REVIEW ARTICLE

Scapular Winging – A Schematic Review

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ABSTRACT

Scapular winging is a rare, painful and debilitating condition that leads to limited functional activity of the upper extremity. The composite scapular movement of rotation, abduction, and tilting is necessary for proper shoulder function. Weakness or loss of scapular mechanics can lead to difficulties with elevation of the arm and lifting objects. It can result from numerous causes, including traumatic, iatrogenic, and idiopathic processes that most often result in nerve injury of either the serratus anterior, trapezius, or rhomboid muscles. Diagnosis is easily made by inspection of the scapula from back, with serratus anterior paralysis resulting in medial winging of the scapula while lateral winging is caused by trapezius and rhomboid paralysis. Most cases of serratus anterior and rhomboid paralysis spontaneously resolve within 24 months, while conservative treatment of trapezius paralysis is less effective. Patients become candidates for corrective surgery if they fail a 6–24 month course of conservative treatment. This review explores the causes of scapula winging, with overview of the relevant anatomy, proposed aetiology and treatment.

Key Words: Scapular Winging, Serratus Anterior, Trapezius, Rhomboids

INTRODUCTION

Scapular winging is one of the most common abnormalities of the scapulothoracic articulation that may be defined as “abnormal prominence of the medial border of the scapula”. It is a known fact that Scapulothoracic motion contributes to 1/3rd of the total shoulder motion. Hence winging significantly affects the normal shoulder function. It is a painful and incapacitating condition with numerous underlying etiologies.¹ Daily tasks, including brushing hair and cleaning teeth, are difficult and the scapula prominence may be cosmetically distressing. Scapula winging is characterized by a failure of the dynamic stabilizing structures that keep the scapula anchored to the chest wall, leading to a prominence of the scapula.² These stabilizers are comprised of three main muscle groups: serratus anterior, trapezius and rhomboids major and minor.

This review explores the causes of scapula winging, with an overview of the relevant anatomy, proposed etiology and management.

Anatomy

The scapula is a triangular bone overlying the second to

seventh ribs on the posterior thorax. At rest, the scapula is rotated 30° anterior on the chest wall and 20° forward in the sagittal plane, while the inferior angle is tilted 3° upward.¹ Scapula serves as the attachment site for seventeen muscles. It is nearly completely stabilized by its muscular attachments except for its connection to the clavicle by the acromioclavicular and coracoclavicular ligaments. This gives scapulothoracic interval adequate freedom for multiplanar movements.³ Scapula exhibits three motions along an axis and two translations. These includes upward / downward rotation along an anteroposterior axis that passes through the scapular body, internal / external rotation along a vertical axis that passes through the medial border of scapula and anterior / posterior tilt around an horizontal axis that passes through the scapular spine. The translatory movements includes upward / downward sliding and anterior / posterior sliding.³ Combination of above movements at the scapulothoracic articulation are essential to achieve full ROM of shoulder joint. Six muscles (serratus anterior, trapezius, rhomboid major / minor, levator scapulae & pectoralis minor) work synergistically on scapulothoracic joint to produce the complex ST movements. Dysfunction of the initial five muscles result in scapular winging.

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Figure 1. Serratus anterior

Serratus Anterior

The serratus anterior is a broad flattened sheet of muscle originating from the first nine ribs and passes posteriorly around the thoracic wall before inserting into the costal surface of the medial border of the scapula. It has three functional components⁴ (**Figure 1**). The superior component originating from the first and second ribs stabilizes superior scapula and helps in downward rotation of the glenoid. The middle component originating from the third, fourth, and fifth ribs functions to protract the scapula. The inferior component originating from the sixth to ninth ribs functions to protract the scapula and rotate the inferior angle upward and laterally. As a whole, the major function of the serratus anterior is to protract and rotate the scapula, keeping it closely opposed to the thoracic wall for maximum efficiency for upper extremity movements.⁴ It is supplied by the long thoracic nerve (C5,6,7) that runs a long course (24cms) on the chest wall along mid-axillary line which makes it more susceptible to mechanical injury.⁵

Trapezius

Trapezius originates from the skull and the spinous processes of the first cervical vertebra through the 12th

Figure 2. Trapezius

Figure 3. Rhomboid major & minor muscle

thoracic vertebra and inserts along the spine of the scapula. Like serratus anterior, it has three functional components (**Figure 2**). The superior portion elevates the scapula and rotates the lateral angle upwardly, the middle portion adducts and retracts, and the inferior portion depresses the scapula and rotates the inferior angle laterally. It is solely innervated by the spinal accessory nerve (C1-5), that crosses the posterior cervical triangle superficially where it is vulnerable for mechanical injury.⁵

Rhomboids

The rhomboids originate from the ligamentum nuchae of the neck and the spinous processes of the C7 to T5 vertebrae lying deep to trapezius. They insert along medial border of the scapula starting at the base of the scapular spine to the inferior angle of the scapula⁶ (**Figure 3**). Both rhomboid muscles are innervated by the dorsal scapular nerve (C5). Rhomboids retract and elevate the scapula and rotate its lateral border downward.

Levator scapulae

Levator scapulae muscle extends from the transverse processes of vertebrae C1-C4 to the medial border of scapula (from superior angle to root of spine of scapula). Acting on the scapulothoracic joint it elevates the scapula superomedially and rotates the glenoid cavity inferiorly. It is innervated by the anterior rami of C3, C4 nerves & Dorsal scapular nerve (C5). Along with rhomboids, it contributes to scapular winging as both share a common innervation.

CLASSIFICATION SCAPULAR WINGING

Etiology:

Serratus anterior palsy: The primary etiology is neurogenic in majority which may be traumatic, non-traumatic or idiopathic in origin.¹ Traumatic causes includes

Table 1. Based on displacement of scapula⁵

	Medial winging	Lateral winging	
Nerve injured	Long thoracic N.	Spinal Acc. N.	Dorsal scapular N.
Muscle palsy	Serratus anterior	Trapezius	Rhomboids
Physical exam.	-Weak shoulder protraction -Weak arm flexion -Wall push positive	- Weak abduction >90deg - weak shrug - ER against resistance test	- weak arm extension from flexion
Scapula position	Displaced more medial and superior, inferior angle rotated medially	Superior angle more laterally displaced	Inferior angle more laterally displaced

Traction nerve injury (>50% cases) due to repetitive stretch, Compression nerve injury (RTA, contact sports, scalene muscles, subcoracoid /subscapular inflamed bursa, Direct nerve laceration due to iatrogenic causes (Mastectomy / axillary lymph node dissection/1st rib excision / Chest tube placement for pneumothorax /Abnormal positioning – GA). Non-traumatic neurogenic causes includes post-viral illness palsy (Parsonage Turner syndrome), C7 radiculopathy, Allergic-drug reactions / drug overdose, Poliomyelitis and toxic exposure (herbicides). Myogenic causes include traumatic avulsion of the serratus anterior and Muscular dystrophy-fascioscapulohumeral dystrophy (FSHD). Osseous causes include inferior pole fractures scapula and malunited scapula fractures.

Trapezius palsy: The primary etiology is neurogenic in majority of trapezius palsy cases like serratus anterior palsy. This may be of traumatic, non-traumatic or idiopathic origin.¹ Most common traumatic cause is iatrogenic injury during surgical procedures in the posterior triangle of the neck (cervical lymph node biopsy, radical neck dissection etc). Traction injury can happen due to sudden lateral flexion of the neck (motor vehicle or motorcycle accidents). Rarer causes includes Mononeuropathy, Arnold-Chiari I malformation, Guillain- Barré syndrome which may show involvement of sternocleidomastoid muscle as well.

Rhomboid palsy: Neurogenic palsy predominates here also which may be of traumatic, non-traumatic or idiopathic origin.¹ Entrapment of the nerve in scalene medius is one of the common cause. Other causes includes C5 root lesion or avulsion (RTA), C5 radiculopathy or muscle injury / ruptures during overhead athletics (volley ball player) (Table 1).

Secondary causes:

Secondary scapular winging originates from disorders of the glenohumeral / acromioclavicular/ scapulothoracic joint that produce abnormal scapulothoracic dynamics. These are probably the commonest cause of scapular winging seen in daily practice. When examining any

Table 2. Based on the etiology²

Primary	Secondary	Voluntary
Neurologic origin Spinal accessory nerve (Trapezius palsy) Long thoracic nerve (Serratus anterior palsy) Dorsal scapular nerve (Rhomboid palsy)	Rotator cuff pathology	Look for
Osseous origin Scapular osteochondromas Scapular fracture malunions	Shoulder instability	
Soft-tissue origin Contractural winging Scapulothoracic bursitis Muscle avulsion or agenesis	Mal-united acromial / clavicle fractures	
	Acromioclavicular joint disease	
	Impingement	
	Biceps tendonitis	
	AVN humeral head	
	Adhesive capsulitis	
	Suprascapular nerve entrapment	
	Scapular osteochondroma	
	Scoliosis	

patient with a shoulder pathology, secondary scapular winging should be looked for with the shoulder at rest, with dynamic forward elevation, and with resisted forward elevation. Contractural shoulder winging is an important cause of secondary scapular winging in some parts of the world. This can happen secondary to obstetric birth palsy or deltoid contractures that can be congenital or post injection sequelae. A patient with secondary scapular winging is expected to have normal findings on EMG and NCS of serratus anterior, trapezius and rhomboids. Patients with painful shoulder pathologies may reflexively limit glenohumeral motion. This causes the periscapular muscles to work in excess to compensate for the limited glenohumeral motion and early fatigue. The fatigue of the periscapular muscles, especially the serratus anterior, trapezius, and rhomboid muscles leads to secondary scapular winging.¹ We must always rule out the secondary

Table 3. Common winging patterns

	Winging pattern	
1.	Winging present at rest and becomes prominent with shoulder forward flexion /abduction	Serratus anterior
2.	Winging minimal at rest and becomes prominent with shoulder abduction	Trapezius
3.	Winging minimal at rest and becomes prominent with shoulder extension	Rhomboids
4.	Nonspecific pattern of winging	Secondary / voluntary

Figure 4. Tests for serratus anterior (a) Wall push-up test (b) Forward elevation test (c) Protraction against resistance

causes of scapular winging before diagnosing as primary winging. The common causes of secondary scapular winging is listed in **Table 2**.

Presentation:

The patient usually presents with vague, nonspecific shoulder girdle pain and fatigue feeling at the base of neck, scapula and deltoid. They may complain of recurrent muscle spasms in the periscapular region and weakness when lifting away from body and overhead activity or feeling of shoulder instability. Few patients complain of discomfort while sitting against a chair like in a long car drive. Patients presenting with secondary winging presents with features of the primary pathology. Ask for any history of surgery of the neck, shoulder, thorax, or axilla, recent viral illness and immunizations, injury while playing or road trauma.

Examination:

Inspect the patient from front and back after exposing upto waist. Compare the scapular rhythm both at rest and with forward flexion and abduction movements multiple times. Look for any visible wasting of periscapular muscles. Finally perform the scapula compression test to predict the outcome of surgical stabilization procedures for winging scapula (**Table 3**). We can document the winging by measuring the distance of the medial border of the scapula at T2 and T7 spine levels and comparing with the opposite side.

Serratus anterior examination :

Clinical examination shows medial scapular winging at resting posture that gets exacerbated with forward flexion of arms. Active arm flexion is not possible >120 degrees. The medial and inferior borders of the scapula are more prominent and closer to the spine, lifted superiorly when compared to the normal side due to unopposed action of rhomboids and trapezius. The commonly performed tests (**Figure 4**) are :

- Wall push-up test- standing position
- Forward elevation test –sitting position
- Protraction against resistance – supine posture

In Brachial plexus palsy with flail limb, we can test for supported protraction or protraction against resistance.

Trapezius palsy

Clinical examination shows a drooping shoulder with minimal winging at rest. On arm abduction, lateral scapular winging appears. The superior angle of the scapula is more lateral to the midline than the inferior angle due to the pull of Rhomboids. There is visible atrophy of trapezius with asymmetrical neck line and difficulty in abducting the arm more than 80-90 degrees (**Figure 5**). Always examine for functioning sternocleidomastoid to rule out proximal lesions of accessory nerve. Clinically, we have to test upper, middle and lower trapezius separately. Other less

Figure 5. (a)Trapezius atrophy & asymmetrical neck line (b) Lateral winging

Figure 6. Rhomboids testing

commonly performed tests for trapezius palsy are Resisted active external rotation test and Triangle sign.^{7,8}

Rhomboid palsy

Clinically, patient presents with subtle lateral winging of the scapula that accentuates the arm is taken to extension from flexed position. Unlike the trapezius palsy, the inferior angle of the scapula is more lateral to the midline than the superior angle due to the pull of trapezius. Rhomboids palsy is difficult to diagnose as atrophied rhomboids and lateral winging are masked by the hypertrophied trapezius. Rhomboids can be tested in sitting or prone posture by checking the retraction of the scapula against resistance with shoulder in internal rotation (**Figure 6**).

Scapulothoracic compression test: It refers to active compression of the scapula against the thoracic wall using palms of the examiner (to compensate for the weak muscle action) and checking for the recovery of the lost shoulder movement (**Figure 7**). A positive compression test denotes good prognosis of the scapular winging surgeries.

Pseudowinging: It refers to appearance of scapular winging in the absence of true etiology. Common causes are Scapula /rib osteochondromas, Scapular malunions. Examination may not show the classical positional variation of winging with change of arm positions. This type of winging is structural and may be associated with scapular crepitus. Muscle function is not impaired. EMG findings will be normal. Diagnosis is by Xrays and CT scans.

Muscular Origin

These include traumatic ruptures and congenital absence of periscapular muscles. Traumatic avulsion has been reported with serratus anterior.¹⁰ Surgical reattachment is recommended in all cases. Congenital absence of the serratus anterior, the trapezius, and the rhomboideus major and trapezius muscles have all been reported as causes of scapular winging.^{11,12} Patients with these congenital anomalies seem to function well without surgical treatment.

Figure 7. Scapula compression test⁹

Bursal Origin

The articulation between the scapula and the thorax is characterized by bursae, which may become inflamed in rare circumstances causing scapular crepitus and pain. Percy et al reported winging in 50% of patients with a symptomatic snapping scapula and no bone abnormalities.¹³ This type of winging may be related to subscapular bursitis. Treatment of the bursitis, either by nonoperative means or surgical bursectomy resolves the winging.

Voluntary Scapular Winging

Voluntary scapular winging is a rare condition.¹⁴ Patients with voluntary scapular winging seeking medical attention, may have unaddressed psychological issues like patients with voluntary subluxation of the shoulder, that can complicate their management. Rowe's report of four cases were patients were reassured and instructed on the normal muscle-firing patterns of the shoulder. All four recovered with this treatment approach.¹⁵ Psychotherapy and scapular and core strengthening forms the keystone of the treatment of such cases.

Investigations:

The most important diagnostic modality to diagnose the causes of primary winging is Electromyogram (EMG) and nerve conduction studies (NCS). NCS of the long thoracic nerve is very useful to diagnose the neurogenic causes for serratus anterior palsy. Radiographs & CT scans are useful to diagnose malunited scapula fractures, Osteochondromas etc. MRI of the shoulder and cervical spine helps to rule out the secondary causes of winging.

Treatment :

Treatment depends on the duration and severity of symptoms. Conservative treatment for 6-18 mths is the norm unless there are evident causes like open nerve

Figure 8. Pectoralis major sternal head transfer

transection. Physical therapy, neck and core strengthening, transcutaneous nerve stimulation are the key components of the nonsurgical therapy. Specific treatment for each type of scapular winging is described.

Serratus anterior palsy: Scapular brace may be given but patient compliance is poor. Range-of-motion exercises to prevent adhesive capsulitis of the shoulder should be implemented immediately. There is little data in the literature regarding the results of neurolysis, nerve repair, or nerve grafting 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.¹⁶ Transfer of the lateral branch of the thoracodorsal nerve to the long thoracic nerve has been attempted. A large number of patients with persistent impairment of the serratus anterior are often able to compensate and does not require surgical treatment.¹⁶ Supraclavicular decompression as the nerve traverses the scalene has also been tried in indicated cases. For serratus anterior muscle avulsion, an early repair is indicated. 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.

Surgical options can be divided into static and dynamic procedures.¹ Static stabilization includes scapulothoracic fusion¹⁷ and other operations that tether the scapula to the spine. The dynamic procedures involves some form of muscle transfer. As scapulothoracic fusions represent a major surgical procedure that limits motion significantly, and because fascial sling suspensions tend to fail due to stretching of the sling causing recurrence of winging in 2- 3 years, dynamic muscle transfers have become the procedure of choice.

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 (**Figure 8**) is probably the most popular.^{18,19} The sternocostal head of the pectoralis

Figure 9. Eden-Lange procedure

major is released from its insertion on the bicipital groove of the humerus and transferred to the inferior border of scapula with fascia lata extension. Scapulothoracic fusion is used as a salvage operation after failure of other surgical procedures and in facioscapulohumeral dystrophy (FSHD).¹⁷ Issues with fusion includes restricted shoulder ROM, pseudarthrosis, and pulmonary complications.

Trapezius palsy:

An initial treatment regimen including physical therapy is helpful to maintain glenohumeral motion and prevent adhesive capsulitis. There is less response to conservative therapy as compared to the serratus anterior palsy. It is due to the inability of physical therapy to adequately strengthen adjacent muscle groups enough to compensate for the cross-sectional area and direction of pull of the trapezius. In cases with injury to spinal accessory nerve, there is role for neurolysis, nerve suturing and/or nerve Grafting.^{20,21}

Surgical options can be divided into static and dynamic procedures like above. The muscle-transfer operation most commonly performed for trapezius paralysis is the Eden-Lange procedure (**Figure 9**). It involves lateral transfer of the levator scapulae, rhomboid minor, and rhomboid major muscles along the scapula. Bigliani et al reported their results with this procedure. Of the treated 23 patients with trapezius winging, 87% had good or excellent results.²² Romero and Gerber demonstrated excellent pain relief and function in nine out of 12 patients at mean follow-up of 32 years.²³ Predictors of poor surgical outcome are age above 50 years and concomitant long thoracic nerve palsy.²³

Rhomboid palsy:

Majority of the cases are treated conservatively as there is good compensation by trapezius.⁵ Strengthening of the trapezius esp. the middle portion is the primary objective

of physical therapy. Surgical options involves neurolysis or decompression in the scalene muscles, repair of detached muscles and rarely fascial sling operation.

SUMMARY

A variety of disorders can cause scapular winging. Neurogenic etiology is the major contributor of primary scapular winging with weakness of Serratus anterior being the commonest. Examining the patient from the back is of paramount importance to diagnose any scapular pathology. A thorough understanding of the causative factors with appropriate physical examination will prevent misdiagnosis and assist in directing treatment. EMG studies are a useful adjunct for distinguishing long thoracic nerve palsy from other causes of scapula winging. Majority of the patients gets relieved with conservative treatment, which includes scapular rehabilitation emphasizing range of motion and periscapular muscle strengthening exercises. If symptoms persist despite adequate trial of conservative treatment, surgical options may be attempted. Scapular compression test assists to predict the outcomes of the surgical intervention.

END NOTE

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