Use of a Movement System Impairment Diagnosis for Physical Therapy in the Management of a Patient With Shoulder Pain

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houlder pain is a problem commonly treated by physicians and physical therapists. Shoulder pain is associated with a variety of diagnoses, such as impingement, instability, acromioclavicular joint pathology, and rotator cuff tear. Both physical therapists and physicians attempt to differentiate among possible causes of pain before selecting an approach to treatment.

The diagnoses made by physicians are based on the findings from their examination and special tests, with a focus on identifying the injured tissue that appears to be the source of the symptoms and ruling out other sources that may be referring pain to the shoulder region.

Common to the medical diagnoses for shoulder pain is the fact that the diagnoses relate to the specific anatomical tissues that are considered the source of the symptoms. In general, the findings from the physician’s examination determine whether immediate surgical intervention is required rather than a trial of conservative management, including medications, restriction of activities, and physical therapy. In most cases, conservative management is the first approach, of which physical therapy is an important component. The physician’s diagnoses related to the pathoanatomical source of pain are not designed to guide physical therapy intervention.

As in this case, most often the pain is associated with movement; thus we believe that alterations in the precision of movement are the cause of the tissue irritation and need to be corrected for achieving the optimal outcomes. Based on the premise that the physical therapist has primary expertise in analysis of the movement system, Sahrmann has developed a system of diagnoses for the shoulder, based on movement system impairments (MSI), to guide physical therapy treatment. The diagnoses are named for the alignments and movements that appear to be related to the patient’s symptom behavior. The focus of the diagnoses is on the movement that produces the pain rather than the pathoanatomical source of the pain. TABLE 1 provides a list of the proposed diagnoses. TABLE 2 provides definitions of the scapular movements.

The MSI system of classification of shoulder problems is based on the basic premise that loss of precise movement is the result of repetition of movements and positions in specific directions with...
The repetition is proposed to induce alterations in the biomechanical and motor control components of the movement system. For example, repetition may result in increases or decreases in tissue stiffness or changes in timing or magnitude of activity of various muscles. The loss of movement precision is proposed to contribute to repeated low-magnitude stresses to the tissues in the same direction. This accumulation of stresses to the tissues in a specific region of the shoulder may lead to microtrauma and eventually shoulder symptoms. The MSI theory also contends that, until the alterations in the biomechanical and motor control components are modified, the shoulder problem has the potential to persist or recur.

The clinical examination includes a history and a set of clinical tests of movements and positions. The examination is unique in the way the effect of each test on the person’s shoulder symptoms is monitored. The person performs each test using his preferred strategy, while the examiner assesses symptoms and makes judgments about direction-related patterns of movement or alignment. If a movement or position provokes symptoms, the test is standardly modified to correct the person’s preferred pattern. The effect of the modification on the symptoms is assessed relative to the symptoms, using the preferred pattern. Overall, the modifications involve either changes in (1) movement to improve the timing and magnitude of the scapular movement or to improve movement of the humerus relative to the scapula, (2) initial alignment to improve movement of the humerus and scapula, or (3) static alignment of the trunk, scapula, and humerus.

Upon completion of the examination, the findings are reviewed to determine if there is a consistent pattern of symptom responses (increased and decreased) associated with movement and alignment patterns related to a specific direction. Consistency of responses across the direction-related tests leads to the assignment of the MSI-related diagnosis and the focus of physical therapy treatment. Treatment involves (1) educating the person about the specific direction(s) of alignment and movement that appear to be contribut-
ing to the shoulder problem, (2) modifying the direction-specific alignment and movement patterns during daily activities, and (3) exercises to address the impairments (for example, weak scapular upward rotator muscles) that appear to contribute to the direction-related alignment and movement patterns.

The purposes of the following case report are to (1) illustrate the use of a MSI diagnosis for physical therapy in a patient with shoulder pain, (2) illustrate how the diagnosis guided treatment prescription, and (3) describe the outcomes of treatment based on a MSI diagnosis for shoulder pain.

Informed consent for clinical case studies was obtained according to the established procedures of the Human Studies Committee of Washington University.

**CASE DESCRIPTION**

**History**

The patient was a 46-year-old, Caucasian, female physical therapist who was referred to physical therapy for evaluation and treatment of right shoulder pain. The patient was right handed, weighed 61 kg, and was 1.68 m tall. At the time of her first clinic visit, she was taking Fosomax for osteopenia and Celexa for depression, but was not taking medication for the shoulder pain. She was working.

**Pain Location and Behavior**

The patient reported (1) pain located in the superior and anterior aspects of her right shoulder that had begun 2 months ago, (2) pain that was constant, with varying intensity and had a stabbing and aching quality, (3) pain intensity at rest of 1 on a 0-to-10 verbal numeric pain scale, with 0 being no pain present and 10 severe pain that would require going to the emergency room, and (4) a worst pain intensity of 6/10 for this episode. The patient also reported that her pain started while riding an Aerodyne bicycle 2 months ago and gradually increased. She stopped riding the bike 1 month ago and initiated the exercises that were prescribed for a previous episode of right shoulder pain. The exercises did not relieve but increased the pain. The pain increased with (1) reaching out to the side and was worse if the shoulder was laterally rotated versus medially rotated, (2) horizontal adduction associated with turning off her alarm clock, (3) reaching across the car from the driver’s seat, and (4) using a curling iron. The patient’s pain was worse upon awakening in the morning. She reported sleeping in supine or left sidelying. Her pain decreased with rest. The patient reported no neck pain, paresthesias, stiffness, feelings of instability, clicks, or weakness, and her pain never extended beyond the mid deltoid region.

**Occupation and Fitness Activities**

As a physical therapist she led exercise classes for people with osteoporosis and cancer. She also performed interventions for patients with lymphedema, including bandaging and lymphedema massage. Her fitness activities included use of the treadmill, bike, Stairmaster, or elliptical glider for 45 minutes, 5 times per week.

**Physical Examination**

The examination was performed by the first author, a physical therapist with 28 years of experience, with expertise in the shoulder and certification as a hand therapist. The examination consisted of direction-specific tests of movements and alignments, during which, pain was monitored and judgments were made regarding alterations relative to a kinesthetic standard. The tests were performed in various positions. Functional movements that were painful were simulated by the patient and analyzed by the examiner. The examiner’s judgments of alignment and movement were based on visual or visual and tactile information. If the patient reported an increase in pain with a primary test in which the patient used her preferred strategy, the patient’s preferred movement was immediately followed by a secondary test in which the patient’s preferred movement or alignment was modified. The modification was performed in an attempt to decrease or eliminate the pain. Modifications were accomplished using either verbal cues, muscle activation by the patient, as instructed by the examiner, or manual assistance by the examiner. **TABLE 1** provides the standard and the positive findings from the primary and secondary tests for the patient in this case.
**CASE REPORT**

**Alignment** Impairments in alignment are believed to correlate with specific movement-related diagnoses and also to provide clues as to the resting lengths of the muscles. Alignment findings on the right, with the patient in the standing position, included an anterior humeral head, glenohumeral joint resting in extension, and anteriorly tilted and adducted scapula (**TABLE 3**). An anteriorly positioned humeral head relative to the acromion and the glenohumeral joint extension are signs typical of the MSI diagnosis of humeral anterior glide (**TABLE 1**).60 Anteriorly tilted scapulae may indicate a short or stiff pectoralis minor.9,34,60 Adducted scapulae may indicate shortness or stiffness of the scapular adductors.24,60 The left scapula was also anteriorly tilted and adducted, but not as much as the right.

**Movement Testing** The patient’s preferred method of shoulder flexion in standing produced pain on the right, and movement impairments included decreased scapular upward rotation, a humeral head that by visual assessment appeared too prominent anteriorly, and increased shoulder medial rotation. During the modified shoulder flexion test in standing, manual correction of the scapular motion resulted in a minimal decrease in pain. The examiner next corrected the humeral head position by applying a posteriorly directed force during shoulder motion. The posterior glide decreased the pain more than correction of the scapular motion. Thus, the primary impairment was assumed to be the anterior humeral head position (**TABLE 1**). Based on the pain response, the scapular movement impairment of insufficient upward rotation was also believed to be contributing to the production of pain but was not considered the primary problem. Correction of the humeral medial rotation was also performed, resulting in an increase of symptoms. Therefore shoulder medial

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**TABLE 3**

**Positive Findings From Standardized Examination**

<table>
<thead>
<tr>
<th>Test*‡</th>
<th>Standard Findings ‡</th>
<th>Findings†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alignment: side view</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Humeral head relative to acromion</td>
<td>No more than 1/3 of humeral head anterior to anterolateral corner of acromion60</td>
<td>Greater than 1/3 of right humeral head anterior to acromion</td>
</tr>
<tr>
<td>• Resting position of glenohumeral joint</td>
<td>0º flexion or extension62</td>
<td>Right glenohumeral joint resting in extension</td>
</tr>
<tr>
<td>• Shoulder joint relative to plumb line</td>
<td>Plumb line bisects shoulder joint34</td>
<td>Shoulders anterior relative to imaginary plumb line</td>
</tr>
<tr>
<td>Alignment: posterior view</td>
<td>Vertebral border of scapula 762 cm from spine64</td>
<td>Adducted bilaterally, less than 762 cm from spine</td>
</tr>
<tr>
<td>• Scapula anteriorly tilted 20º50</td>
<td>Tilted anteriorly bilaterally greater than 20º</td>
<td>Tilted anteriorly bilaterally greater than 20º</td>
</tr>
<tr>
<td>Active shoulder flexion</td>
<td>Humeral head should not medially rotate excessively40</td>
<td>Right humeral head anterior greater than left</td>
</tr>
<tr>
<td>• Humeral head should not medially rotate excessively40</td>
<td>Scapula upwardly rotated 45º</td>
<td>Humerus medially rotated greater than left</td>
</tr>
<tr>
<td>• Scapula upwardly rotates 60º and posteriorly tilts40</td>
<td>Painful arc of motion with active shoulder flexion</td>
<td></td>
</tr>
<tr>
<td>Modified active shoulder flexion</td>
<td>Motion consists of both glenohumeral horizontal abduction and scapular adduction</td>
<td></td>
</tr>
<tr>
<td>• Manually assisted to increase scapular upward rotation</td>
<td>Minimal decrease in symptoms</td>
<td></td>
</tr>
<tr>
<td>• Manually applied posterior glide to head of humerus</td>
<td>Resulted in greater decrease in symptoms</td>
<td></td>
</tr>
<tr>
<td>• Active increased glenohumeral lateral rotation1</td>
<td>Increased symptoms</td>
<td></td>
</tr>
<tr>
<td>Functional active reaching out to the side</td>
<td>Decreased scapular adduction and increased humeral anterior glide</td>
<td></td>
</tr>
<tr>
<td>• Scapula upwardly rotated 45º §</td>
<td>Symptoms were produced</td>
<td></td>
</tr>
<tr>
<td>• Painful arc of motion with active shoulder flexion</td>
<td>Symptoms alleviated</td>
<td></td>
</tr>
<tr>
<td>Modified functional active reaching out to the side</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Sitting** |                       |           |
| Manual muscle test9 of serratus anterior | 5/5 strength | 4/5 |
| Supine |                       |           |
| Muscle length (tested passively) |                       |           |
| • Pectoralis minor | Posterior aspect of acromion less than 2.54 cm from table with passive stretch60 | Short on right |
| • Teres major | 170º-180º of shoulder flexion with lateral border of scapula protruding from posterior lateral border of trunk no greater than 1.27 cm60 | Short on right |

continued on next page
rotation was not considered as a likely diagnosis.

No winging or tilting of the scapula was noted during shoulder flexion or the return from shoulder flexion, so the diagnosis of scapular winging/tilting was unlikely. The diagnosis of scapular abduction was also unlikely because at rest the patient’s scapulae were adducted and did not abduct excessively during active shoulder flexion.

When simulating reaching out to the side in standing (scapular adduction and horizontal abduction), pain was produced and excessive glenohumeral joint movement was noted relative to scapulothoracic movement. This movement impairment was believed to be contributing to the anterior humeral head position. Pain was reduced by decreasing the amount of glenohumeral movement relative to the scapulothoracic movement.

Shoulder active lateral rotation in prone was tested to assess the pattern of muscle recruitment. The muscles involved included the trapezius, serratus anterior, infraspinatus, teres minor, and posterior deltoid. The patient’s preferred method of performing shoulder lateral rotation produced pain, and excessive humeral anterior glide was palpated during the movement. Based on visual observation of slight glenohumeral horizontal abduction, prominence of the posterior deltoid muscle belly, and palpation, the posterior deltoid seemed to have excessive activity. The boundaries of the posterior deltoid muscle were clearly visible and easily palpable, and glenohumeral horizontal abduction coincided with the increase in humeral anterior glide. Consistent with the MSI diagnosis of humeral anterior glide, pain was abolished if shoulder lateral rotation was performed without anterior glide and horizontal abduction (Table). The impairments were corrected by the examiner applying suf-

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**TABLE 3**

<table>
<thead>
<tr>
<th>Test*†</th>
<th>Standard</th>
<th>Findings‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active and passive range of motion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Shoulder lateral rotation (with 90° abduction)</td>
<td>90° with shoulder abducted 90°&lt;sup&gt;0&lt;/sup&gt;</td>
<td>Greater than 90° lateral rotation on right</td>
</tr>
<tr>
<td>• Shoulder medial rotation&lt;sup&gt;0&lt;/sup&gt; (with 90° abduction)</td>
<td>70° with shoulder abducted 90°&lt;sup&gt;0&lt;/sup&gt;</td>
<td>40° on right; greater than 70° on left</td>
</tr>
<tr>
<td>• Horizontal adduction</td>
<td>Olecranon passes midline during passive horizontal adduction with scapula stabilized</td>
<td>Range of motion into horizontal adduction limited bilaterally</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal adduction produced symptoms on right</td>
</tr>
</tbody>
</table>

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The table continues with additional tests and findings, including manual muscle strength tests and modifications of specific movements.
ficient force posteriorly to align the head of the humerus properly with the glenoid for the starting position, and during the active motion. The patient was also cued to avoid moving the glenohumeral joint into horizontal abduction.

**Manual Muscle Testing** The strength of the serratus anterior was tested in sitting, as described by Kendall et al. Although testing the right shoulder of the patient in this case was painful, the pain was minimal and did not appear to affect the test, so a grade of 4/5 was assigned. Optimal function of the serratus anterior is needed for appropriate pain-free scapular motion during overhead movements. Weakness is a contributing factor to insufficient scapular upward rotation. Weakness of the serratus anterior when tested at its shortened length is proposed to be consistent with the alignment fault of scapular adduction in standing. These signs are consistent with a MSI diagnosis of scapular downward rotation (TABLE 1).

Manual muscle tests of the right middle and lower trapezius indicated weakness of the muscles that upwardly rotate the scapula. This finding is consistent with the insufficient scapular upward rotation noted during shoulder flexion in standing. During the testing of the middle trapezius muscle, the patient-preferred movement pattern was excessive glenohumeral joint horizontal abduction rather than scapulothoracic adduction and posterior tilt. This movement pattern is consistent with a proposed diagnosis of humeral anterior glide.

**Flexibility and Range of motion** Muscle length tests of the pectoralis minor, teres major, latissimus dorsi, and pectoralis major were tested in supine, as described by Kendall et al and Sahrmann. Short pectoralis minor and teres major muscles were identified. The finding of a short pectoralis minor was consistent with the alignment of an anteriorly tilted scapula. A short pectoralis minor may contribute to insufficient scapular upward rotation during shoulder flexion and insufficient scapular posterior tilt during the functional motion of reaching out to the side.

Shoulder medial rotation and horizontal adduction in supine were performed to assess the length of the posterior structures of the glenohumeral joint. The posterior structures include the posterior deltoid, infraspinatus, teres minor, and the posterior capsule. Shortness of the posterior structures of the shoulder are believed to contribute to humeral anterior glide by not allowing sufficient posterior glide during overhead motions and horizontal adduction.

The length of the posterior deltoid and glenohumeral joint posterior capsule were assessed by moving the glenohumeral joint into horizontal adduction while manually stabilizing the scapula. Shoulder medial rotation was assessed as described by Kendall et al and Sahrmann. Both glenohumeral joint medial rotation and horizontal adduction were considered limited on the right.

Shoulder lateral rotation was performed in supine with the arm abducted 90° to assess the length of the anterior structures of the glenohumeral joint. The anterior glenohumeral joint structures include the clavicular pectoralis major, subscapularis, and the anterior capsule. This patient’s shoulder lateral rotation motion was excessive. Excessive shoulder lateral rotation may be indicative of laxity of the anterior structures of the glenohumeral joint, potentially allowing excessive anterior translation of the humeral head during arm movements.

The shortness of the posterior structures and the laxity of the anterior structures of the glenohumeral joint are findings consistent with the proposed MSI diagnosis of humeral anterior glide. Glenohumeral hypomobility was ruled out because the criteria for this MSI diagnosis is limitation of glenohumeral motion in all directions.

**Diagnosis**

The patient was given the primary MSI diagnosis of humeral anterior glide and a secondary diagnosis of scapular downward rotation. The findings from the history and examination that led to...
these diagnoses included the following: (1) resting alignment of anterior humeral head and glenohumeral joint extension, (2) excessive anterior humeral head position during active shoulder flexion that produced pain and was alleviated when a posteriorly directed force was applied, (3) insufficient scapular upward rotation during active shoulder flexion that produced pain and decreased when scapular rotation was corrected, (4) a reduction of pain that was greater with the application of a posterior force to the head of the humerus than the reduction of pain with the correction of scapular upward rotation, (5) excessive glenohumeral joint movement relative to scapulothoracic movement during scapular adduction and posterior tilt with horizontal abduction, and pain that was reduced by decreasing the amount of glenohumeral relative to scapulothoracic movement, (6) limited passive shoulder medial rotation and horizontal adduction range of motion, (7) excessive passive shoulder lateral rotation, and (8) a movement pattern of humeral anterior glide and excessive activity of the posterior deltoid during prone lateral rotation, with a decrease in pain by correction of the humeral anterior glide.

Factors believed to be contributing to the movement impairments were (1) short pectoralis minor9 and posterior structures of the glenohumeral joint, and (2) weakness of the middle and lower trapezius and serratus anterior muscles.30,31

Treatment
Based on the MSI diagnosis, the patient was educated to avoid positions and movements that promoted excessive humeral anterior glide and to increase scapular upward rotation with overhead motions. Treatment consisted of instruction in a home exercise program (HEP), practice correcting functional movements, and patient education. Practice of the modified movement patterns during functional activities was incorporated into the treatment sessions and HEP. The patient was educated regarding how to increase scapular upward rotation during overhead motions, scapular adduction, and posterior tilt during horizontal abduction motions, and to avoid prolonged positions with the glenohumeral joint in extension. The patient was cued to elevate the acromion to increase scapular upward rotation, especially in the last half of overhead movement. Manual assistance was provided during the learning process to increase scapular upward rotation during overhead motions, scapular adduction and posterior tilt during horizontal abduction, and to avoid excessive anterior positioning or movement of the humeral head. The exercises were performed initially without resistance. Resistance was added when the exercise could be performed without pain, maintaining the modified alignment and performing the modified movement pattern. During each visit, the pain-provoking functional activities were simulated, observed, corrected, and practiced. The patient was consistently able to move without pain if the movement pattern was modified. She was told that none of the exercises should produce or increase her pain.

Home Exercise Program
Passive shoulder horizontal adduction and shoulder medial rotation were prescribed to increase the flexibility of the posterior deltoid, shoulder lateral rotators, and glenohumeral joint posterior capsule (FIGURES 1 and 2).3,26,41,72,80

Active shoulder lateral rotation in prone was prescribed to teach the patient to rotate without excessive anterior glide, while keeping the scapula stationary. FIGURE 3 displays the incorrect positioning for the exercise and FIGURE 4 the correct position. Correct positioning is believed to increase the recruitment of the infraspinatus and teres minor, and to decrease recruitment of the posterior deltoid.

Active shoulder medial rotation in prone was initiated to improve the performance of the subscapularis, which helps to prevent humeral anterior trans-

FIGURE 4. Correct alignment and instructions for movement for shoulder lateral and medial rotation exercises in prone. A towel roll was placed under the anterior aspect of the glenohumeral joint so that the scapula was aligned on thorax approximately 7.62 cm from the spine, and the humerus was aligned in the scapular plane. This is believed to promote good alignment of the humerus with the glenoid cavity. During the exercise the patient was instructed to rotate the humerus on an axis, avoiding lifting the elbow (horizontal abduction) and moving the head of the humerus anteriorly against the towel roll. The patient was instructed to keep the scapula stable during the humeral movement.

FIGURE 5. Middle trapezius exercise in prone. The patient was positioned prone with a pillow under the chest and abdomen and a towel roll under the forehead. The head was positioned in midline. The arms were positioned overhead so that the shoulder was abducted greater than 90° and the humerus in lateral rotation maintaining the scapula in an upwardly rotated position. The elbows were flexed to decrease resistance. The patient was instructed to adduct the scapula and lift the arms off the surface without horizontal abduction of the glenohumeral joint.

FIGURE 6. Starting position for serratus anterior exercise in quadruped. The back should be flat, hips aligned vertically over knees, hips flexed 90°, vertebral border of scapulae flat against thorax.
lation (FIGURE 4). Later, resistance exercises for medial rotation in prone and in standing were added.

Exercises were prescribed for strengthening the middle trapezius and the serratus anterior to improve upward rotation of the scapula. An exercise in prone was prescribed for the middle trapezius and in quadruped for the serratus anterior (FIGURES 5 through 7). Shoulder flexion performed with the back to the wall was prescribed to facilitate activity of the trapezius and serratus at the correct length during arm elevation. We have observed that the sensory feedback provided by contact with the wall facilitates maintaining correct alignment (FIGURE 8).

The patient was instructed in an exercise to stretch the pectoralis minor because shortness may prevent sufficient scapular upward rotation and posterior tilt (FIGURE 9).

TABLE 4 provides information about timing and progression of the prescribed exercises.

![FIGURE 7. Serratus anterior exercise rocking back in quadruped. The patient was instructed to rock back as far as possible allowing her hands to slide forward so that the scapula moved through the full range of scapular upward rotation.](image1)

![FIGURE 8. Shoulder flexion exercise in standing with back against the wall. The patient was instructed to stand with her trunk resting against the wall and her heels 5.08 to 7.62 cm from the wall. The lumbar spine should be flat. Because the patient was unable to flatten the lumbar spine with the heels 5.08 to 7.62 cm from the wall, the feet were moved farther from the wall and the hips and knees flexed until the desired lumbar spine alignment could be achieved. The patient was then instructed to raise her arms overhead in the sagittal plane, sliding her fingertips up the wall as far as possible, while maintaining the correct spinal alignment.](image2)

![FIGURE 9. Pectoralis minor stretching exercise in supine. The patient was instructed to relax while the therapist placed the palm of her hands over the coracoid processes and applied a force diagonally in a posterior, lateral, and superior direction opposite the direction of the muscle fibers of the pectoralis minor. The force was applied bilaterally to avoid any rotation of the patient’s trunk. The patient was instructed to have a partner help her with this exercise at home.](image3)

### TABLE 4 Specific Exercises Included in Home Exercise Program

<table>
<thead>
<tr>
<th>Visit 1 (4/10/02)</th>
<th>Visit 2 (4/23/02)</th>
<th>Visit 3 (5/7/02)</th>
<th>Visit 4 (5/22/02)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supine passive horizontal adduction</strong></td>
<td>Continued</td>
<td>Continued</td>
<td>Continued</td>
</tr>
<tr>
<td><strong>Supine shoulder MR</strong></td>
<td>Not documented</td>
<td>Not documented</td>
<td>Continue (increased ROM to 55º)</td>
</tr>
<tr>
<td><strong>Supine pectoralis minor stretch</strong></td>
<td>Continued</td>
<td>Continued</td>
<td></td>
</tr>
<tr>
<td><strong>Prone active middle trapezius with elbows flexed</strong></td>
<td>Progressed to using 0.17-kg weight</td>
<td>Patient had not added weight, so instructed to add 0.17-kg weight</td>
<td>Continue same</td>
</tr>
<tr>
<td><strong>Prone active shoulder LR</strong></td>
<td>Progressed to using a 0.45-kg weight</td>
<td>Progressed weight to 0.9 kg</td>
<td>Continue same</td>
</tr>
<tr>
<td><strong>Standing active shoulder flexion with back to wall</strong></td>
<td>Continued</td>
<td>Cued to correct anterior glide on return from shoulder flexion and added resistance with yellow Thera-Band</td>
<td>Continue: no problems with exercise</td>
</tr>
<tr>
<td><strong>Quadruped rocking back</strong></td>
<td>Progressed to resistance by self via active knee extension into table</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Prone active medial rotation</strong></td>
<td>Worked on alignment/positioning during exercise. No weight added because patient getting pain if not positioned very carefully. Needed cues for positioning</td>
<td>Progressed to using 0.45-kg weight. Provided cues for positioning</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Resisted shoulder MR in standing with humerus adducted using yellow Thera-Band and with careful alignment (elbow in front of shoulder)</td>
</tr>
</tbody>
</table>

*Abbreviations: LR, lateral rotation of shoulder; MR, medial rotation of shoulder; ROM, range of motion.*
Specific Functional Activities The patient was given instructions to support her right arm on pillows when sleeping on her left side, to maintain the correct alignment of the shoulder. The patient was cued to increase the amount of scapular adduction and posterior tilt and decrease the amount of glenohumeral horizontal abduction during reaching into the passenger seat of the car. She was cued to increase scapular upward rotation and keep the humerus in the scapular plane during use of the curling iron.

Suggestions were made to avoid excessive glenohumeral horizontal abduction or extension and to increase the amount of scapular upward rotation with overhead movements used during her fitness activities. The suggestion was made that the patient ride a regular bicycle rather than the Aerodyne, because the Aerodyne requires repetitive motion of the glenohumeral joint into extension.

OUTCOMES

Outcome measures included (1) a visual analogue pain scale to measure pain intensity at rest and with the use of her right arm, (2) patient report of overall percentage decrease in pain from first physical therapy visit, (3) frequency of pain with painful functional activities, (4) range of motion of passive shoulder medial rotation and horizontal adduction, and (5) strength of the scapular muscles. Table 5 provides the outcome measures across the treatment period.

The patient was contacted by phone twice after discharge from treatment, and was given a standardized 5-item written questionnaire to measure long-term outcomes. Three of the items on the questionnaire related to pain intensity and presence of pain with movements or functional activities. The remaining 2 items related to whether the patient was performing the HEP and consciously modifying her functional movements.

The patient was seen every other week for a total of 4 sessions. By the last visit, the patient was pain free at rest, with turning off the alarm clock, and upon awakening in the morning. She still reported pain with use of her curling iron. Shoulder medial rotation had increased from 40° to 55°, and horizontal adduction was considered normal and pain free. The patient called 1 month after discharge stating that her shoulder continued to be pain free at rest, with turning off the alarm clock, and upon awakening in the morning. She reported 95% improvement in her pain compared to the first visit. One hundred percent improvement was defined as no longer having any shoulder pain at rest.

Table 5

Table of Measures of Treatment Outcome

<table>
<thead>
<tr>
<th>Measure</th>
<th>Visit 1 (4/10/02)</th>
<th>Visit 2 (4/23/02)</th>
<th>Visit 3 (5/7/02)</th>
<th>Visit 4 (5/22/02)</th>
<th>Phone Call (6/19/02)</th>
<th>Phone Call (8/5/02)</th>
<th>Questionnaire and Final Measures (10/13/02)</th>
<th>Questionnaire (8/31/05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With use</td>
<td>6/10</td>
<td>5/10</td>
<td></td>
<td></td>
<td>0/10</td>
<td>0/10</td>
<td>10/10</td>
<td>0/10</td>
</tr>
<tr>
<td>At rest</td>
<td>1/10</td>
<td></td>
<td>1/2/10</td>
<td>0/10</td>
<td>0/10</td>
<td>0/10</td>
<td>0/10</td>
<td>0/10</td>
</tr>
<tr>
<td>Turning off alarm clock</td>
<td>Painful</td>
<td>Minimal pain</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
</tr>
<tr>
<td>Upon awakening</td>
<td>Painful</td>
<td>Improved</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
</tr>
<tr>
<td>Using curling iron</td>
<td>Painful</td>
<td>Painful</td>
<td>7/10 pain</td>
<td>Painful</td>
<td>Painful</td>
<td>Pain free</td>
<td>Pain free</td>
<td>Pain free</td>
</tr>
<tr>
<td>Work and fitness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent decreased</td>
<td>N/A</td>
<td>70%-75%</td>
<td>85%</td>
<td>95%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Shoulder ROM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MR†</td>
<td>40°</td>
<td></td>
<td>55°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal adduction‡</td>
<td>Limited, painful</td>
<td>Normal, no pain</td>
<td>Normal, no pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength§</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serratus anterior</td>
<td>4/5, painful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4/5</td>
</tr>
<tr>
<td>Middle trapezius</td>
<td>3/5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3+/5</td>
</tr>
<tr>
<td>Lower trapezius</td>
<td>3/5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3+/5</td>
</tr>
<tr>
<td>Rhomboid</td>
<td>5/5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5/5</td>
</tr>
</tbody>
</table>

Abbreviations: MR, medial rotation; ROM, range of motion.
1. Verbal pain scale: 0 to 10, with 0 as no pain present and 10 as the worst pain imaginable.
2. Medial rotation range of motion of shoulder measured in supine with humerus abducted 90°.
3. Assessed passively supine with the scapula stabilized manually by the examiner. This was considered limited if the olecranon did not move past midline.
4. Tested as described by Kendall et al. Scoring scale: 5/5, normal strength; 4/5, able to hold against moderate resistance; 3+/5, able to hold against minimal resistance; 3/5 able to hold against gravity but not against additional minimal resistance applied manually.
and during or after work, fitness, or activities of daily living. She was pleased with the results of the physical therapy and did not feel like she needed further treatment. As a result, some of the outcome measures were not retested at the time of the last physical therapy visit.

The second written questionnaire was administered in person. Upon request, the patient consented to come in to obtain photographs and final measures, including manual muscle testing, tests for soft tissue differential diagnosis, and range of motion. At this time, the patient was performing all activities that she performed prior to her episode of shoulder pain without pain.

Three years postdischarge the patient completed a third questionnaire. At this time, the patient still reported that her shoulder was pain free and she was performing all activities that she performed prior to this episode of shoulder pain. She was no longer performing the prescribed home exercises but continued to modify her movement pattern during functional activities.

DISCUSSION

We have proposed that physical therapists identify the MSI diagnosis to select the most effective and efficient treatment for the patient. The MSI diagnosis assigned to our patient was humeral anterior glide with scapular downward rotation. The diagnosis extends beyond a list of impairments in that it identifies the primary movement impairment that provoked the patient’s shoulder pain and describes the contributing impairments such as alignment and tissue adaptations. In this way the MSI diagnosis describes a syndrome. The patient was instructed in methods of modifying the movement patterns that had been identified as contributing to her shoulder pain. She practiced the modifications during her home exercises and functional activities until the movements could be performed correctly and without pain. The MSI diagnosis specifically guided the treatment, resulting in positive short- and long-term outcomes. Patients with a diagnosis of impingement have a variety of different movement impairments.\(^5^0\) Depending on the type of scapular or humeral movement impairment, the treatment provided to the patient would vary.\(^5^0\) We are proposing that the same exercises are not equally effective across all the movement-based diagnostic categories, nor for all patients with a diagnosis of impingement. Of importance in this case was the differential MSI diagnosis for the shoulder region (TABLE I).

Diagnostic Systems for Patients With Shoulder Pain

To our knowledge no other shoulder pain diagnostic classification systems have been described that specifically guide physical therapy intervention. The Guide to Physical Therapy Practice\(^2\) describes “patient diagnostic classifications” and options for care. The classifications are named for the “preferred practice patterns” for various conditions.\(^2\) These practice patterns have served as an important resource. The MSI diagnostic categories, however, add a level of specificity for treatment not currently provided by the patient diagnostic classifications in The Guide.

Some investigators have documented relationships between movement patterns and shoulder pain in patients with the physician’s diagnosis of shoulder impingement.\(^5^2,5^4,5^9,6^3,6^7^9\) These investigators selected subjects based on the physician’s diagnosis of impingement and were compared to healthy control subjects rather than differentiating shoulder conditions according to specific movement-system impairments. Ludewig and Cook\(^5^0\) found that decreased scapular posterior tilt, decreased upward rotation, and increased scapular internal rotation are related to shoulder impingement. Jobe and Kvitne\(^5^3\) and Ludewig and Cook\(^4^2\) have provided evidence to suggest that patients with impingement may have more humeral anterior glide than control subjects. The findings in our patient seem consistent with the fact that some patients with impingement may have increased humeral anterior glide and decreased scapular upward rotation.

MSI Theory

The theory underlying the approach to examination and treatment used in our case proposes that the patient’s preferred movement pattern is the cause of the patient’s pain for 2 reasons: (a) the movement pattern is associated with symptoms, and (b) when the movement is modified the pain is alleviated.\(^5^0\) In this case, the scapular and humeral movement impairments are believed to decrease the subacromial space,\(^5^6,5^9,6^0,6^5\) increasing the wear and tear on the structures within the space. We hypothesize that correction of the patient’s alignment and movement pattern will increase the subacromial space and thus remove the cause of the tissue irritation. The treatment of the patient in our case focused on correction of the movement impairments of both the scapula and the humerus.

Reliability and Validity of the Examination and Diagnostic Categories

Reliability and validity have been established for parts of the clinical examination used in this case, including (1) manual muscle testing,\(^5^9\) (2) goniometric measurement of range of motion,\(^4^4,5^9\) and (3) testing the length of the posterior deltoide.\(^6^3\) Reliability and validity have not yet been established for many of the other judgments made during the tests of alignment and movement used in this clinical examination. Borstad\(^8\) questioned the validity of the supine test for assessing the length of the pectoralis minor used in this case. Our proposed diagnostic categories have also not yet been tested for validity. Therefore, it is possible that another therapist might not agree with the findings or the diagnostic category assigned in this case. Planning for future studies related to these issues is in progress.

Treatment

Impairments such as decreased strength or shortened muscles may contribute to
functional limitations, therefore these were addressed in the patient’s HEP.  

For example, short lateral rotators and posterior deltoid muscles and posterior capsule are thought to contribute to humeral anterior glide during overhead arm motions. Specific exercises to stretch these structures were prescribed (FIGURES 1 and 2). Others also recommend stretching of the posterior structures of the glenohumeral joint for the patient with shoulder impingement.  

To improve muscle performance we first correct the alignment and movement pattern so that the pain is alleviated. In our experience, this is often accomplished initially by decreasing, instead of increasing, the load on the muscle. Once the movement pattern is corrected, resistance is gradually increased. Various investigators have demonstrated beneficial effects of different aspects of training on muscle activation. However, none of these studies have examined the benefit of muscle activation at a certain muscle length and correlated that with pain reduction during the movement.  

A common exercise we prescribe to correct scapular downward rotation is shoulder flexion in standing with the back against the wall (FIGURE 8). The purpose of the exercise is to improve the performance of the serratus anterior, and upper and lower trapezius as upward rotators of the scapula with shoulder flexion. The strength grades of our patient’s right serratus anterior and lower trapezius were 4/5 and 3/5, respectively, as defined by Kendall et al. In theory, a muscle with a strength grade of 3/5 should be capable of moving a joint through the full range of motion against gravity. Therefore, we believe that strength alone does not explain our patient’s pattern of movement. Our patient had insufficient scapular upward rotation and pain that was partially relieved by modification of the scapular movement in the last half of the shoulder flexion range of motion. Our patient practiced modifying her scapular movement in the last half of the shoulder flexion range of motion, instead of strengthening the muscles. The elbow is flexed to decrease the load on the muscles, making it easier for the person to correctly perform the modified scapular movement pattern. There is evidence for prescribing specific exercises for improving the performance of the trapezius and serratus anterior, based on EMG data. However, we do not believe that performance of exercises based solely on EMG data will necessarily result in correction of the movement pattern.  

Other perceived key exercises prescribed were exercises to improve the performance of the rotator cuff muscles, both medial and lateral rotators (FIGURES 3 and 4). The purpose of these exercises was to correct the anterior position and movement of the humeral head. Our initial emphasis was on maintaining the correct alignment of the humerus relative to the scapula and the scapula relative to the trunk during active shoulder rotation exercises, instead of strengthening muscles. We believe that performing rotation exercises maintaining the correct alignment facilitates recruitment of the infraspinatus and teres minor instead of the posterior deltoid muscle. This should minimize humeral anterior glide during shoulder lateral rotation. Maintaining the correct scapular alignment during the rotation exercises is also thought to be important to maintaining the correct length tension capabilities of the rotator cuff muscles. A load was added to the exercise when the patient was able to perform the modified shoulder rotation movement pattern without pain.  

Addressing the repetitive functional activities or prolonged postures that are believed to cause impairments of the movement system is considered more important than addressing specific impairments, such as short or weak muscles, with a HEP. We believe that these activities must be modified to achieve long-term benefits from treatment. A primary focus of the physical therapy treatment in our case, therefore, was correction of the movement impairments noted during the functional activities that produced the patient’s pain. Our patient reported that her right shoulder continued to be pain free 3 years after discharge from treatment. She reported that she no longer performed the home exercises that were prescribed, but that she continued to consciously modify her movements during functional activities. Others have described successful treatment outcomes with functional training as applied to the patient with low back pain based on the MSI model.  

Outcomes  

The patient in this case appeared to respond favorably to the treatment provided. It is possible that the patient would have recovered spontaneously. The natural history of shoulder pain is unclear. The fact that this episode, however, had lasted 2 months and was reported as worsening until the initiation of physical therapy treatment increases the potential value of the described treatment. One case is not sufficient, however, to establish a cause-and-effect relationship between intervention and outcomes. Use of a standardized functional outcome measure would have enhanced the credibility of the outcomes in this case. Some studies have been completed, providing evidence to support the use of exercise to treat shoulder pain, but these studies have not examined the exercise approach used in this case.  

This report illustrated the use of a MSI diagnosis for physical therapy, the treatment of a patient with shoulder impingement based on the assigned diagnosis, and the outcomes of treatment. The patient in our case had positive short- and long-term outcomes with the described treatment. Prospective, randomized controlled trials should be done to test the efficacy of the physical therapy treatment used in this case.  

ACKNOWLEDGEMENTS  

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it, and can it, be modified? A study of passive tissue stiffness and lumbar position during activities of daily living. Phys Ther. 2003;83:907-917.