



December 1998 EMG Case-of-the-Month

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HISTORY

A 30-year-old right-hand-dominant man presents with a three month history of right shoulder pain and weakness. While at work, he lifted a heavy table overhead and felt a sudden, sharp pain in the right shoulder. A month later he was diagnosed with rotator cuff tendinitis, and has since been participating in physical therapy. Although the pain has improved, electrodiagnostic consultation is requested due to persistent weakness of the shoulder girdle musculature.

- **Prior to continuing, please develop a differential diagnosis and list each possible diagnosis in order of likelihood.**
- **Is there any additional information regarding the clinical history that might be helpful in clarifying your differential list or changing its order of priority?**

COMMENTARY I

The patient's shoulder weakness and pain would appear to be temporally related to the lifting incident three months ago. Differential diagnosis at this point should include neurogenic causes of weakness such as cervical radiculopathy, brachial plexopathy and focal neuropathies of nerves supplying the shoulder girdle musculature, including the suprascapular, long thoracic and axillary, any one of which is subject to possible traction injury. Historical data regarding the following musculoskeletal causes should also be obtained: rotator cuff pathology, glenohumeral instability, acromioclavicular joint separation, and myofascial pain.

HISTORY, continued

Radiologic studies of the right shoulder are unremarkable. The patient initially had pain over the entire shoulder. This diffuse pain improved with physical therapy, but he now experiences deep aching in his upper lateral chest wall. He denies numbness, tingling, neck pain, or any popping sensation in the shoulder region, and there is no past history of shoulder instability. His primary difficulty is in raising his arm above his head.

- **If necessary, revise your differential diagnosis based on the additional clinical history.**
- **On which details of the physical examination should you focus at this point?**



COMMENTARY II

Musculoskeletal causes should still be considered, but the weakness of arm elevation warrants neurologic investigation, focusing not only on the shoulder girdle musculature but also throughout the limb to detect subtle weakness of more distal muscles. Attention should be paid to scapulohumeral rhythm during humeral abduction, as abnormalities may be indicative of nerve or rotator cuff pathology. A cervical nerve root lesion seems less likely in the absence of neck pain, but is still possible.

PHYSICAL EXAMINATION

Range of motion of the cervical spine is full, with no paracervical tenderness. No atrophy of the infraspinatus, supraspinatus, deltoid or other muscles of the right upper limb is noted. Forward elevation of the right upper limb is limited to 120 degrees with normal passive range of motion. At rest, there is prominence of the lower medial border and inferior angle of the right scapula compared to the left. This is markedly accentuated by active shoulder flexion. Otherwise, strength of the muscles controlling the shoulder, elbow, wrist, and hand intrinsic muscles is normal. The biceps, brachioradialis, pronator teres and triceps reflexes are present and symmetric bilaterally. Sensory examination to light touch and pinprick is intact in the C5-T1 dermatomes. Impingement and apprehension signs are negative, and there is no acromioclavicular, bicipital, or subacromial tenderness.

- **At this point, review your differential diagnosis and revise as appropriate.**
- **Are there additional observations on physical examination that might be helpful in narrowing your differential list?**

COMMENTARY III

Unilateral scapular winging results most commonly from neuropathy of the long thoracic nerve to the serratus anterior or the accessory nerve to the trapezius. An isolated dorsal scapular nerve lesion to the rhomboids is rare but may also result in scapular winging. The position of the scapula at rest and with provocative maneuvers is most helpful in discerning the specific nerve involved, viz. the medial border is vertical with serratus weakness and angles outward at the top with trapezius weakness. Also, with trapezius weakness, the scapula translocates laterally. Finally, glenohumeral joint stiffness and shoulder instability may cause non-neurogenic scapular winging but should have been detected with range of motion and stability tests.

PHYSICAL EXAMINATION, continued

There is no obvious shoulder drooping on the right and the scapula is not laterally translocated. While forward flexion of the humerus accentuates the scapular winging, humeral abduction to 90 degrees does not increase winging.

- **If necessary, revise your differential diagnosis based on the additional physical findings.**
- **Design your approach to the electrophysiologic examination based on the existing data.**



COMMENTARY IV

Physical findings suggest scapular winging on the basis of serratus anterior weakness. The serratus anterior functions to upwardly rotate and protract the scapula, as well as maintain the scapula's position against the chest wall during forward elevation of the limb. The position of the scapula at rest in long thoracic palsy confirms these functions: (a) prominence of the medial border, particularly the inferior angle due to unopposed downward pull from the weight of the limb and (b) a slight medial translocation of the entire scapula. The winging is accentuated with forward elevation of the humerus. More subtle weakness may require resisted scapular protraction by pressing the raised hand against a wall. Conversely, the winging is not marked with humeral abduction, as it is with trapezius weakness.

Unlike serratus anterior dysfunction, winging from trapezius weakness is accentuated with humeral abduction rather than forward flexion. With an accessory nerve lesion, the scapula at rest may show a prominent medial border, but there is lateral translocation of the scapula due to weakness of middle trapezius fibers, as the medial border angles outward at the top due to weakness of the upper trapezius fibers. Drooping of the shoulder also occurs due to weakness of upper trapezius function.

Rhomboid weakness from an isolated dorsal scapular lesion is most unusual and difficult to discern on examination of the winged scapula. In this case, there may be a prominent inferior angle at rest but lateral scapular translocation and upward rotation, rather than the downward rotation seen in serratus anterior weakness. The winging is increased with overhead elevation of the humerus.

The history and physical examination in the case point toward a long thoracic nerve injury. In designing the electrophysiologic study, it is important to verify involvement of the serratus anterior versus other causes of scapular winging, determine the extent of axon loss if possible, and distinguishes an isolated long thoracic nerve lesion from a more diffuse neuropathic process.

ELECTROPHYSIOLOGIC DATA

ELECTROMYOGRAPHY										
N = normal incr = increased decr = decreased 0 = absent 1+ = minimal 4+ = maximal crd = complex repetitive discharge fasc = fasciculation potential myk = myokymic discharge myt = myotonic discharge nmt = neuromyotonic discharge p wave = positive sharp waves fib = fibrillation potentials recr = recruitment amp = amplitude dur = duration poly = polyphasic potential										
R/L	MUSCLE	INSERTION		SPONTAN		VOLUNTARY				
		activ	P wave	fib	other	recr	amp	dur	poly	effort
R	biceps	N	0	0	0	N	N	N	N	full
R	brachioradialis	N	0	0	0	N	N	N	N	full



R	extensor indicis proprius	incr	2+	2+	0	mild decr.	N	N	N	full
R	pronator teres	N	0	0	0	N	N	N	N	full
R	abductor pollicis brevis	incr	3+	3+	0	1 muap 20 Hz	N	N	N	full
R	flexor carpi ulnaris	incr	2+	2+	0	mild decr.	N	N	N	full
R	abductor digiti minimi	incr	3+	3+	0	mild decr.	N	N	N	full
R	pectoralis major, sternal head	incr	0	1+	0	marked decr.	N	N	N	full
R	pectoralis major, clavicular head	N	0	0	0	N	N	N	N	full
R	latissimus dorsi	N	0	0	0	N	N	N	N	full
R	paraspinals, cervical	N	0	0	0	N	N	N	N	full

SENSORY NERVE CONDUCTION									
nr = no response									
NERVE	LATENCY			AMPLITUDE (µV)			CONDUCE VEL(m/s)		
	R	L	Norm	R	L	Norm	R	L	Norm
radial wrist to thumb, 10 cm	2.3	-	<2.9	14	-	>10	-	-	-
median wrist to thumb, 10 cm	2.3	-	<2.9	17	-	>15	-	-	-
ulnar wrist to little finger, 14 cm	nr	-	<3.7	nr	-	>15	-	-	-

MOTOR NERVE CONDUCTION									
nr = no response									
NERVE	LATENCY (ms)			AMPLITUDE(mV)			CONDUCE VEL (m/s)		
	R	L	Norm	R	L	Norm	R	L	Norm
median	-	-	-	-	-	-	-	-	-
wrist to thenar	4.8	-	<4.3	1.8	-	>5	-	-	-
elbow to thenar	-	-	-	1.7	-	>5	56	-	-
ulnar	-	-	-	-	-	-	-	-	-
wrist to	3.8	-	<4.3	4.6	-	>5	-	-	-



hypothenar									
below elbow to hypothenar	-	-	-	4.3	-	>5	57	-	-
above elbow to hypothenar	-	-	-	4.0	-	>5	76	-	-

- **On the basis of both the clinical and electrophysiologic evaluations, formulate your diagnostic impression. List the most likely diagnosis first and follow in order with the other possibilities that are not excluded by the data. Eliminate those diagnoses not supported by the data.**

DIAGNOSTIC IMPRESSION

There is moderately severe right lower trunk plexopathy. Axonal continuity is present in all branches of the plexus. There is not yet any evidence of collateral reinnervation.

There are no root avulsions.

Due to the fact that there were no root avulsions and these are postganglionic lesions the prognosis is better. In addition, presence of motor units with recruitment in EMG and presence of motor amplitudes also is a better prognosis.

- **What other diagnostic procedures (laboratory tests, etc.), if any, are needed?**
- **What treatment would you recommend?**

COMMENTARY I

Clinical examination: A carefully constructed clinical examination of the upper limbs can usually localize the lesion(s) in cases of traumatic nerve injuries. For example, noting if there is clawing helps localize the lesion. Severe clawing results from a more distal lesion due to the fact that the flexor digitorum profundus (FDP to the ring and little fingers) is still intact. Mild clawing can result from a lesion proximal to the FDP.

Weakness of both median and ulnar innervated muscles of the hand points to a lesion where the nerves course together (upper brachium/axilla) or to a lesion proximal to the origin of these two nerves (medial cord/lower trunk/C8/T1). Weakness of one head of the pectoralis major may be difficult to detect due to the fibers that remain intact, but the observation of atrophy sometimes can help to localize the lesion to one head or the other. The lateral pectoral nerve to the clavicular head arises from the lateral cord, the medial pectoral to the sternal head arises from the medial cord.

Testing the volar and dorsal surfaces of the ulnar aspect of the hand determines if the lesion is distal or proximal to the origin of the dorsal ulnar cutaneous nerve [1].

Electromyographic Examination: Localization of a plexus lesion is an exercise in anatomy and is done by tracing the innervation of a particular muscle proximally through the plexus to the roots. For example, nerve fibers innervating the extensor indicis proprius (EIP) originate at the C7 and 8 segmental levels and travel through the lower trunk to the posterior division and cord to reach the radial nerve. When there is an abnormality of this muscle there is a lesion somewhere along this pathway. This process is repeated with other



abnormal muscles. Then the pathways are traced proximally and where they intersect is the site of the lesion.

The lower trunk does not give off nerve branches. Localization of a lesion to this site must be done by a process of elimination as follows: Involvement of the medial pectoral nerve suggests that the lesion is proximal to this portion of the medial cord. The next step is to show the extensor indicis proprius is involved. This places the lesion proximal to the posterior division of the lower trunk. With sparing of the paraspinal muscles, this places the lesion at the lower trunk [2].

Nerve Conduction Studies: Selection of appropriate nerve conduction tests also assist in diagnosing the location of the lesion [3]. Sensory recordings from the thumb represent the C6 dermatome and upper plexus, whereas recording from the small finger evaluates the C8 dermatome and lower plexus. In this particular case, we demonstrated that nerves from the thumb are intact whereas nerves fibers from the little finger lack a response. In contrast, the recordings from the median and ulnar innervated muscles are both abnormal. Nerve fibers to these muscles originate at the C8 and T1 levels and traverse the lower trunk and medial cord. This combination of motor and sensory studies supports a lesion proximal to the origin of the median and ulnar nerves, yet distal to the dorsal root ganglion.

With regard to treatment, Kline and Judice [4] evaluated 171 patients with brachial plexopathy over a 12 year period. They found that lesions of the brachial plexus that are in continuity e.g., stretch injuries and some gunshot wounds, the surgical exploration should be delayed for several months. In contrast, in lacerations in which continuity of the nerve is lost yet ends can be approximated, primary repair is advocated.

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