American Academy of Physical Medicine and Rehabilitation

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EMG Case No. 45, June 2000

This case is no longer available for CME credit.

Presenting Symptom: Arm Weakness

Case prepared by Robert A. Werner, MD

Appropriate Audience: Residents and practicing physicians.

Learning Objectives: After completing this educational activity, participant will be able to (1) list the differential for unilateral arm weakness, (2) discuss the electrodiagnostic findings that differentiate a cervical radiculopathy from a brachial plexopathy, and (3) discuss the difference in presentation of a brachial plexopathy resulting from tumor invasion versus radiation induced.

History

A 52-year-old man is referred to the EMG laboratory with weakness of the left arm. The patient had a history of a mass in the left axilla in 1987. The mass was determined to be an adenocarcinoma of unknown primary. He was treated with chemotherapy, surgery, and radiation. The chemotherapy consisted of cisplatin, vinblastine, and bleomycin. He noted some arm stiffness and edema in the left arm following radiation but this was felt to be lymphedema and scarring of the skin secondary to the radiation. He was never evaluated for neurologic compromise until he complained of weakness and numbness in the left arm that started in January, 1999. Upon further questioning, the patient related that the weakness had been present for a year but he was not concerned until recently when the weakness appeared to worsen. He has not had any pain associated with the weakness. He does report some numbness in the lateral aspect of the left arm and forearm and in the tips of his all fingers. He does not have any other active medical problems. He denies any recent trauma or symptoms in the neck.

- *Prior to continuing, please develop a differential diagnosis and list each possible diagnosis in order of likelihood.*

The history of an axillary tumor and radiation treatment make brachial plexopathy high on the list of diagnostic possibilities. This could be related to recurrence of the tumor or secondary damage from the radiation treatment. Other causes of a brachial plexopathy should be considered such as acute brachial neuritis, local scarring from the previous surgery, and radiation induced tumors. Additionally, the possibility of a cervical radiculopathy must be considered. Finally, for any person complaining of progressive, painless weakness, motor neuron disease or a monomelic motor neuron disorder included in the differential.

- *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 amount of chemotherapy and the any complication associated with the surgery would influence the differential diagnosis. The patient had 4 courses of chemotherapy including cisplatin, vinblastine (velban), and bleomycin. The poorly differentiated carcinoma was treated as an extra-gonadal tumor. This is a typical chemotherapy program. The only neurotoxic chemotherapeutic agent is the cisplatin which is associated with a primarily

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sensory peripheral polyneuropathy. It is typically dose dependent and presents acutely or subacutely. Thus chemotherapy as the etiological agent is reduced. After the chemotherapy a small, stable axillary mass remained and this was surgically removed in 1987. There were no reported complications of the surgery. This reduces the likelihood of surgery as the cause of the neuropathy but secondary scarring cannot be excluded from the differential.

History, continued

Knowledge of the dosage of radiation would be helpful in prioritizing the differential since subjects exposed to >6,000 rads are at higher risk of radiation induced nerve injury while those subjects receiving <5,000 rads are less likely to have associated nerve injury. He had a total of 5760 rads to the left axilla and 5160 rads to the left supraclavicular region. He initially had local skin irritation but later developed edema of the left arm and shoulder. The swelling was felt to be lymphedema but did not respond to a Jobst pump. The lymphedema can result in a compression neuropathy and this must be added to the differential.

Any history that would clarify the work-up of tumor recurrence would also modify the priority listing of the differential. Follow-up CT and PET scans have not demonstrated re-occurrence of the tumor. Repeated physical examinations have not demonstrated enlargement of lymph glands or obvious mass in the axillary region. There was evidence of sclerotic changes in the scapula that were felt to be secondary to the radiation. Note was made of mild degenerative changes in the cervical spine at C4-5 and C5-6. He also had thickened scarring of the skin in the axilla that was felt to be related to radiation treatment. This information makes tumor recurrence less likely and radiation more likely.

The timing of his symptoms may influence the differential; symptoms within one year of treatment suggest radiation while after one year there is an equal chance of radiation or tumor recurrence as the etiology. He has had decreased left shoulder abduction since 1989 secondary to the sclerotic skin changes around the shoulder but did not complain of shoulder pain until 1995; this was not found to be associated with recurrence of the tumor and radiation treatment was suspected as the precipitating cause. He did not report arm weakness until 1999 although when evaluated in the EMG laboratory, he reported being aware of some weakness as early as 1990. The weakness worsened over the past year. He also noted numbness in the hand and arm that had been present for the past year.

Past medical history was significant for trauma to the left foot from a land mine, resulting in amputation of the left great toe.

- *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

The additional history would argue against recurrence of the tumor since repeated scans have been negative. Additionally, metastatic tumor associated with brachial plexopathy is frequently painful. This history does not exclude tumor as an etiology but places it lower in the differential. The chemotherapy did include a potent neurotoxin (cisplatin) but this is most likely to be associated with a primarily sensory polyneuropathy, sometimes quite profound. We have added lymphedema as a possible etiology.

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Physical Examination

The patient is a middle-aged man who looks older than his stated age of 52. He is in no apparent distress. He has a slight loss of muscle mass in the left shoulder girdle and the arm. The skin in the axillary region is thickened and scarred. He has a slight decrease in active shoulder abduction that seemed limited by tautness of the axillary fold. He is able to place his hands behind his head as well as touch the small of his back. All other joint range of motion in the left upper limb is normal. His muscle stretch reflexes in the left upper limb are reduced compared to the right. He has a subjective loss of light touch sensation over the shoulder and the lateral aspect of the arm and forearm. Manual muscle testing reveals 4/5 strength in all left upper limb muscle groups tested. Strength and sensation in the right upper limb is normal.

- *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

The physical examination confirms the motor and sensory deficits. The sensory findings suggest involvement of the C5-6 dermatomes. The decreased reflexes and diffuse loss of strength suggest a pan plexopathy or a more extensive cervical polyradiculopathy affecting C5 through T1.

Electrophysiologic Data

SENSORY NERVE CONDUCTION									
nr = no response									
NERVE	**LATENCY**			**AMPLITUDE (µV)**			**CONDUC VEL(m/s)**		
	R	**L**	**Norm**	**R**	**L**	**Norm**	**R**	**L**	**Norm**
median (wrist to Index)	3.8	3.9	3.8	17.0	3	17.0	45.0	42.0	45.0
ulnar (wrist to 5th digit)	3.5	nr	3.5	9.0	nr	8.0	48.0	nr	45.0

MOTOR NERVE CONDUCTION									
nr = no response									
NERVE	**LATENCY (ms)**			**AMPLITUDE (mV)**			**CONDUC VEL (m/s)**		
	R	**L**	**Norm**	**R**	**L**	**Norm**	**R**	**L**	**Norm**

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median wrist	3.8	3.9	4.4	9.1	8.3	5.0	-	-	-
median elbow	-	8.4	-	-	8.2	-	-	50.0	49.0
ulnar wrist	-	3.1	3.5	-	5.5	5.0	-	-	-

F-WAVE								
# = number of stimuli P = persistence CD = chronodispersion F:M = ratio of average F-wave amplitude to M-wave amplitude								
R/L	**NERVE**	**#**	**LATENCY (ms)**			**CD (ms)**	**P (%)**	**F:M(%)**
			min	**mean**	**max**			
L	ulnar	-	30.9	31.0	-	-	-	-

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**	**recrt**	**Amp**	**dur**	**poly**	**effort**
L	biceps brachii	N	0	0	0	dec 1+	inc 1+	inc 1+	N	N
L	infraspinatous	N	0	0	0	dec 1+	inc 1+	inc 1+	N	N

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L	triceps	N	0	0	0	dec 1+	inc 1+	inc 1+	inc 1+	N
L	flexor carpi radialis	N	0	0	myk	dec 1+	inc 1+	inc 1+	inc 1+	N
L	abductor pollicis brevis	N	0	0	0	dec 1+	inc 1+	inc 1+	N	N
L	first dorsal interosseous	decr	0	0	0	dec 1+	inc 1+	inc 1+	inc 1+	N
L	cervical paraspinal-mid	incr 1+	0	0	myk	-	-	-	-	-
L	cervical paraspinal-lower	incr 1+	0	0	myk	-	-	-	-	-
R	biceps brachii	N	0	0	0	N	N	N	N	N
R	triceps	N	0	0	0	N	N	N	N	N
R	flexor carpi radialis	N	0	0	0	N	N	N	N	N
R	first dorsal interosseous	N	0	0	0	N	N	N	N	N
R	cervical paraspinal-lower	N	0	0	0	-	-	-	-	-

- *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.*
- *Are there additional electrophysiologic data that you feel would further delineate the diagnosis? (Remember, collecting data that are not needed for the diagnosis is costly and uncomfortable for the patient.)*

Electrophysiologic Data, continued

The nerve conduction results demonstrate an absent left ulnar sensory evoked response and a low amplitude left median sensory response. The relatively preserved distal latency of the left median sensory response suggests axon loss as opposed to demyelination. The sensory responses on the right are normal for the patient's age and height. The left median and ulnar motor evoked responses are within normal limits, as is the conduction velocity. The loss of sensory amplitude on the left combined with preserved responses on the right suggests a lesion that is distal to the dorsal root ganglia (DRG). If the lesion was proximal to the DRG, the sensory evoked responses would be normal despite the loss of sensation.

The needle examination revealed large amplitude, polyphasic motor units in all muscle in the left upper limb. The only spontaneous activity noted was the finding of myokymia. The presence of myokymia (continuous, repetitive bursts of motor unit potentials) is a hallmark of radiation induced nerve injury. Nerve block research studies have demonstrated that the

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myokymia originates in the proximal nerves, presumably at the site of the radiation damage.

The finding of myokymia in the anterior myotomes as well as the posterior myotomes is not consistent with an isolated brachial plexopathy. However, this patient had radiation to the axilla as well as to the supraclavicular region, including the cervical paraspinal region. In this case there is electrodiagnostic evidence of radiation induced nerve injury in both the cervical roots as well as the brachial plexus.

The normal findings in the right upper limb rule out a more diffuse process.

Diagnostic Impression

This is electrodiagnostic evidence of a moderately severe, left, pan brachial plexopathy superimposed upon a left cervical polyradiculopathy. These findings are most consistent with a radiation induced injury. The injury at two sites is consistent with the history of two portal for the radiation treatment: axillary and supraclavicular. The finding of myokymia, although not pathognomonic, is highly correlated with radiation induced neuropathy.

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

The appropriate tests have been done. Repeat CT scans as well as PET scans have failed to demonstrate a recurrence of a tumor. EMG is the most sensitive means of confirming a radiation induced plexopathy. The finding of myokymia is highly suggestive of radiation induced nerve injury. Sometimes SEPs are done to help evaluate the possibility of nerve injury but it rarely adds to the traditional EMG study and does not yield any unique information to help distinguish the cause of the nerve injury. Surgical exploration or a needle biopsy could be considered if tumor recurrence is clinically suspected.

- *What treatment would you recommend?*

There is no effective treatment for radiation induced nerve injury. Usually reducing the radiation load to less than 6000 rads is helpful at limiting the incidence of post radiation induced nerve injury, but 10-30 % of women undergoing radiation treatment for breast cancer develop a radiation induced brachial plexopathy.

Prognosis is guarded. Most cases of radiation induced brachial plexopathy go on to progress for many years although about 25% stabilize after 4 to 9 years.

Commentary IV

This case is a typical presentation for radiation induced plexopathy. The presentation of painless weakness years after radiation treatment with electrodiagnostic findings of myokymia is almost pathognomonic for radiation induced nerve injury. Approximately 50% of all radiation induced plexopathies present with myokymia. Although myokymic discharges can be seen in other chronic nerve injuries, it is quite rare and has not been reported associated with metastatic lesions.

A significant consideration in the differential diagnosis is recurrence of the tumor. The clinical presentation of tumor recurrence varies but is much more likely to be associated with pain, and more sensory complaints than motor weakness. If the latency of onset is less than a year and less than 5000 rads have been used, this increases the likelihood of tumor recurrence. Higher radiation doses (>6000 rads) can be associated with onset of plexopathy within a year. If the onset occurs after 1 year, both possibilities need to be considered. The

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mean latency for onset is 6.5 years in both groups. Radiation induced plexopathy is more often associated with swelling, paraesthesias, and weakness; pain is seen in fewer than 20% of cases.

It is difficult to precisely determine the incidence of radiation induced nerve injury since treatment protocols vary significantly and the symptoms may not occur for many years. The role of lymphedema in contributing to the nerve injury is unresolved. Symptoms can be reduced by the use of diuretics, steroid therapy, pressure bandaging, or even decompressive surgery to relieve local compression.

Most authors think that nerve damage is caused by extra-neural fibrosis that eventually envelops and constricts the nerve trunks. The endoneurial and perineurial fibrosis leads to interruption of the blood vessels, disintegration of the myelin sheaths and axons, and Wallerian degeneration of the nerve fibers. This is similar to the process that causes lymphedema. If the radiation load is high enough, there can be direct nerve injury, though it still takes approximately 2 months for nerve degeneration to occur.

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