Scapular Winging

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Abstract

Scapular winging, one of the more common scapulothoracic disorders, is caused by a number of pathologic conditions. It can be classified as primary, secondary, or voluntary. Primary scapular winging may be due to neurologic injury, pathologic changes in the bone, or periscapular soft-tissue abnormalities. Secondary scapular winging occurs as a result of glenohumeral and subacromial conditions and resolves after the primary pathologic condition has been addressed. Voluntary scapular winging is not caused by an anatomic disorder and may be associated with underlying psychological issues. The evaluation and treatment of these three types are discussed.

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Scapular winging is one of the most common abnormalities of the scapulothoracic articulation. Winging may be described as primary, secondary, or voluntary (Table 1). Primary scapular winging is caused by anatomic disorders that directly affect the scapulothoracic articulation. Secondary scapular winging usually accompanies some glenohumeral disorder and should resolve once that disorder has been addressed. Voluntary winging may have psychological overtones and is quite rare.

Evaluation

Patients with scapular winging should be first observed at rest with the arms at the sides. A static deformity should be sought, as well as muscle atrophy. The patient is then asked to elevate his arms in the forward plane, and the scapulae are observed in relation to the chest wall. The scapulothoracic rhythm and the presence of crepitus should be noted; alterations in the normally smooth rhythm may become evident with dynamic testing. The examiner must also look for winging with resisted motion, such as may occur when the patient pushes against a wall or resists forward elevation with the arms at 30, 90, and 150 degrees. Static, dynamic, or resisted winging may be graded subjectively as mild, moderate, or severe.

Primary Scapular Winging

Neurologic Origin

Trapezius Winging

The spinal accessory nerve, which provides the only innervation to the trapezius muscle,[1] is located in the subcutaneous tissue on the floor of the posterior cervical triangle. Its superficial location makes it susceptible to injury, which can result in significant deformity as well as painfully disabling alterations in scapulothoracic function.[2-4] Injury can be caused by blunt trauma,[4,5] traction,[4] or penetrating trauma (including surgical biopsy of lymph nodes in the posterior cervical triangle[3,4] and radical neck dissection).[1]

After injury to the spinal accessory nerve, the patient assumes a position with the shoulder depressed and the scapula translated laterally with the inferior angle rotated laterally (Fig. 1, A). Patients will attempt to compensate for this deformity by using muscles of the shoulder girdle, including the levator scapulae and the rhomboids. This strain may lead to disabling pain and muscle spasm.[5] Patients can also have pain due to secondary effects of winging, including adhesive capsulitis, subacromial impingement, and radiculitis from traction on the brachial plexus. On examination, patients will have trapezius wasting, will be unable to shrug the shoulder, and will have associated weakness on forward ele-

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Table 1
Classification of Scapular Winging

Primary
Neurologic origin
Spinal accessory nerve (trapezius palsy)
Long thoracic nerve (serratus anterior palsy)
Dorsal scapular nerve (rhomboideus palsy)
Osseous origin
Osteochondromas
Fracture malunions
Soft-tissue origin
Contractural winging
Muscle avulsion or agenesis
Scapulothoracic bursitis
Secondary
Voluntary

vation and abduction of the arm. The diagnosis can be confirmed by electromyographic (EMG) examination.

Treatment depends on the duration and severity of symptoms. An initial treatment regimen including physical therapy is helpful to maintain glenohumeral motion and prevent adhesive capsulitis. In patients in whom spinal accessory nerve injury is due to blunt trauma, serial EMG examinations may be performed at 6-week intervals to follow the returning function of the nerve. This is usually not begun until 3 months after the injury, because denervation changes in the muscle may not be manifest before that time. In nerve injuries due to penetrating trauma, or when there is no evidence of nerve function on EMG analysis, neurolysis and/or nerve grafting can be considered.[3,6-8] The results of these procedures have been variable. If neurolysis is performed, the success rate seems to be improved if the procedure is done within 6 months of the injury.[5]

Patients who have had debilitating symptoms for more than 1 year are unlikely to benefit from continued conservative treatment, and surgery can be offered. Historically, a variety of surgical procedures have been described for the treatment of spinal accessory nerve paralysis.[2,9,10] These can be divided into static and dynamic procedures. Static stabilization includes scapulothoracic fusion[9] and any of the many operations that tether the scapula to the spine.[2] The dynamic procedures all involve some form of muscle transfer.[5,10,11] Because scapulothoracic fusions represent a huge undertaking and may limit motion significantly, and because fascial-sling suspensions tend to fail, causing recurrence of winging in 2 to 3 years,[5] dynamic muscle transfers have become the procedure of choice for persistent trapezius winging.[5,10-13]

The muscle-transfer operation perhaps most commonly performed for trapezius paralysis is the Eden-Lange procedure,[5,12,13] in which the levator scapulae, rhomboideus minor, and rhomboideus major muscles are transferred laterally (Fig. 2). The levator scapulae substitutes for the upper third of the trapezius; the rhomboideus major, for the middle third; and the rhomboideus minor, for the lower third. By moving these muscle insertions laterally, their mechanical advantage is improved, and winging is diminished or eliminated.

The surgical technique involves two incisions. The first is along the medial scapular border, and the second is over the spine of the scapula. The levator scapulae, rhomboideus minor, and rhomboideus major are detached from their origins, taking a small portion of insertional bone from the medial scapula. The rhomboid muscles are advanced laterally under the infraspinatus and are secured with suture, which is passed through drill holes placed 5 cm lateral to the medial border of the scapula. The levator scapulae is passed 5 cm laterally, subcutaneous to the second incision, and is sutured to the scapular spine through drill holes. Postoperatively, a sling is used for 6 weeks, after which passive and then active range-of-motion exercises are used.

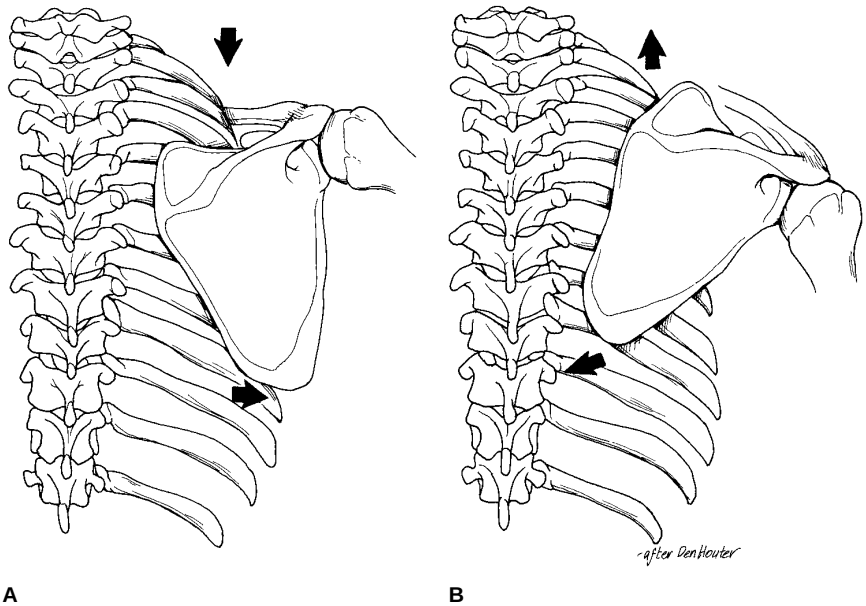

Fig. 1 Position of the scapula with primary scapular winging due to trapezius palsy (A) and serratus anterior palsy (B).

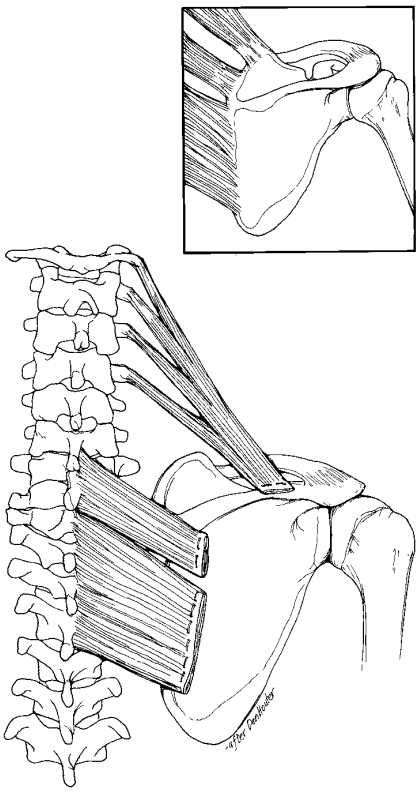

Fig. 2 Eden-Lange dynamic transfer, used to treat trapezius paralysis.[5] The levator scapulae, rhomboideus minor, and rhomboideus major muscles are detached from their origins (inset), taking a small portion of insertional bone from the medial scapula. The rhomboid muscles are advanced laterally under the infraspinatus and are secured with suture, which is passed through drill holes placed 5 cm lateral to the medial border of the scapula. The levator scapulae is passed 5 cm laterally and is sutured to the scapular spine through drill holes.

Bigliani et al[5] recently reported their results with this procedure. Of 23 patients with trapezius winging, 87% had good or excellent results. Significant improvement in pain was seen in 91% of these patients, and 87% demonstrated an improvement in function.

Serratus Anterior Winging

Palsy of the serratus anterior muscle can also cause painful, disabling scapular winging. The long thoracic nerve originates from the ventral rami of the C5, C6, and C7 cervical nerves and travels beneath the brachial plexus and clavicle over the first rib. The nerve then travels along the lateral aspect of the chest wall superficially, making it susceptible to injury. Blunt trauma or stretching of this nerve is particularly common in athletes and has been reported in almost every sport.[14-16] Repetitive industrial use of the shoulder has also been implicated as a cause of serratus anterior paralysis.[17] Penetrating trauma will rarely cause injury to this nerve, although surgical procedures such as radical mastectomy, first-rib resection, axillary lymph-node dissection, and transaxillary sympathectomy have been implicated as sources of injury to the long thoracic nerve.[16]

The long thoracic nerve can also be affected by nontraumatic events, including positioning during anesthesia,[17] the sequelae of viral illness,[18] inoculations,[19] and neuritis affecting the brachial plexus or the long thoracic nerve alone.[20,21] Even prolonged bed rest has been reported to trigger dysfunction of the long thoracic nerve, particularly if the arm is abducted while propping up the head to read.[17,22] Since the long thoracic nerve has its origin at C7, patients with C7 radiculopathy may also manifest serratus anterior weakness and scapular winging.[23]

With an injury to the long thoracic nerve, the scapula assumes a position of superior elevation and medial translation, and the inferior pole is rotated medially (Fig. 1, B). Patients will complain of pain as the other periscapular muscles try to compensate for the serratus weakness. More severe pain may indicate acute brachial plexus neuritis or Parsonage-Turner syndrome, which may affect the long thoracic nerve alone.[21] The patient will have difficulty with arm elevation above 120 degrees, which will magnify the degree of winging. Pain may be increased with this maneuver and when the head is tilted toward the contralateral shoulder.

Electromyography is recommended to confirm the diagnosis. Electromyographic examinations at 3-month intervals have also been recommended to follow nerve recovery.[22,24]

Range-of-motion exercises to prevent adhesive capsulitis of the shoulder should be implemented immediately on diagnosis. Many types of braces and orthotic devices have been developed.[20] They may have some role, but often their cumbersome nature overshadows symptom relief.[22] Most injuries of the long thoracic nerve recover spontaneously within 1 year,[15,17,20,22,25] but recovery may take up to 2 years.[26]

There is little data in the literature regarding the results of neurolysis, nerve grafting, or nerve repair of an injured long thoracic nerve. Nevertheless, penetrating injuries should be treated with nerve exploration and early repair. Neurorrhaphy may be indicated when the lesion can be localized.[22] Patients with persistent impairment of the serratus anterior are often able to compensate, and most do not require surgical reconstruction.[22] For patients who have had symptomatic serratus winging for more than 1 year and whose EMG studies show total denervation, surgical options may be offered to alleviate pain and improve function.

Like the surgical treatments for trapezius winging, the operations for serratus paralysis can be classified into three types: scapulothoracic fusions,[9] fascial sling suspensions,[7] and muscle transfers. A variety of muscle-transfer operations have been described; these include the use of the pectoralis minor, the pectoralis major, the sternocostal head of pectoralis major, the clavicular

head of the pectoralis major, the teres major, the rhomboid muscles, and combinations of these muscles.

Scapulothoracic fusions for serratus winging have been discouraged by some,[20] primarily because of the associated inherent loss of motion, as well as the magnitude of the surgery. Pain relief, however, is a reasonable expectation.[9] Complications of scapulothoracic fusions are many and include nonunion and pneumothorax.[9] For these reasons, as well as the limited expectations with regard to motion, scapulothoracic fusions have been generally reserved for salvage operations after failure of other techniques and for treating patients with paralysis of other shoulder girdle muscles in addition to the serratus anterior.[24] Although controversial, a primary scapulothoracic fusion may also be considered for the laborer with disabling serratus winging who places heavy demands on the shoulder.[26]

Fascial-sling suspensions to correct serratus winging have been advocated by some.[7,27] However, there are significant concerns about sling failure and recurrence of winging.[10] For these reasons, muscle transfers for dynamic scapular stabilization have gained broader acceptance.

Of the variety of muscle transfers that have been described, transfer of the sternocostal head of the pectoralis major with a fascia lata graft extension[28] (Fig. 3) is probably the most popular.[22,24,25,29] In this technique,[24,28,29] the patient is placed in the lateral decubitus position with use of a beanbag, and the involved arm and forequarter are prepared and draped. An incision is made, crossing the axilla from the pectoralis major muscle anteriorly to the inferior tip of the scapula. The sternocostal head of the pectoralis major is released from its insertion on the bicipital groove of the humerus,

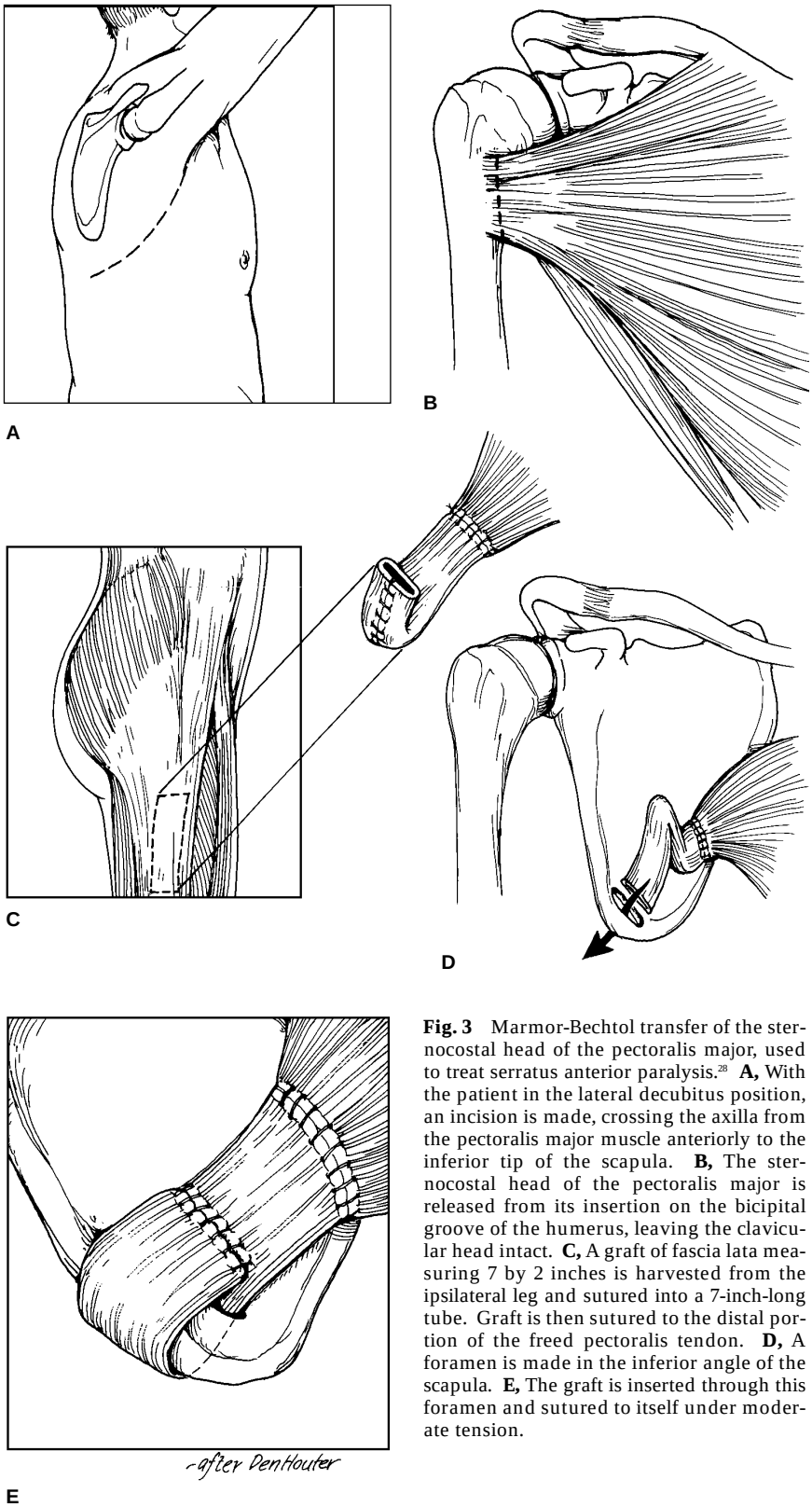

Fig. 3 Marmor-Bechtol transfer of the sternocostal head of the pectoralis major, used to treat serratus anterior paralysis.[28] **A,** With the patient in the lateral decubitus position, an incision is made, crossing the axilla from the pectoralis major muscle anteriorly to the inferior tip of the scapula. **B,** The sternocostal head of the pectoralis major is released from its insertion on the bicipital groove of the humerus, leaving the clavicular head intact. **C,** A graft of fascia lata measuring 7 by 2 inches is harvested from the ipsilateral leg and sutured into a 7-inch-long tube. Graft is then sutured to the distal portion of the freed pectoralis tendon. **D,** A foramen is made in the inferior angle of the scapula. **E,** The graft is inserted through this foramen and sutured to itself under moderate tension.

leaving the clavicular head intact. A graft of fascia lata measuring 7 by 2 inches is harvested from the ipsilateral leg and sutured into a 7-inch-long tube. This graft is then sutured to the distal portion of the freed pectoralis tendon. After the inferior border of the scapula has been exposed, a foramen is made in the inferior angle. The graft is inserted through this defect and sutured to itself under moderate tension. Postoperatively, the arm is placed in a sling, and passive motion is started after 4 weeks. Active motion is begun at 6 weeks and strengthening at 12 weeks. Although there are few large series in the literature, results with this technique have been encouraging, with 70% to 91% success rates, defined on the basis of normal shoulder motion and a significant reduction in pain and winging.[16,24,25,29]

Rhomboideus Major and Rhomboideus Minor Winging

Weakness of the greater and lesser rhomboid muscles is a rare source of scapular winging. These muscles are innervated by the dorsal scapular nerve, which takes its origin from the C5 nerve root. The dorsal scapular nerve passes deep to or, in some patients, through the levator scapulae on its way to the rhomboid muscles. A C5 radiculopathy or an injury to the dorsal scapular nerve may produce rhomboid weakness and scapular winging.[30] Patients may complain of pain along the medial border of the scapula. The winging produced by rhomboideus palsy at rest is usually minimal but may appear similar to trapezius winging, with the shoulder slightly depressed, the scapula laterally translated, and the inferior angle rotated laterally.

On physical examination, atrophy may be evident along the medial border of the scapula. During arm elevation, the inferior angle of the scapula is pulled downward and laterally by the unopposed serratus anterior muscle.[27] With weakness of the rhomboid muscles, the winging is accentuated when the arm is slowly lowered from the forward elevated position. The inferior angle of the scapula is pulled laterally and dorsally.[30] The patient will also have difficulty pushing the elbow backward against resistance with the hands on the hips.

Treatment of rhomboideus winging consists of trapezius-strengthening exercises. Although no muscle-transfer operations have been described for rhomboideus palsy, the patient with significant symptoms for whom conservative therapy has proved a failure may be helped by a fascial-sling operation, as described by Dickson.[7,27] In this operation, two fascia lata grafts are tubularized and used to connect the lower vertebral border of the scapula to the spinal muscles and the inferior angle of the scapula to the fibers of the latissimus dorsi. This procedure is thought to be useful in stabilizing the scapula and partially arresting the high thoracic scoliosis that may occur with rhomboideus and levator scapulae paralysis.[27]

Osseous Origin

Osteochondromas, the most common scapular tumors, can be a cause of "pseudowinging."[14] Rib osteochondromas may also cause the deformity.[14] This type of winging is structural and may be associated with scapular crepitus. The winging may not change when the position of the arm is varied. The EMG findings will be normal in patients with such osteochondromas; however, the lesion can be identified on radiographs obtained tangential to the plane of the scapula or on computed tomograms. Winging is alleviated with resection of the abnormal bone.

Malunions of scapular fractures have also been implicated as a source of primary winging.[31] Because muscle function is not impaired, affected patients may not be symptomatic.

Muscular Origin

Muscle abnormalities that cause winging include traumatic ruptures and congenital absence of periscapular muscles. In patients with serratus anterior muscle avulsion, significant trauma has occurred, which pulls the muscle insertion from the medial border of the scapula.[17,32-34] Fiddian and King[14] reported the case of a patient in whom serratus anterior division occurred during thoracotomy, which produced symptomatic winging. In this situation, early nerve-conduction studies may be normal, and magnetic resonance imaging should be considered to assist in the diagnosis. Surgical reattachment is recommended in all cases, and excellent results can be expected.[17,32,34] However, the combination of advanced age and systemic disease may be a contraindication to surgery.[33]

Congenital absence of the serratus anterior,[35] the trapezius,[36] and the rhomboideus major and trapezius muscles[36] have all been reported as causes of scapular winging. Patients with these congenital anomalies seem to function very well without treatment.[36]

Bursal Origin

The articulation between the scapula and the thorax is characterized by bursae, which in rare circumstances may become inflamed, causing scapular crepitus and pain. In one study,[37] winging was identified in 50% of patients with a symptomatic snapping scapula and no bone abnormalities. This type of winging is presumably related to subscapular bursitis. With treatment of the bursitis, either by nonoperative means or surgical bursectomy, the winging resolves.

Asymptomatic scapulothoracic crepitus also exists but is usually not associated with scapular winging.

Secondary Scapular Winging

Secondary scapular winging originates from disorders of the glenohumeral joint that produce abnormal scapulothoracic dynamics. This phenomenon has not been thoroughly investigated in the published literature.

A thorough evaluation of the patient with secondary scapular winging will usually, but not always, identify the source as a glenohumeral or subacromial disorder.[38] When examining any patient with a shoulder condition, secondary scapular winging should be sought with the shoulder at rest, with dynamic forward elevation, and with resisted forward elevation. One would expect a patient with secondary scapular winging to have normal findings on EMG and nerve-conduction examinations of the long thoracic nerve and serratus anterior muscle, the spinal accessory nerve and trapezius muscle, and the dorsal scapular nerve and rhomboid muscles.

In contractural winging, contractures about the glenohumeral joint produce secondary scapular winging. Patients with obstetric shoulder trauma may develop contractures due to unbalanced muscle forces with the humerus abducted and internally rotated relative to the scapula. When the arm is forcibly adducted to the chest wall and externally rotated, the superior corner of the scapula projects away from the chest wall at the upper margin of the trapezius, producing the "scapular sign of Putti."[39]

Contractural winging can also occur with fibrosis of the deltoid.[40] This type of winging decreases when the arm is raised and increases when it is lowered. Fibrosis of the deltoid muscle is thought to be either congenital[41] or related to a history of injections,[42] and is almost always associated with scapular winging.[42]

Common disorders involving the glenohumeral joint can also be a cause of secondary scapular winging. The mechanism is thought to be due to reflex muscle spasm provoked by some painful condition in the glenohumeral or subacromial area.[40] Winging has been associated with rotator cuff tears,[40] nonunion of acromion fractures,[15] malunion of clavicular fractures,[14] fractures of the glenoid,[14] osteonecrosis of the humeral head,[15] acromegalic arthropathy of the shoulder,[14] acromioclavicular joint disorders,[14,38] and shoulder instability.[14,38] In our practice, we have observed secondary scapular winging in patients with adhesive capsulitis, the impingement syndrome, anterior shoulder instability, posterior shoulder instability, and multidirectional shoulder instability. We have also encountered secondary impingement due to subtle shoulder instability in throwing athletes.

Winging frequently accompanies the asynchronous shoulder motion seen in patients with voluntary posterior shoulder subluxation. If the scapula is forcibly held against the chest wall, preventing winging, the patient may have difficulty subluxating the shoulder.

Patients with painful shoulders may reflexively limit glenohumeral motion. This forces the periscapular muscles to work in excess, because scapulothoracic motion must increase to compensate for the limited glenohumeral motion. With fatigue of the periscapular muscles, particularly the serratus anterior, trapezius, and rhomboid muscles, secondary scapular winging occurs. As has been shown,[38,40] treatment of the primary glenohumeral disorder will alleviate the scapular winging; conversely, scapular winging is unlikely to improve until the primary problem is addressed.[38] Nevertheless, in every patient with secondary scapular winging, a scapular rehabilitation program should be added to the treatment of the primary glenohumeral disorder to facilitate recovery.

Voluntary Scapular Winging

Voluntary scapular winging is very rare.[14,15,38,43] In fact, the largest series is Rowe's report of four cases.[43] The patients were reassured and instructed on the normal muscle-firing patterns of the shoulder, with "instructions not to tighten or contract their shoulder muscles when elevating the arm." All four recovered after this coaching. In another report, Gregg et al[15] described asymptomatic bilateral voluntary scapular winging in an orthopaedic resident. It is important to appreciate that patients with voluntary scapular winging who seek medical attention, like patients with voluntary subluxation of the shoulder, may have unaddressed psychological issues that complicate their care.

Summary

A variety of disorders can cause scapular winging. An understanding of these disorders and an appreciation of the physical examination findings will prevent misdiagnosis and assist in directing treatment. For most patients, conservative treatment, which includes scapular rehabilitation emphasizing range of motion and periscapular muscle strengthening, will alleviate symptoms. If symptoms persist despite adequate time and conservative treatment, one should consider the surgical options, which are capable of resolving pain and winging.

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