



November 1998 EMG Case-of-the-Month

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Case prepared by Faye Y. Chiou-Tan, MD, and Thao Tran, MD

Edited by Ian C. MacLean, MD; Lawrence R. Robinson, MD;

and Steve R. Geiringer, MD

HISTORY

A 41-year-old construction worker lost his balance on a platform and fell at work one month ago. As he fell, he used his right upper limb to grab onto a steel pipe. The patient noted that his shoulder was not in place and felt an electrical shooting pain down the medial part of his limb immediately after falling. In the emergency room, the patient's shoulder was realigned and the patient was sent home. He now complains of inability to flex the fingers of his right hand and numbness in the ulnar aspect of the hand and medial forearm.

- **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

A differential diagnosis can be organized anatomically. Starting proximally, one possibility is spinal root avulsion or radiculopathy. A further history regarding whether there was injury to the head or loss of consciousness would help determine the likelihood. Another possibility is a lesion of the brachial plexus. This is supported by the patient's complaints thus far. Peripheral nerve lesions are also a consideration. The radial nerve is often injured with humeral fractures. Further history could help determine the possible occurrence of a humeral fracture. An ulnar nerve lesion is also possible given the distribution of the patient's symptoms of numbness.

HISTORY, continued

The patient denies loss of consciousness or further trauma to the head or right upper limb due to the fall. He denies that the bone in his arm was broken. He states the symptoms occurred immediately at the time of the fall and preceded the relocation of his shoulder in the emergency room.

- **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

Based upon the patient's additional history, it is less likely that spinal nerves, nerve roots, or the upper portion of the brachial plexus are involved because his head was not injured.



The patient is complaining of inability to flex his fingers. In radial nerve injuries, patients complain of both wrist-drop plus difficulty grasping objects which is due to impaired tenodesis that results from the wrist-drop. In addition, the absence of a humeral fracture and the fact that the patient's symptoms are on the medial aspect of the upper limb make radial nerve injury highly unlikely.

Physical exam should evaluate strength, reflexes and sensation with regard to segmental level and the distribution of the brachial plexus and peripheral nerves.

PHYSICAL EXAMINATION

The patient is a well-developed gentleman with no apparent muscle atrophy including the proximal portion of the right upper limb and the intrinsic muscles of the hand. No clawing of the hand was noted. There were no abnormal skin or hair changes in the hand. Muscle strength in the right upper limb was 5/5 in the biceps, deltoid, triceps and pronators; 4/5 in the extensor indicis proprius; 3/5 in the abductor pollicis brevis and 0/5 in the interossei and the deep and superficial finger flexors.

- **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

It is necessary that the physical examination be performed carefully to reflect potential EMG muscle testing sites. Special attention should be paid to muscle bulk and skin changes. The latter reflects nerve fibers which control autonomic functions. Based upon the motor exam in this case, it is unlikely the upper portion of the plexus is involved. The findings support either a lower trunk/medial cord plexopathy or multiple peripheral lesions. A combined lesion of the C8 and T1 roots is also possible. In gunshot wounds to the neck, the latter is more likely, but in falls and motor vehicle accidents, the former is more likely. Evaluation of proximal muscle strength and a sensory examination will help narrow the possibilities.

PHYSICAL EXAMINATION, continued

Strength in the right pectoralis major was 4+/5 and there was no obvious alteration of the bulk of that muscle. Muscle stretch reflexes (biceps, brachioradialis and triceps) were present and symmetric bilaterally. Pinprick sensation was diminished in ring and small fingers on both volar and dorsal surfaces and the medial and lateral aspects of the ring finger. Sensation was also diminished in the medial forearm.

- **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

Examining the upper and lower portions of the pectoralis muscle can sometimes assist in differentiating medial cord vs. lower trunk lesions. This is because the medial pectoral nerve



originates from the medial cord whereas the lateral pectoral nerve arises from the lateral cord. At times, it is possible to see selective atrophy of the upper or lower pectoral fibers. Testing this patient's pectoral strength established a proximal lesion. The sensory exam is consistent with diminished pinprick in the C8 dermatome or lower brachial plexus distribution rather than an ulnar distribution.

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 | rectr | 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) | | | CONduc VEL(m/s) | | |
| | R | L | Norm | R | L | Norm | R | L | Norm |
| radial | 2.3 | - | <2.9 | 14 | - | >10 | - | - | - |



| | | | | | | | | | |
|---|-----|---|------|----|---|-----|---|---|---|
| wrist to thumb, 10 cm | | | | | | | | | |
| 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 hypothenar | 3.8 | - | <4.3 | 4.6 | - | >5 | - | - | - |
| 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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