

This case series describes the intervention and outcome of 10 patients with SAIS who were treated with thrust and nonthrust manipulation applied to the posterior and inferior glenohumeral joint and thoracic spine, a 3-phase progressive exercise and flexibility program, patient education, and a home exercise program. Using our measure of success based on both the patient's rating of moderately better or higher on the GRC score and a 50% or greater improvement in DASH score, 6 of 10 patients achieved a successful outcome at discharge after 6 weeks, and an additional 2 patients qualified as having a successful outcome at 12-week follow-up. As this was a small case series, the efficacy of the intervention program cannot be generalized to a larger population. Future large-scale clinical studies should seek to clearly define the optimal combination of manual therapy and exercise dose required to achieve optimal outcomes and to elucidate those factors that would prospectively predict a positive response to rehabilitation for patients with SAIS. ◉

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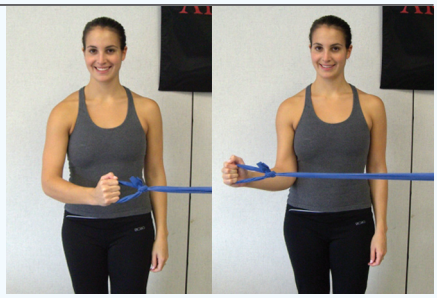
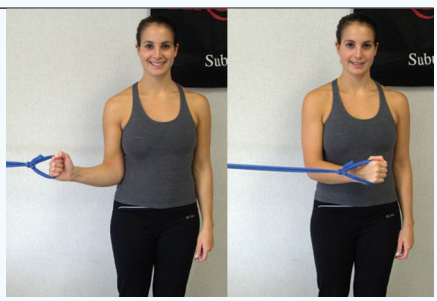
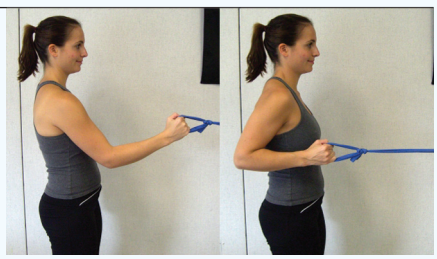
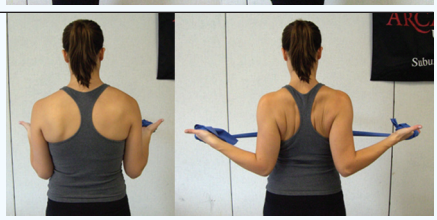
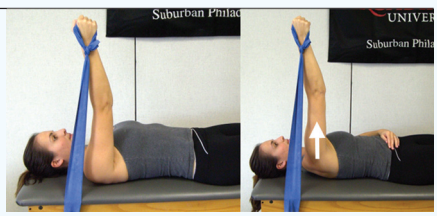
## APPENDIX A

### MOTOR CONTROL/STRENGTHENING

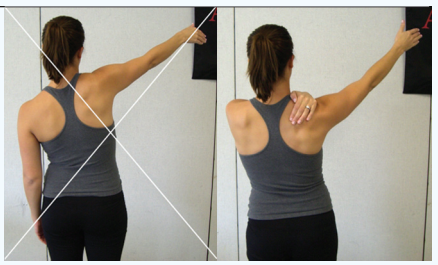
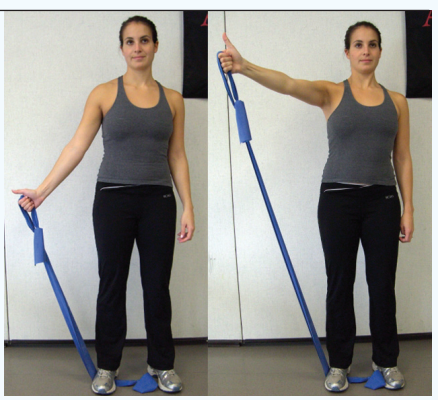
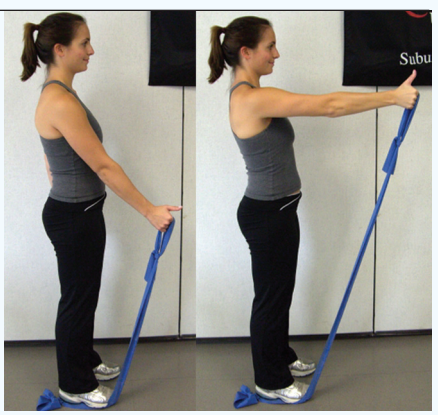
*2 to 3 sets of 10 repetitions, progressing from yellow to red to green to blue band*

| Intervention | Details | Figures |
|---|---|---|
| Phase 1 | | |
| 1. Resisted shoulder external rotation (neutral) | • Begin with hand in front of the stomach. Pull away from abdomen, then slowly release. Can use towel in armpit if more comfortable. |  |
| 2. Resisted shoulder internal rotation (neutral) | • Begin with forearm out to the side and elbow against body. Pull towards your abdomen, then slowly release. Can use towel in armpit if more comfortable. |  |
| 3. Resisted shoulder extension | • Begin with arms forward flexed about 45°. Pull band towards you, keeping your elbow bent. |  |
| 4. Resisted scapular retraction | • Grasp band with both hands, elbows bent. Pinch your shoulder blades together, which will stretch the band, then slowly release. |  |
| 5. Resisted scapular protraction supine | • Grasp band while lying on your back with arm flexed to 90°. Punch arm up towards the ceiling, while keeping arm straight. Your shoulder blade should lift off table. |  |

## APPENDIX A (CONTINUED)

### MOTOR CONTROL/STRENGTHENING

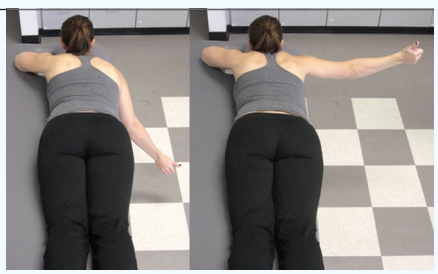
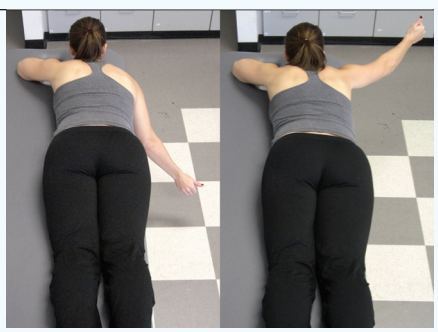
*2 to 3 sets of 10 repetitions, progressing from yellow to red to green to blue band*

| Intervention | Details | Figures |
|---|---|---|
| 6. Active elevation with upper trapezius relaxation | • Lift your arm upwards, while keeping your shoulder relaxed (avoid shrugging). You may use a mirror or your other hand to check to see if your shoulder is lifting up. |  |
| 7. Chin tuck with scapular retraction (postural exercise) | • Sitting or standing, tuck your chin and pull shoulder blades down and back. Avoid tilting of the head back or looking at the ceiling. |  |
| Phase 2 | | |
| 1. Shoulder abduction "scaption" (0°-90°) | • Stand on band and grasp other side, thumb pointing up. Lift band to shoulder level, staying in a plane of movement midway between front and side, then slowly lower. |  |
| 2. Shoulder flexion (0°-90°) | • Stand on band and grasp other side, thumb pointing up. Lift band forward to shoulder level and slowly release. |  |

## APPENDIX A (CONTINUED)

### MOTOR CONTROL/STRENGTHENING

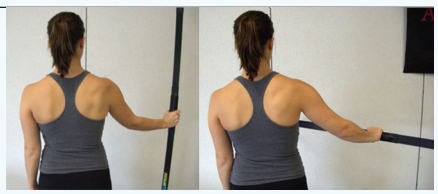
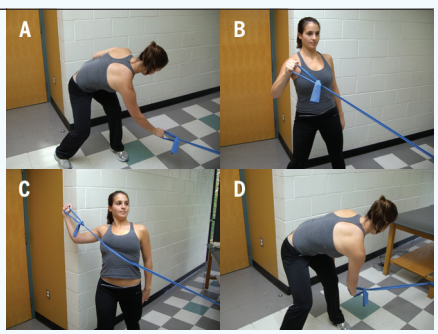
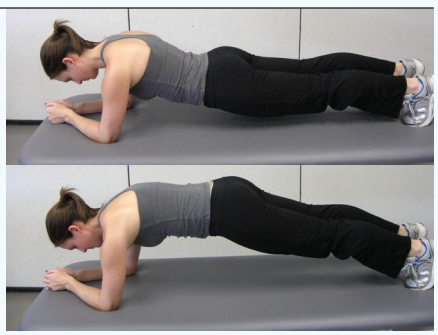
*2 to 3 sets of 10 repetitions, progressing from yellow to red to green to blue band*

| Intervention | Details | Figures |
|---|---|---|
| 3. Shoulder external rotation with abduction (45°-90°) | • Standing facing doorway, with arm at or below shoulder level and elbow bent 90°. Pull band away from the door, keeping your elbow bent and slowly release. |  |
| 4. Shoulder internal rotation with abduction (45°-90°) | • Stand facing away from the doorway, with arm at or below shoulder level and elbow bent to 90°. Grasp band and pull palms down toward the floor. Slowly release. |  |
| 5. Quadruped push-up plus "camel" | • Begin on hands and knees with arms shoulder width apart. Push downward, causing your upper back to round, then slowly release. |  |
| 6. Prone shoulder horizontal abduction with scapular retraction "T" | • Thumb turn up and lift arm up towards ceiling, while squeezing shoulder blades towards spine. Slowly lower. |  |
| 7. Prone scapular retraction and shoulder elevation "T" | • Turn thumb up and lift arm diagonally above shoulder towards the ceiling, while squeezing shoulder blades towards spine. Slowly lower. |  |

## APPENDIX A (CONTINUED)

### MOTOR CONTROL/STRENGTHENING

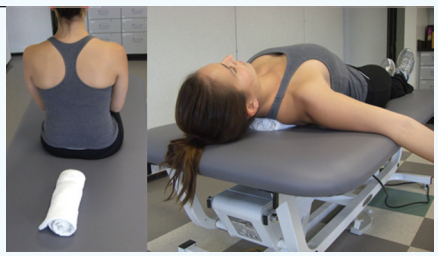
*2 to 3 sets of 10 repetitions, progressing from yellow to red to green to blue band*

| Intervention | Details | Figures |
|---|---|---|
| Phase 3 (continue all exercises from phase 2 and add the following) | | |
| 1. Bodyblade below 60° | • Standing, hold the Bodyblade in the scapular plane below 60°. Perform exercise on both vertical and horizontal planes. Progress to above 60° when able to perform exercise pain free and with good scapular control. |  |
| 2. Bodyblade above 60° | • Standing, hold the Bodyblade in the scapular plane above 60°. Perform exercise on both vertical and horizontal planes. |  |
| 3. Lawn mower pull | • Anchor band around a leg of bed or couch. Begin grasping band from across your body with hips and knees bent. Pull diagonally overhead while straightening legs and trunk. Slowly control return to start position. |   |
| 4. Forearm push-up plus "protraction plank" | • Begin in forearm plank position with upper back sagged. Push downward through your forearm causing your upper back to round then slowly release. |  |

## APPENDIX B

### STRETCHING

*30 seconds, 3 repetitions*

| Intervention | Details | Figures |
|---|---|---|
| 1. Thoracic extension towel stretch supine | • Lie on top of a towel roll placed vertically under thoracic spine. Arms out to the side with palms up. |  |
| 2. Doorway pectoral stretch | • Bring arm out to the side with elbow bent, forearm contacting wall. Turn your body away from the wall until you feel a stretch. |  |
| 3. Cross-body posterior shoulder stretching | • Bring arm across your body and use other hand to apply overpressure, pulling the elbow. |  |
| 4. Shoulder external rotation cane stretch | • Grasp cane with affected elbow bent. Use unaffected arm to push hand back toward plinth. |  |

## APPENDIX B (CONTINUED)

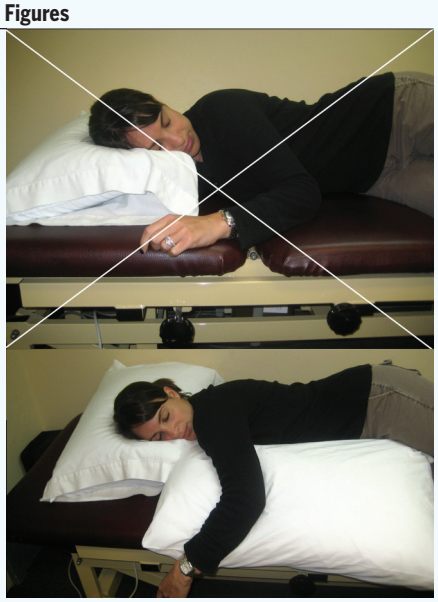
### STRETCHING

*30 seconds, 3 repetitions*

| Intervention | Details | Figures |
|---|---|---|
| 5. Shoulder internal rotation towel stretch | • Grasp towel behind your back with affected hand below. Use unaffected arm to lift affected arm until you feel a stretch. |  |
| 6. Shoulder flexion stretch. Phase 1, supine cane flexion; phases 2 and 3, standing wall stretch | • Phase 1: grasp cane with elbows straight and lift up until you feel a stretch.<br>• Phases 2 and 3: stand facing wall with arm reaching as high as possible. Slowly walk closer to the wall to increase your stretch. |  |

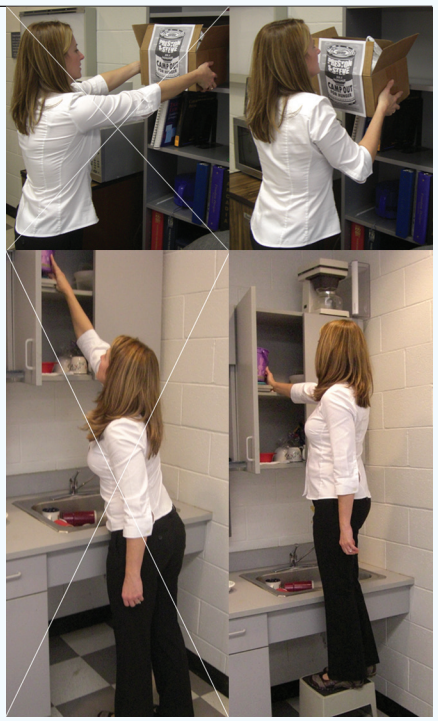
## APPENDIX C

### PATIENT EDUCATION

| Intervention | Details | Figures |
|---|---|---|
| 1. Sleeping | • If you sleep well and wake up without pain, do not change anything.<br>• If you have trouble sleeping because of your shoulder, avoid resting your arm over your head and letting your arm rest across your body (may decrease blood flow).<br>• Also try propping your arm on a pillow to keep the arm slightly away from your side. |  |

## APPENDIX C (CONTINUED)

### PATIENT EDUCATION

| Intervention | Details | Figures |
|---|---|---|
| 2. Daily activities | • Avoid working with arms near or above horizontal. Keep your elbows near your body for any prolonged work.<br>• Keep objects close to body when lifting, especially repetitive activities.<br>• Use a stool when a high reach is required. |  |
| 3. Strenuous work/sports | • Incorporate the spine and hips for extreme and overhead movements.<br>• Be sure your fitness level matches the task you are doing, don't go beyond your capacity.<br>• Avoid excessive fatigue, take breaks when needed.<br>• Use assistive devices whenever possible (eg, carts, lift trucks). |  |

## APPENDIX D

### MANUAL THERAPY

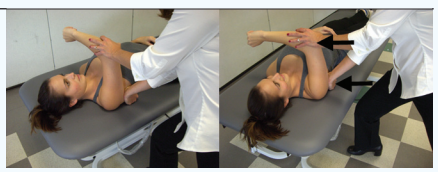
*10 to 15 minutes total duration, at least 1 thoracic, posterior shoulder, and inferior shoulder technique required*

| Intervention | Details | Figures |
|---|---|---|
| Thoracic spine | | |
| 1. Thoracic posterior-to-anterior (PA) glides in prone | • Patient assumes prone position. Use pisiform to apply PA glide on spinous process. Hook fifth digit of top hand with index of bottom hand or use pisiform of both hands on either side of spinous process to apply PA glide. |  |
| 2. Thoracic PA glides seated | • Seated, patient grasps hands behind neck. Clinician makes a "V" with thumb and index fingers or uses pisiform to apply PA glide, while extending patient's thoracic spine. |  |
| 3. Thoracic thrust in prone (maximum 2 reps) (**ONLINE VIDEO**) | • Patient assumes prone position. Target area is mid to low thoracic spine. Place pisiforms over transverse processes of single vertebra, then rotate hands so they are parallel to the spine to improve traction on the skin. Take up slack then ask patient to exhale. Perform a low-amplitude high-velocity thrust at end range in a PA direction. |  |
| 4. Thoracic thrust in supine (maximum 2 reps) (**ONLINE VIDEO**) | • The target area is the mid to upper thoracic spine. Ask patient to clasp hands at the base of the neck. Stabilize segment using the "pistol" grip then use patient's arms to adjust spinal position over selected segment. Clasp patient's elbows and use body weight to apply high-velocity, low-amplitude thrust through patient's arms. |  |
| 5. Distraction thrust (maximum 2 reps) | • Targets are upper thoracic and lower cervical area. Patient is seated with hands clasped at base of neck. Clinician feeds hands through the patient's upper extremities to lie on top of patient's hands. Take up slack then apply high-velocity, low-amplitude distraction thrust. |  |

## APPENDIX D (CONTINUED)

### MANUAL THERAPY

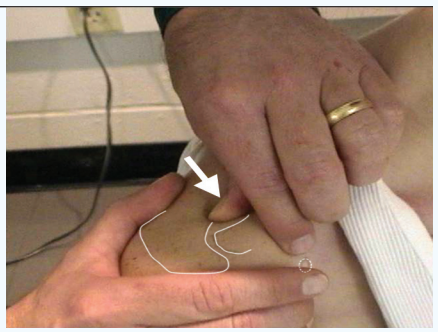
*10 to 15 minutes total duration, at least 1 thoracic, posterior shoulder, and inferior shoulder technique required*

| Intervention | Details | Figures |
|---|---|---|
| Posterior shoulder | | |
| 1. Posterior glide glenohumeral mobilization | • Patient is positioned supine with towel under scapula. Apply a posterior glide to the head of the humerus. Humeral position can vary. |  |
| 2. Mulligan mobilization with movement (posterior glide with elevation) | • Patient assumes seated position. Wrap one arm around patient on head of the humerus. The other hand stabilizes the scapula. Apply posterior glide with frontal hand. Apply constant force as patient actively elevates and lowers the arm. |  |
| 3. Posterior shoulder stretch (cross-body) | • With patient supine, stabilize the scapula medially using thenar eminence of 1 hand. Use the other hand to apply a medially directed force. Hold for 30 seconds and repeat 3 times. |  |
| 4. Passive stretching into internal rotation | • Patient in sidelying or supine position. Place shoulder in internal rotation end range and use one of the following techniques: sustained stretch, contract-relax, or oscillations at the end range. |  |

## APPENDIX D (CONTINUED)

### MANUAL THERAPY

*10 to 15 minutes total duration, at least 1 thoracic, posterior shoulder, and inferior shoulder technique required*

| Intervention | Details | Figures |
|---|---|---|
| Inferior shoulder and acromioclavicular joint | | |
| 1. Inferior glenohumeral glides | • Place patient in supine. Technique can be applied throughout the range. Stabilize scapula if performing glide in neutral. If in abducted position, be lateral to the acromion process. |  |
| 2. PA glide on clavicle | • Patient assumes seated position. Head is in neutral or turned away from shoulder to allow upper trapezius to relax. One of clinician's hands is wrapped around the patient's lateral shoulder, and the other pinches the distal clavicle. Anterior mobilization is applied to patient's distal clavicle. |  |
| 3. Inferior glide of clavicle on acromion | • Patient assumes supine position. Head is in neutral position or turned away from shoulder to allow upper trapezius to relax. Clinician has one hand stabilizing the patient's scapula and the other hand on the superior aspect of the distal clavicle. An inferior mobilization force is applied to the distal clavicle via thenar eminence. |  |