A Primary Care Provider’s Guide to Shoulder Pain After Spinal Cord Injury

Sara J. Mulroy, PhD, Luke Hafdahl, MD, and Trevor Dyson-Hudson, MD

Abstract: Shoulder pain is a common occurrence after spinal cord injury (SCI) and can have significant negative effects on health and function as many individuals with SCI are reliant on their upper extremities for mobility and self-care activities. Shoulder pain after SCI can be caused by acute injury or chronic pathology, but it is most often related to overuse injuries of the rotator cuff. Both acute strain and chronic overuse shoulder injuries in persons with SCI typically result from increased weight bearing on the upper extremities during transfers, weight-relief raises, and wheelchair propulsion, which are often performed in poor postural alignment owing to strength deficits. This article discusses management of patients with SCI who present with shoulder pain from the perspective of primary care physicians including evaluation and diagnostic procedures, interventions appropriate for both acute and chronic shoulder pain, and strategies for prevention. Key words: rehabilitation, rotator cuff, shoulder pain, spinal cord injury

Health Maintenance Checklist
1. Routinely screen for shoulder pain using the Wheelchair User’s Shoulder Pain Index.
2. Recommend ongoing stretching exercises to maintain shoulder joint flexibility and strengthening exercise for rotator cuff, scapular stabilizers, and thoraco-humeral depressor muscles.
3. Ensure optimized postures and performance techniques to reduce shoulder demands during wheelchair propulsion, depression transfers, and ischial pressure reliefs.
4. Oversee and allow cautious return to full activity after periods of prolonged bedrest with preemptive shoulder muscle strengthening.

Episodic Care Key Points
When a patient with SCI presents with shoulder pain that is consistent with rotator cuff overuse/impingement:
1. Intervention should begin with pain reduction and gentle mobility exercise.
2. As acute pain subsides, targeted shoulder stretching and strengthening exercises with particular focus on the rotator cuff should be performed three times per week.
3. A review of sitting posture and wheelchair propulsion, depression transfer, and ischial pressure relief techniques should be conducted for both temporary modifications and long-term optimization to reduce shoulder demands. Consider power add-ons for manual wheelchair users or switching to power wheelchair if warranted.

Case Report
Ms. B is a 28-year-old female with a 6-year history of a T10 level, American Spinal Injury Association Impairment Scale (AIS) B spinal cord injury (SCI). She presents with a 3-month history of bilateral shoulder pain that localizes to the deltoid area bilaterally. Transferring out of her manual wheelchair has become very painful and has led to more time in her wheelchair. She has bilateral stage 2 ischial tuberosity pressure injuries and is worried about infection as she is struggling to keep the wounds clean.

No abnormalities are identified on inspection. She has a positive painful arc test bilaterally and improvement of pain with passive range of motion. The empty can test reveals pain and asthenia. Neer sign and Hawkins-Kennedy testing are positive bilaterally. Speed’s test, Spurling test, and Yergeson maneuvers are negative. Perianal exam reveals perianal irritant dermatitis and a new stage 2 sacral pressure injury. The ischial pressure injuries do not show signs of infection but appear unchanged from the previous exam.
Shoulder pain is a common secondary condition in persons with SCI, with a prevalence ranging from 30% to 73%. Should pain can interfere with activities of daily living (ADLs), functional independence, and quality of life, and, when chronic, may lead to functional decline, obesity, depression, pressure injuries, contractures, and spasticity. Shoulder pain may also adversely affect community mobility and vocational activities, including employment. Overall, all-cause shoulder pain is more common in persons with tetraplegia and in those with neurologically complete injuries. However, overuse-related shoulder pain is more common in those with paraplegia and is seen in later years after injury. Other risk factors for shoulder pain include female gender, higher body mass index, and older age. Duration of injury may also be a risk factor; however, this is not a consistent finding. Reduced shoulder muscle strength, particularly in the shoulder adductors, and shoulder and trunk biomechanics during wheelchair propulsion also were identified as significant predictors of shoulder pain onset in individuals with paraplegia.

Etiology

Musculotendinous overuse syndromes are the most common cause of shoulder pain in persons with SCI and can be separated into two broad categories: (1) pain in the rotator cuff tendons and surrounding structures (e.g., bursa, biceps tendon), and (2) pain in the muscles of the shoulder and shoulder girdle (e.g., rotator cuff and scapular stabilizers). Rotator cuff-related pain is most common and is typically a consequence of overuse combined with subacromial impingement rather than acute trauma. Common diagnoses include rotator cuff tendinitis, supraspinatus tendinitis, bicipital tendinitis, subacromial bursitis, and impingement syndrome. Since it is often difficult to reliably establish which structure in the shoulder is causing the pain, some advocate using the terms subacromial pain syndrome or rotator cuff disease (syndrome). Pain in the muscles of the shoulder and shoulder girdle may be caused by acute muscle strains or chronic muscle pain. Acute muscle strains present as a sudden onset of localized pain during strenuous activities. They are usually caused by a rapid change from an eccentric to concentric contraction, by awkward positioning during transfers, or by sudden bouts of increased activity as seen during rehabilitation after SCI or in persons living in the community. Chronic muscle pain, on the other hand, results from overuse. Myofascial pain syndromes may also be present, and these refer to a specific condition characterized by the presence of trigger points and are associated with muscular strain or overuse. In addition, acromioclavicular and glenohumeral joint osteoarthritis, osteolysis of the distal clavicle, and osteonecrosis of the humeral head are all conditions that have been associated with shoulder overuse in persons with SCI. Additional causes of
shoulder pain not related to overuse include other musculoskeletal conditions (e.g., degenerative changes and mechanical instability at the cervical spine, spasticity, and heterotopic ossification), neuropathic conditions (e.g., syringomyelia, nerve root entrapment, transitional zone pain), and other pain conditions (e.g., complex regional pain syndrome Type II).

Diagnosis

A thorough pain history and physical exam of the neck and upper limbs are critical to develop an accurate diagnosis. While typical items of the pain history are important (e.g., location, onset, duration, quality, intensity, radiation, and aggravating/alleviating factors), the clinician must also consider elements that are unique to persons with SCI, including neurological level of injury, baseline motor and sensory function, posture and position of the shoulder complex, handedness, and wheelchair type and configuration. A detailed review of ADLs is crucial to reveal unique culprits of shoulder injury and allow the clinician to appreciate the impact of the shoulder pain on function and quality of life.

Indications of supraspinatus overuse/impingement include aching, throbbing, and/or stabbing pain in the anterolateral location over the deltoid at rest or during ADLs, pain when lying on the affected shoulder, or pain with elevation greater than 90 degrees.

Anterior joint pain or pain with all range-of-motion testing suggests glenohumeral arthritis versus adhesive capsulitis. The history should also include a thorough review of systems to rule out referred sources of shoulder pain. New onset weakness, sensory loss, or radiating pain may be a sign of cervical radiculopathy. All warrant further investigation.

Clinical questionnaires can be used to assess and monitor pain intensity and interference. The PEG survey is a validated, three-item survey evaluating average pain intensity (P), pain interference with enjoyment of life (E), and pain interference with general activity (G), and it is ideal for use in a busy outpatient practice. The Wheelchair Users Shoulder Pain Index (WUSPI) is a 15-item functional measure of shoulder pain intensity in wheelchair users during various ADLs; it is a valid and reliable measure of pain intensity and has been shown to be sensitive to treatments that impact shoulder pain intensity. (To obtain a copy of and permission to use the WUSPI, email Kathleen Curtis at kacurtis@utep.edu)

The physical examination should include assessment of flexibility, strength, and posture, including positions of trunk and shoulder complex, and sensory testing of the neck and upper limb structures. Increased thoracic kyphosis, common in persons with complete lower cervical and upper thoracic SCI, results in a posture of protracted and anteriorly tipped scapula and an internally rotated humerus that narrows the subacromial space and increases the risk for impingement. Palpation of the supraspinatus tendon insertion on the greater tuberosity, the biceps tendon in the bicipital groove, and the acromioclavicular joint as well as special provocative tests are all commonly used during the physical examination to reproduce symptoms of pain. Provocative tests for rotator cuff disease include tests for subacromial impingement, such as Hawkins-Kennedy impingement sign and the painful arc, as well as tests of rotator cuff muscle integrity, such as the supraspinatus (Jobe’s or “empty can”) test, Codman’s drop arm test, and the resisted external rotation test. Other provocative tests, such as the Speed’s test, active compression (O’Brien’s) test, and cross-body adduction (Scarf) test, are used to identify other shoulder complex abnormalities, such as biceps tendon, superior labral, or acromioclavicular joint abnormalities.

Treatment

Treatment should focus on decreasing acute pain, addressing secondary disabilities caused by pain, and prevention. These goals can be achieved by (1) control of pain and inflammation, (2) rest and activity modification, (3) rehabilitation (e.g., restoration of shoulder complex flexibility, muscle strength and balance, and endurance), (4) evaluation of posture and wheelchair set-up, (5) review of ADLs, and (6) education.

Acute pain may be relieved with pharmacological interventions (e.g., nonsteroidal anti-inflammatory
drugs (NSAIDs), acetaminophen, muscle relaxants), local anesthetic and corticosteroid injections, and modalities, including ice, superficial heat, transcutaneous electrical nerve stimulation, and ultrasound (Table 1).

Unlike able-bodied persons, it is difficult for persons with SCI to rest their shoulders due to their dependency on the upper limbs for mobility and ADL. A period of relative rest or activity modification may be the only realistic option.

### Table 1. Interventions for acute and chronic shoulder pain after SCI

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Time frame</th>
<th>Dose and delivery</th>
<th>Expected outcome</th>
<th>Cautions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pharmacologic pain management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, muscle relaxants</td>
<td>Acute onset (1-4 weeks)</td>
<td>Per recommendations for individual medications</td>
<td>Reduction of pain, inflammation</td>
<td>Long-term use of NSAIDs has been associated with increased risk of gastrointestinal bleeding and inhibition of collagen repair.</td>
</tr>
<tr>
<td>Tricyclic antidepressants (e.g., amitriptyline)</td>
<td>Acute/Chronic</td>
<td>Per recommendations for individual medications</td>
<td>Reduction of myofascial pain</td>
<td></td>
</tr>
<tr>
<td>Local anesthetic and corticosteroid injections</td>
<td>Acute onset (1-4 weeks)</td>
<td>Injection into subacromial bursae or other appropriate spaces no more frequently than once every 6 weeks and no more than 3 times per year.</td>
<td>Reduction of pain, inflammation, restoration of mobility</td>
<td>May compromise tendon healing potential, weaken tissue, and pre-dispose to further injury. Avoid vigorous muscle activity of an injected joint for 2 weeks (may be impractical for those dependent on arms for mobility).</td>
</tr>
</tbody>
</table>

| **Physical modalities** | | | | |
| Heat, ultrasound | Acute/Chronic | Frequently used prior to stretching or joint mobilization | Reduction of pain, reverse tendinosis by stimulating fibrosis and collagen repair | Extra caution when using on insensate areas of skin to avoid burns |
| Ice or cryotherapy | Acute/Chronic | Frequently used after stretching or joint mobilization | Reduction of pain, inflammation | Extra caution when using on insensate areas of skin to avoid burns |
| Acupuncture, Transcutaneous Electrical Nerve Stimulation | Chronic | | Reduction of pain | Not associated with adverse events |
| Manual therapy, magnetic therapy | Chronic | | Reduction of rotator cuff and myofascial pain | Evidence of effectiveness is conflicting. |

| **Ortho-biological treatments** | | | |
| Platelet-rich plasma (PRP) injection | Chronic/Recalcitrant rotator cuff disease | | Small sample size studies |
| Autologous, micro-fragmented adipose tissue (MFAT) injection performed under ultrasound guidance | | | |

Shoulder Pain 189
### Reduction of shoulder demands with ADL modifications

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time frame</th>
<th>Modification</th>
<th>Expected outcome</th>
<th>Cautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfers</td>
<td>Acute (temporary) or chronic</td>
<td>Use sliding board; lean farther forward; alternate leading arm; transfer to similar height surfaces</td>
<td>Reduction of superior shoulder joint reaction forces</td>
<td></td>
</tr>
<tr>
<td>Pressure relief maneuvers</td>
<td>Acute (temporary) or chronic</td>
<td>Use forward and/or side leans instead of press-up lifts</td>
<td>Reduction of superior shoulder joint reaction forces</td>
<td></td>
</tr>
<tr>
<td>Sitting posture</td>
<td>Acute (permanent) or chronic</td>
<td>Pelvic support; higher backrest; lateral support; smaller seat-to-back angle - “dump”</td>
<td>Provide trunk/pelvic stabilization, reduce thoracic kyphosis, and open subacromial space</td>
<td>Transfers may be more difficult with smaller seat-to-back angle; transfer training may be needed.</td>
</tr>
<tr>
<td>Wheelchair (WC) propulsion</td>
<td>Acute (temporary) or chronic</td>
<td>Switch to power WC, power assist wheels, or power add-on (e.g., SmartDrive); use lightest possible WC; adjust rear wheel axle as far forward without compromising stability; adjust rear wheel axle height so that elbow angle is 100-120° when hand is at top of pushrim; push WC with long, smooth strokes, reducing cadence and increasing contact time with the pushrim; regular maintenance of WC tire pressure and wheel and caster function</td>
<td>Reduces force required for WC propulsion; power WCs may require home or vehicular modifications.</td>
<td></td>
</tr>
</tbody>
</table>

### Shoulder complex exercises

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Time frame</th>
<th>Dose and delivery</th>
<th>Expected outcome</th>
<th>Cautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stretching and passive mobility exercises</td>
<td>Acute/Chronic</td>
<td>Pendulum stretching; open book (supine); doorway stretch</td>
<td>Increase flexibility of anterior shoulder joint structures, reduce thoracic kyphosis, and open subacromial space</td>
<td>Use heat before to increase mobility and ice/cold after to reduce pain/ inflammation</td>
</tr>
<tr>
<td>Muscle strengthening, rotator cuff</td>
<td>Acute (1-2 weeks) and chronic</td>
<td>External rotation (infraspinatus); shoulder abduction (supraspinatus) 3 days/week with a day of rest between exercise days¹¹ Initially, repetitions and resistance should be set to pain tolerance. After 2-4 weeks, 3 sets of 8 repetitions at an 8-repetition maximum resistance for external rotation and 3 sets of 15 repetitions at a 15-repetition maximum resistance for shoulder abduction.¹¹</td>
<td>Muscle re-education for activation without pain Muscle strengthening to prevent superior migration of the humeral head during weight-bearing and humeral elevation</td>
<td>Should be performed in the scapular plane or at 0 degrees abduction to minimize superior humeral head migration and reduce risk of subacromial impingement</td>
</tr>
</tbody>
</table>
Referral to physical therapy is recommended for assessment and optimization of the patient’s posture, pressure relief techniques, transfer techniques to all surfaces, wheelchair set-up and propulsion, and a review of work, home, community, and driving environments (Table 1). 2

Once pain has subsided, functional rehabilitation should be initiated to restore shoulder complex flexibility, muscle strength, and endurance (Table 1; Figures 1 and 2). Stretching exercises are recommended to counter tightness of the anterior shoulder that is associated with shoulder pain in persons with SCI. 1 Shoulder strengthening exercises are effective in reducing pain in most individuals with SCI with overuse-related shoulder pain. Begin with exercises for the rotator cuff muscles (Figures 3 and 4). 18 Exercises for scapular retractors (rhomboids/middle trapezius), scapular protractors (serratus anterior), and thoracohumeral depressors (pectoralis major/latissimus) can be added as pain decreases (Figures 5-7).

Surgery is typically a treatment of last resort; it is generally reserved for failure of conservative management. Recommendations for duration of conservative management vary, however, a minimum 6-month trial is usually recommended in the able-bodied population. Outcome studies of rotator cuff surgery in persons with SCI are limited and conflicting. 19,20 Persons with SCI may be at increased risk of poor outcomes from surgery if manual wheelchair use continues or if other repetitive upper limb tasks are not changed. Finally, one must consider the postoperative immobilization time required and how that may impact an individual’s everyday living situation and needs.

Prevention

Preventive strategies for preserving shoulder health after SCI are recommended as treatments typically prescribed for existing chronic shoulder pain are not universally effective. A periodic referral to physical therapy is recommended to screen for shoulder pain using the WUSPI to identify incipient shoulder pathology and specific pain-provoking activities and to review ADL techniques and shoulder stretching and strengthening exercises and aerobic conditioning programs. Ergonomics of seating posture and biomechanics of wheelchair propulsion, transfers, and weight relief maneuvers should be reviewed and optimized as described previously for treatment of shoulder pain (Table 1). 21-30 Consider recommending a power add-on device for those individuals who use manual wheelchairs or who are transitioning to a power wheelchair if warranted. It is important to keep in mind that a power wheelchair may require additional home or
Figure 1. Bilateral stretch of anterior shoulder structures with “open book” stretch.

Figure 2. Seated stretch of anterior shoulder using a doorway.
Regular strengthening exercises for the rotator cuff, scapular stabilizers, and shoulder adductor muscles are necessary to maintain sufficient strength to prevent upward humeral migration and impingement of the rotator cuff tendons during weight-bearing activities. Proactively engaging in a shoulder exercise program that was developed for treating existing shoulder pain in individuals with paraplegia\textsuperscript{18} reduced the rate of shoulder pain onset in an initially asymptomatic cohort by 50% over a 3-year period.\textsuperscript{21} Additionally, individuals who have experienced a prolonged period of bedrest owing to hospitalization or illness from any cause should return to full activity levels gradually and perform vehicular modifications. Additionally, switching to a power wheelchair may be unpopular with long-term manual wheelchair users who may interpret the change as an indication of greater disability.
Figure 5. Scapular retractors strengthening using a rowing exercise in 0 degrees of abduction.

Figure 6. Strengthening of the scapular protractors with the opposite motion.

Figure 7. Thoracohumeral depressors strengthening with resisted adduction exercises (pull-down from no higher than 90 degrees elevation).
the shoulder exercises, if possible, prior to and during activity reintroduction.

Individuals with SCI should include endurance training exercises to build capacity to meet the physical demands of ADLs and mobility. Individuals with tetraplegia and paraplegia can improve their cardiovascular fitness and physical work capacity through moderate intensity aerobic exercise training (e.g., arm cycle, wheelchair ergometry).30 Fitness programs such as circuit resistance training that incorporate periods of low-intensity, high-paced movements interposed with resistance exercises for the shoulder complex can provide both strength and endurance training. Special emphasis should be placed on stretching anterior structures of the shoulder (e.g., pectoralis and biceps muscles) and strengthening posterior structures that stabilize the scapula (e.g., rhomboids, latissimus dorsi, and serratus anterior muscles).

Case Resolution

Given her pain severity, Ms. B received bilateral subacromial corticosteroid injections that provided enough symptomatic relief to allow her to participate in therapy and complete ADLs with less pain. She began a comprehensive physical therapy program including stretching and strengthening exercises of the rotator cuff, thoracohumeral depressor, and scapular muscles. Her ADL techniques were assessed by a physical therapist who recommended forward or side leans for pressure relief and temporary use of a power add-on to reduce the demands of wheelchair propulsion. The physical therapist also recommended the use of a transfer board until the strength of her shoulder depressors increased enough so that she was able to consistently transfer without hitting her buttocks on her wheelchair tire. At follow-up in 3 months, she reported decreased shoulder pain, successful transfers without a board, and improvement of her decubitus ulcers.

Conclusion

Shoulder pain in persons with SCI is common, negatively impacts daily function, and can be caused by several pathological conditions; however, injuries to the rotator cuff are the most common. Treatment for a patient with SCI presenting with shoulder pain should focus initially on reducing pain and inflammation with a combination of modalities and pain/anti-inflammatory medications. Patients should be advised to engage in a period of relative rest from weight-bearing ADLs. Referral to physical therapy is indicated to restore shoulder flexibility and initiate a program of rotator cuff and shoulder muscle strengthening exercises as well as a review of ADL postures and techniques to reduce shoulder demands. Preventive strategies should include periodic referral to physical therapy for screening for incipient shoulder pain onset, optimization of ADL postures and techniques, and preventive strengthening exercises. Patients should be educated regarding the importance of returning to activity after periods of bedrest gradually and performing shoulder strengthening exercises to prevent acute overload of the shoulder with activity resumption.

Acknowledgments

The authors report no conflicts of interest.

REFERENCES

5. Gutierrez DD, Thompson L, Kemp B, Mulroy SJ. The relationship of shoulder pain intensity to quality of