

Shoulder pain and repetition strain injury to the supraspinatus muscle: Etiology and manipulative treatment

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Chronic inflammation and degenerative tendonitis of the supraspinatus muscle is an important cause of intrinsic shoulder pain. Injury to this muscle is usually caused, not by a single event, but by slight to moderate trauma repeatedly to the same anatomic area. The term *repetition strain injury* is used to describe this form of microtrauma. Repetition strain injury of the supraspinatus muscle is not an isolated event, but rather a form of microtrauma that affects the entire shoulder girdle. This functional unit must be evaluated and considered in the treatment plan. The authors discuss the diagnosis of this pain syndrome, which is based on the patient's work history, motion and strength testing, and palpation for trigger points. They also provide instruction in treatment involving manipulation with functional and counterstrain techniques combined with home exercise and modification of work posture.

Chronic inflammation and degenerative tendonitis of the supraspinatus muscle is an important cause of intrinsic shoulder pain.¹⁻³ Injury to this muscle usually is not caused by a single event, but rather by slight to moderate trauma repeatedly to the same anatomic region. The term *repetition strain injury* is used to describe this form of microtrauma.⁴

Because the supraspinatus muscle and its tendon are frequently subjected to exertion or sustained contraction without adequate rest, these tissues undergo mechanical strain. In reaction to this strain, edema and inflammation develop.⁵

When there is injury to a muscle, antagonistic muscles contract to immobilize the joint. This prevents use of the injured muscle.⁶ In time, antagonistic muscles (pectoralis, latissimus dorsi, levator scapuli, and rhomboids) to scapula elevation as well as agonistic muscles (trapezius seratus and anterior) to shoulder abduction will also suffer injury as a result of sustained contraction. Repetition strain injury of the supraspinatus muscle is not an isolated event, but rather a form of microtrauma that affects the entire shoulder girdle. This functional unit must be evaluated and considered in the treatment plan.^{7,8}

Vulnerability of the supraspinatus muscle

Figure 1 reviews the location and anatomic attachments of the supraspinatus muscle. It is helpful to understand why the supraspinatus muscle is so vulnerable to repetition strain injury. Although the supraspinatus muscle is classically thought of as an abduction starter only, current ergonomic studies indicate that the supraspinatus muscle is active throughout abduction.⁹ The supraspinatus and deltoid muscles are equally responsible for producing abduction. Because these muscles are working at a poor mechanical advantage,¹⁰ they produce a force that must exceed half the body weight. The deltoid muscle is a powerful abductor despite its poor mechanical advantage. The central portion

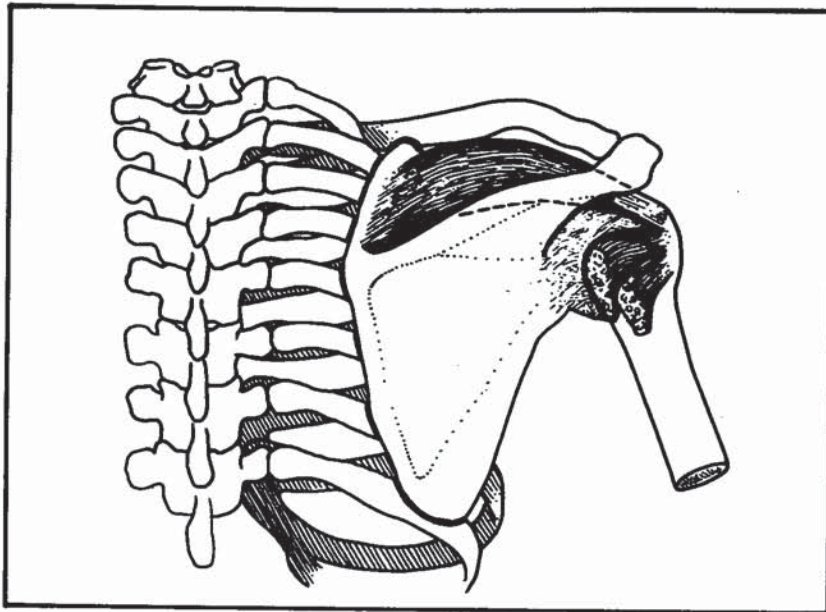


Figure 1. The supraspinatus muscle is a rounded muscle that occupies the supraspinatus fossa of the scapula. It arises from the medial two thirds of the walls of this fossa and inserts on the greater tubercle of the humerus.

has a multipennate architecture. Muscle fibers approach the tendon obliquely and insert serially along its length. This increases the cross-sectional area of the muscle and thereby increases its power.¹¹ Therefore, the structure of this muscle is able to compensate for the short lever arm through which it must act.

Unlike the superficial deltoid muscle, which overlies the coracoacromial arch, the supraspinatus ten-

don must pass under the coracoacromial arch through a rigid and inextensible canal (Fig 2).¹⁰ If the supraspinatus muscle's size increases as a result of scar formation or injury, the muscle cannot glide smoothly through this ring. Repetitive movement associated with certain work tasks may fray and pulverize the muscle and its tendon because of friction created in this ring.¹² During elevated arm positions, the supraspinatus is the first

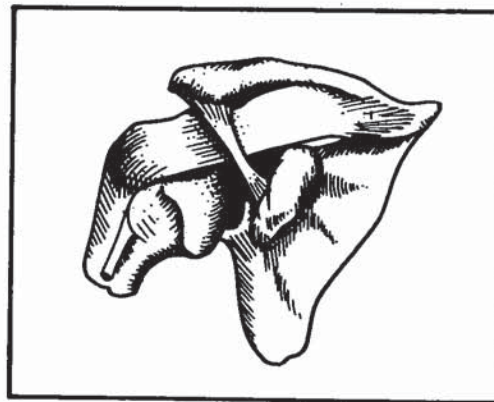
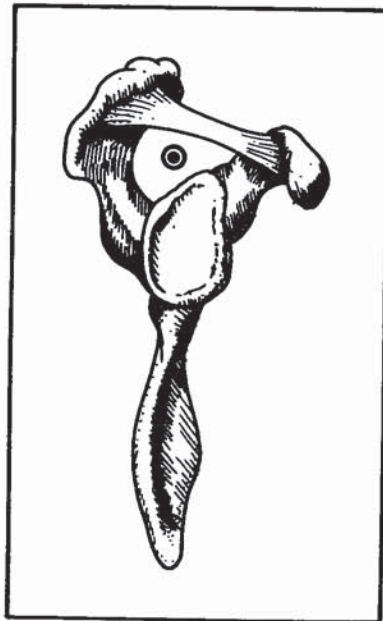


Figure 2. The supraspinatus canal connects the supraspinatus fossa with the subdeltoid region. The acromion, the coracoacromial ligament, and coracoid process together form a fibro-osseous arch called the coracoacromial arch.

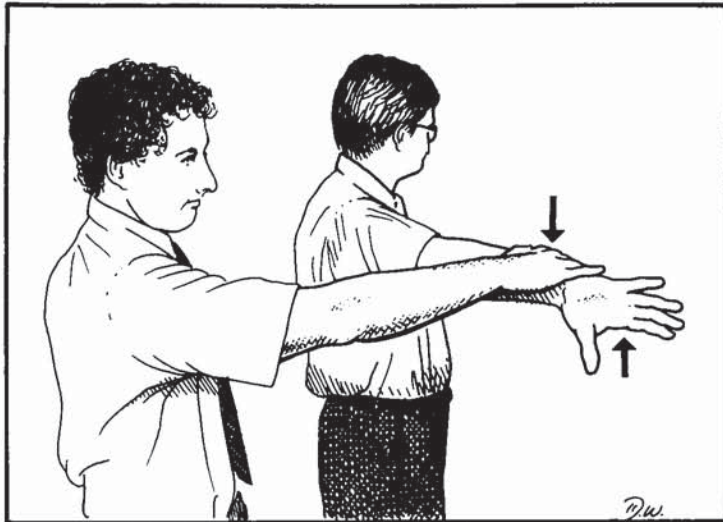


Figure 3. Strength testing to demonstrate weakness of isolated supraspinatus muscle.

muscle to show signs of fatigue, while the deltoid muscle shows signs of fatigue in few subjects.¹³

Its unusual blood supply also contributes to the supraspinatus muscle's vulnerability to injury.¹⁴ Unlike round tendons, whose blood supply enters at intervals along the tendon's length, the vessels of the supraspinatus muscle course through its whole length, running longitudinally rather than entering perpendicularly. Static tension on the vessels through direct pressure by the head of the humerus or by a static muscular load may cause impaired circulation, thereby leading to muscle degeneration.

Diagnosis

Work history

All individuals with occupations in which the work posture involves elevated arms (eg, welders, assembly line workers, cash register operators, and pianists) are susceptible to repetition strain injury to the supraspinatus muscle. Static muscular load and its resultant impairment of circulation and tissue ischemia is an essential causative factor. Working with hands at or above acromion heights constitutes a significant occupational factor, as does job inexperience and working at a rapid rate.

Physical examination

Motion testing. A patient with injury to the supraspinatus muscle will be unable to perform the hand-to-shoulder blade test (adduction, internal rotation) in which the patient puts his or her arm behind the back and attempts to touch the inferior angle

of the opposite scapula.¹⁵ Individuals without injury to the supraspinatus muscle usually reach the spine of the scapula with their fingertips. Patients with repetition strain injury of the supraspinatus muscle will show slight restriction of movement.

Strength testing. Muscle testing against resistance will demonstrate weakness of the isolated supraspinatus muscle. After first testing strength with the arm abducted to 90 degrees, the examiner then isolates the supraspinatus muscle from the deltoid muscle by internally rotating the patient's arm and angling it forward 30 degrees; thumbs should be pointing toward the floor. Strength is then tested by having the patient resist the downward force of the physician's hand (Fig 3).

Jobe and colleagues¹⁶ have shown the subscapularis, infraspinatus, and teres minor muscles to be electrically silent during this maneuver.

Palpation. The third step in diagnosis is to palpate for trigger points (a focus of hyperirritability in the myofascial tissue that, when compressed, is locally tender and has a characteristic reference pattern of pain). The trigger point of the supraspinatus muscle is palpated beneath the trapezius muscle, just above the spine of the scapula and approximately 1 inch lateral to the vertebral border at the midpoint of the muscle belly (Fig 4).¹⁵ Patients with trigger points in the supraspinatus muscle complain of a deep, achy pain in the mid-deltoid region, radiating down the arm, focusing over the lateral epicondyle of the elbow.¹⁵ Pain is increased with active abduction.

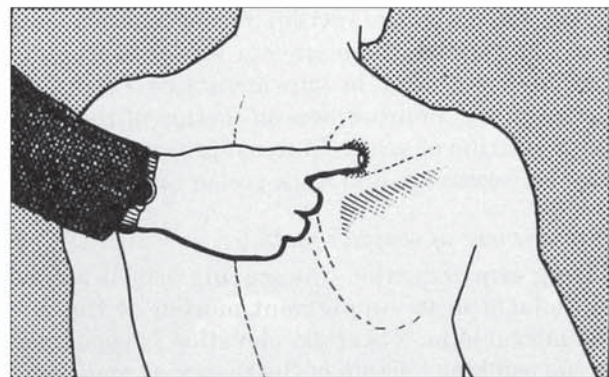


Figure 4. Palpating trigger point of the supraspinatus muscle.

While the exact mechanism of referred pain from trigger points is unknown, it is known that the innervation of the supraspinatus muscle is C-5 and the C-5 dermatome is the same skin area as the pain referral zone of the supraspinatus trigger point. Perhaps this is a somato-somatic reflex where the primary injury to the supraspinatus muscle could be causing a secondary reflex phenomenon at the spinal cord level of C-5 which, in turn, could be responsible for activating the pain reference zone associated with repetition strain injury to the supraspinatus muscle. If this hypothesis is true, it is important to treat somatic dysfunction at C-5 as well as treating the supraspinatus muscle directly.

Treatment

Treatment of somatic dysfunction

Somatic dysfunction is impaired or altered function of related components of the body framework system: skeletal, articular, and myofascial structures, and related vascular, lymphatic, and neural elements. Successful treatment of supraspinatus repetition strain injury requires correcting somatic dysfunction of the axial skeleton before treating the supraspinatus muscle. Specific joint mobilization techniques (muscle energy, high velocity/low amplitude) for removal of restrictive articular barriers can be found in standard manipulation textbooks.^{17,18} A brief review of contributing factors demonstrates the reasons for treating somatic dysfunction.

Muscles that insert on the shoulder girdle have their origin as far cranially as the occiput and as far caudally as the sacrum, and their innervation spans the spinal accessory to the first thoracic nerve.⁶ The sympathetic nerves to the upper extremity are the second thoracic nerve through the eighth thoracic nerve. Increased neuronal activity from any of these spinal segments may contribute to the patient's pain.

After somatic dysfunction of the axial skeleton has been treated, there are four essential steps for optimal treatment of supraspinatus repetition strain injury: improvement of motion of the scapula, reduction of strain in the supraspinatus muscle, home exercise, and work posture modification.

Improvement of scapula motion

During arm abduction, the scapula acts as a movable platform to supplement motion at the glenohumeral joint.¹⁹ Scapula elevation is performed by the combined action of the trapezius and serratus anterior muscles.²⁰ Often work posture involv-

ing elevated arms also adversely affects these muscles. In addition, the muscles that depress the scapula may also harbor trigger points.²¹ These include the pectoralis, latissimus dorsi, levator scapula, and rhomboid muscles. Improving motion of the scapula on the posterior aspect of the thorax is therefore necessary to treat this pain syndrome.⁷

The following is a functional technique for improving motion of the scapula.^{22,23} With the patient supine and the operator seated at the side to be treated, the operator places one hand under the patient's scapula with the other hand on the anterior aspect of the chest cage directly above the inferiorly placed hand. The operator applies a slight compression force simultaneously to the chest cage and scapula with the opposing hands. While using the superiorly placed hand as a firm and immovable foundation, the operator uses the inferiorly placed hand to begin gentle motion testing of the scapula in six directions: superior-inferior glide; medial-lateral glide; and clockwise-counterclockwise rotation.

The operator tests motion and treats simultaneously. As an example, after checking superior-inferior glide, the operator determines a slight preference for superior glide. The operator maintains this position by applying gentle cephalad pressure and simultaneously tests medial-lateral glide. If medial glide shows less resistance, the operator holds the scapula in this position of superior and medial glide while motion testing rotation preference. Once reaching the point of least resistance in all three planes, the operator gently holds this point of balanced ligamentous tension until there is relaxation and palpable softening of the tissues.

Treatment of the supraspinatus muscle

Next, the physician can treat the supraspinatus muscle with counterstrain technique. Though the exact mechanism of counterstrain is unknown, most literature attributes it to a gamma loop neuromuscular effect. When a muscle is under strain, the affected muscle's proprioceptors (the muscle spindles) are discharging at an increased frequency. When the muscle is in a shortened, comfortable position, the proprioceptors will cease their abnormal activity. Another mechanism to explain counterstrain is a circulatory model. In their experiments, Rathbun and Macnab¹⁴ found that an infusion of a micro-opaque suspension injected into the arm of a cadaver with its arm at the side allowed no filling of the zone of avascularity of the supraspinatus muscle. However, when the suspension was injected into the opposite side with the

shoulder in passive abduction, there was almost complete filling of all vessels due to relaxation of tension on the supraspinatus muscle. Unopposed arterial filling may be the same mechanism that occurs in the living tissue during the 90-second counterstrain treatment.

The procedure for treatment of a right-sided supraspinatus tender point is as follows.²⁴ The patient is supine with the physician sitting on the side to be treated. The physician places the index finger of his or her left hand on the painful tender point as a marker. The patient is instructed to relax his or her arm and let the operator have full control of it (Fig 5, top). The operator then passively flexes the arm at the shoulder toward the ceiling 45 degrees, abducts it 45 degrees, and markedly rotates it externally. The operator probes the tender point intermittently and asks the patient if there is less pain at the tender point (Fig 5, center). The physician fine tunes with flexion and extension until there is an 80% reduction in pain. The operator holds the patient's arm in this position for 90 seconds, after which the operator slowly and passively returns the arm to the patient's side (Fig 5, bottom). The operator then rechecks the tender point. Soreness can be expected, but the sharp, hot sensation should be relieved.

Home exercise

After the acute pain has been relieved, the patient should perform home stretching exercises (Fig 6), doing the following two exercises daily for 15 to 30 seconds each. First, the patient puts the supraspinatus muscle in a stretch position by putting the arm being treated behind the back at waist level while seated in a chair with a firm back. The patient then gently pushes the elbow against the back of the chair. After each successive contraction, the patient should rotate the trunk a bit farther in the direction of the arm being treated. The patient repeats three to five times, gently bringing the elbow of the injured arm farther anteriorly after each contraction.^{25,26} This muscle energy treatment uses isometric contractions to stretch hypertonic tissues through the Golgi tendon reflex mechanism.²⁷ Because some patients may find this exercise difficult, modification may be necessary. Patients unable to place the injured arm behind them can perform the same exercise, standing, with the palm on the abdomen and the elbow of the affected arm pushing backward against a wall or doorway while gradually rotating the trunk toward the affected limb.



Figure 5. Procedure for treatment of a right-sided supraspinatus tender point. Top: Patient relaxes arm and lets operator have full control of it. Center: Arm passively flexed at shoulder toward ceiling 45 degrees, abducted 45 degrees, and externally rotated. Examiner probes tender points. Bottom: Fine tuning with flexion and extension until 80% reduction in pain; operator holds patient's arm in this position for 90 seconds, then slowly and passively returns arm to patient's side.

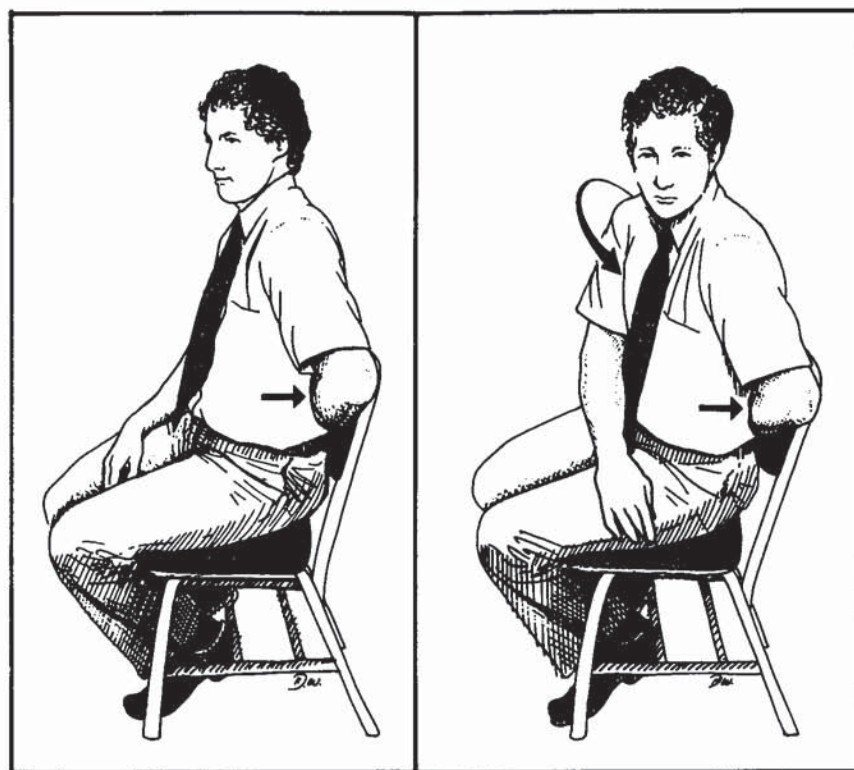


Figure 6. Home stretching exercise using isometric contractions.

Hanging bar exercises are also useful.²⁸ Inexpensive chinning bars are available. Door frame-mounted bars are easiest to install. The patient is instructed to grip the bar and passively hang from extended arms for 15 to 30 seconds daily. This exercise will stretch myofascial tissues of the entire shoulder girdle.

Work posture modification

Modification of the work posture is also necessary for successful treatment. Even when a person holds nominal loads, the supraspinatus muscle cannot support an elevated arm for sustained periods. If the worker cannot keep the arm at the side, a padded forearm support will relieve load at the shoulder girdle. Power hand tools that are used frequently or for sustained periods should be suspended from a tool balancer.⁶ If these corrections cannot be made, the worker should be instructed to flex rather than abduct the arm since the arm can be flexed to 60 degrees before the scapula rotates.²¹ This will transfer load to the anterior deltoid muscle and the clavicular portion of the pectoralis major muscle instead of the vulnerable supraspinatus muscle.

Conclusion

Chronic inflammation and degenerative tendinitis of the supraspinatus muscle is an important cause of intrinsic shoulder pain.¹⁻³ Repetition strain injury of the supraspinatus muscle is not an isolated event, but rather it is a form of microtrauma that affects the entire shoulder girdle. Therefore, this functional unit must be evaluated and considered in the treatment plan.^{7,8}

Diagnosis of this pain syndrome is made on the basis of work history, motion and strength testing, and palpation for trigger points.

Treatment involves manipulation with functional and counterstrain techniques combined with home exercise and modification of work posture.

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