Chapter 6

EXAMPLES OF ELECTRICAL FINDINGS ON NERVE CONDUCTION STUDIES WITH PATHOLOGY

THERE ARE MANY WAYS nerve and muscle pathology can show changes on electrical studies (2, 3, 11, 17, 21, 22, 24, 29, 31, 33, 42, 44, 45, 48, 60, 62, 67). Electromyography in general and nerve conduction studies in particular evaluate the status of the peripheral neuromuscular system. Briefly, this includes the motor cell body, motor axon, neuromuscular junction, muscle, sensory cell body, and sensory axon. Figure 6-1 demonstrates the course and biological placement of the peripheral neuromuscular system that can be evaluated on most nerve conduction studies. The anterior horn of the spinal cord houses the cell body for the motor axon, which ultimately innervates muscle fibers. The cell body for the sensory axon is located outside the spinal cord in the dorsal root ganglion. It is important to remember that sensory nerve conduction studies only include the sensory cell body and the peripheral axon, they do not evaluate the sensory axon proximal to the dorsal root ganglion (dorsal root). Most nerve axons (both sensory and motor) pass through a number of anatomic sites. The first major site is referred to as a root. This is particularly important for it is frequently a site of compression with disk disease. Roots then give off branches known as spinal nerves, which divide into two branches: dorsal and ventral rami. The former innervates the paraspinal muscles. Distal to the spinal nerves the anterior primary rami, from different roots, join to comprise the plexus. The plexus then terminates as different peripheral nerves, as illustrated in Figure 6-2.

Localizing of nerve lesions is one of the purposes of the EMG examination. This can sometimes be accomplished on nerve conduction studies, by studying various recording sites that share some innervations but not others. Although there are different opinions on the exact root, plexus, and peripheral nerve innervation of various muscles, as well as some variation between individuals, Tables I and II illustrate the innervations that are most consistent with our nerve conduction study results. By definition, techniques performed with muscle recording sites are motor studies, and those performed recording or stimulating a pure sensory nerve

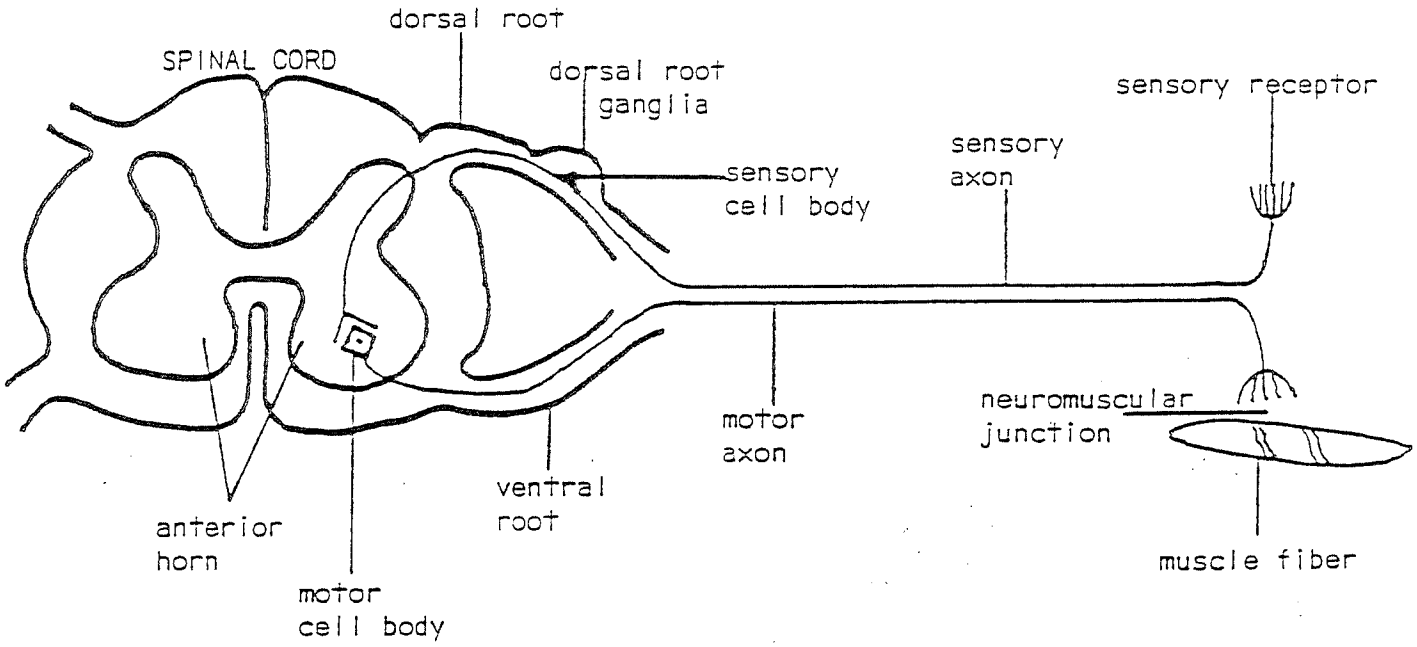


Figure 6-1

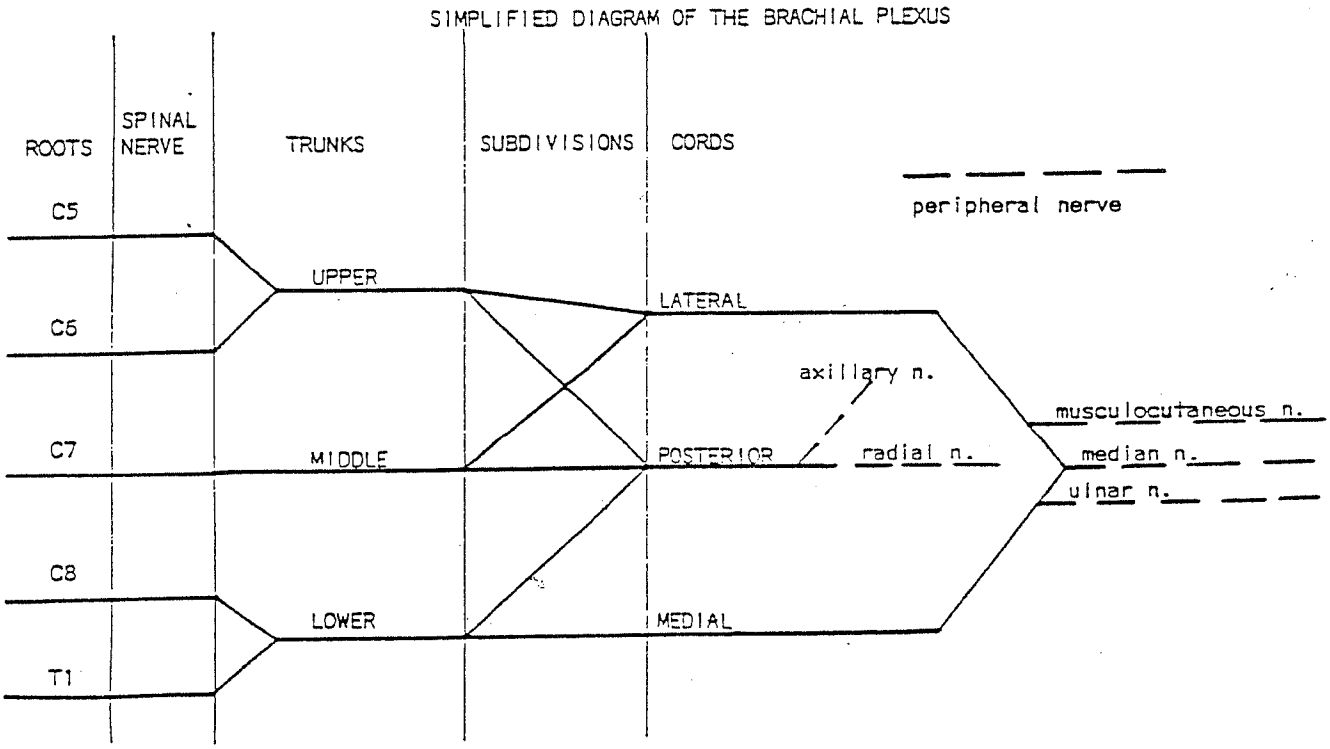


Figure 6-2

Table I

UPPER EXTREMITY

NERVE	TYPE	RECORDING SITE	ROOT INNERVATION	PLEXUS INNERVATION	PERIPHERAL NERVE BRANCH
Axillary	Motor	Deltoid	C5-C6	Upper trunk, Posterior cord	
Median	Sensory	Index	C6(C7)	Upper + Middle trunk, Lateral cord	superficial terminal branch
Median	Sensory	Middle	C7	Middle trunk, Lateral cord	superficial terminal branch
Median	Sensory	Thumb	C6(C7)	Upper (middle) trunk, Lateral cord	superficial terminal branch
Median	Motor	Abductor Pollicis Brevis	C8-T1	Lower trunk, Medial cord	
Musculo-cutaneous	Motor	Biceps	C5-C6	Upper trunk, Lateral cord	
Musculo-cutaneous	Sensory	Forearm	C6	Upper trunk, Lateral cord	lateral cutaneous nerve of the forearm
Radial	Motor	Extensor Digitorum Communis	C7-C8	Middle + Lower trunk, Posterior cord	posterior inter-osseus branch
Radial	Sensory	Dorsum of hand	(C6)C7	(Upper) + middle trunk, Posterior cord	superficial branch
Ulnar	Motor	Abductor Digiti Minimi	C8-T1	Lower trunk, Medial cord	deep branch
Ulnar	Motor	First Dorsal Interosseous	C8-T1	Lower trunk, Medial cord	deep branch (more distal)
Ulnar	Sensory	Dorsum of hand	C8	Lower trunk, Medial cord	dorsal ulnar branch
Ulnar	Sensory	Fifth digit	C8	Lower trunk, Medial cord	superficial terminal branch

( ) = lesser innervation

Table II

LOWER EXTREMITY

NERVE	TYPE	RECORDING SITE	ROOT INNERVATION	PLEXUS INNERVATION	PERIPHERAL NERVE BRANCH
Femoral	Motor	Rectus Femoris	L2-L4	Lumbar	
Peroneal	Motor	Extensor Digitorum Brevis	L5-(S1)	Sacral	deep branch
Peroneal	Motor	Tibialis Anterior	L4-(L5)	Sacral	deep branch
Peroneal	Sensory	Dorsum of foot	L5	Sacral	superficial branch
Posterior Tibial	Motor	Abductor Digiti Quinti Pedis	S1-S2	Sacral	lateral plantar
Posterior Tibial	Motor	Abductor Hallicis	S1-S2	Sacral	medial plantar
Saphenous	Sensory	Medial Malleolus	L4	Lumbar	distal femoral nerve
Sural	Sensory	Lateral Malleolus	S1	Sacral	

( ) = lesser innervation

are sensory studies. In both cases, the nerve fibers stimulated have specific root and plexus innervations.

All of the peripheral nerve examined on nerve conduction studies are large fibers that are surrounded by a myelin sheath. The myelin sheath is an insulator that assists in propagating the nerve impulse. Basically, the impulse jumps from one node of Ranvier to the next node (Fig. 6-3) through a series of chemical changes that depolarize the nerve. (A detailed explanation of this phenomenon can be found in *Electrodiagnosis of Neuromuscular Diseases* by Joseph Goodgold, M.D. and Arthur Eberstein, Ph.D.) Certain pathology of the cell body, the axon, the myelin sheath, the neuromuscular junction, or the muscle can be detected on nerve conduction studies. There are also studies that can evaluate other biological areas, including parts of the central nervous system, but these will not be covered. This chapter will cover a few of the ways the nerve conduction studies can be affected with different types of pathology. It is important to remember that these examples are based only on one type of pathology, and the variations seen with a single type of pathology or a mixture of different types are almost endless. The following are samples of the "classic" or "pure" responses.

NORMAL RESPONSES

Adequately describing responses derived because of pathology necessitates recognizing and understanding the anatomy of a normal response. Besides the standard normals and side-to-side comparisons, there are other aspects to be considered. Figures 6-4 and 6-5 illustrate normal compound muscle action potentials. The objective criteria of amplitude, distal latency, and conduction velocity are all within the standard limits of normal (check normal values for each study found in Chapter 3). The subjective criteria of area, configuration, and distal to proximal comparison are also within normal limits.

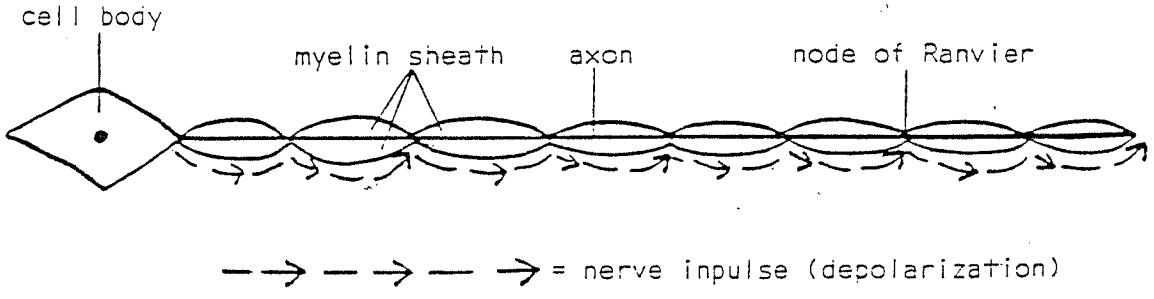
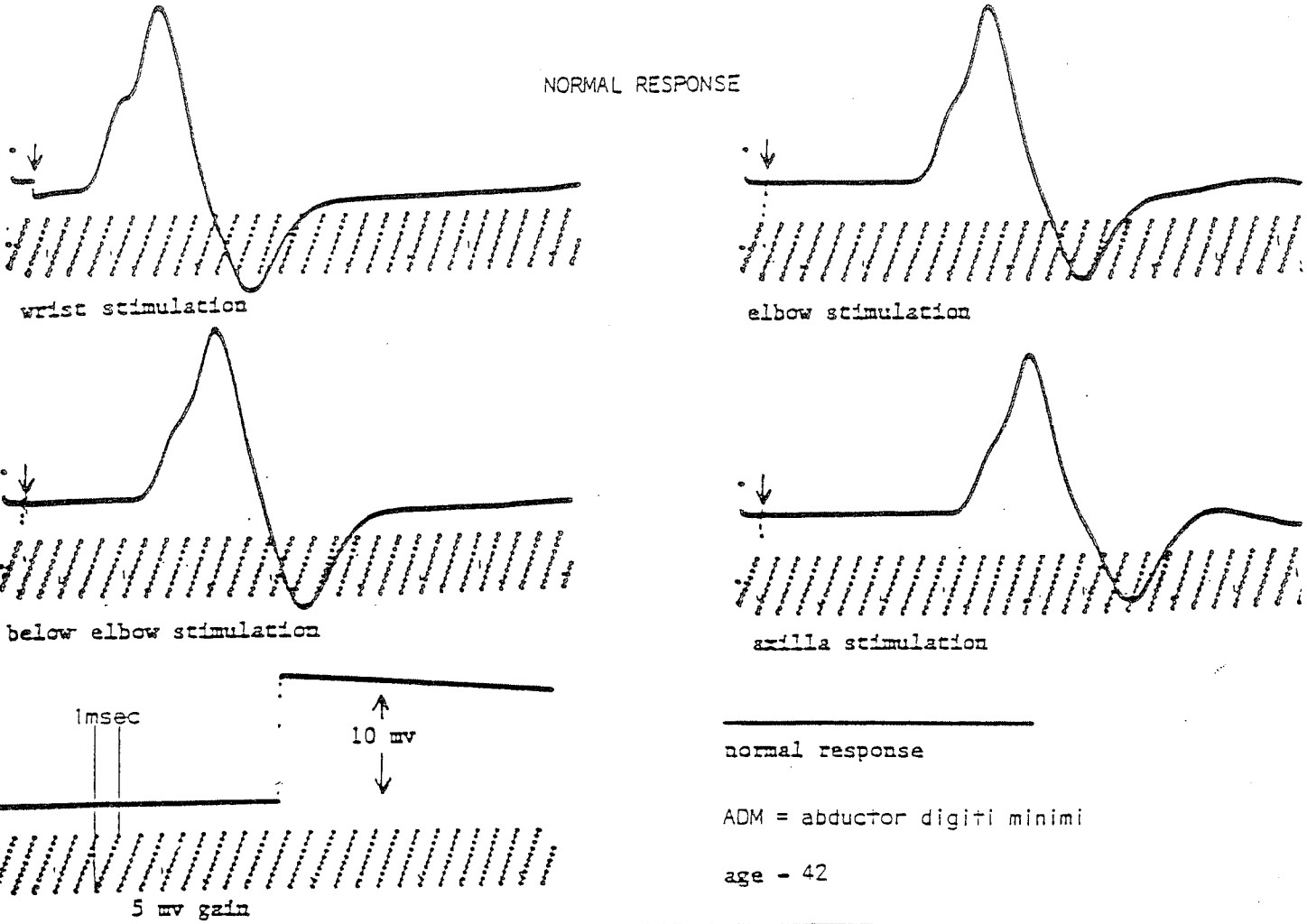


Figure 6-3



Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) ulnar(m)	elbow	ADM	5mv	14.0	7.4	28.0	58
	wrist			14.0	2.6	4.5	
					4.8		
	below elbow			13.5	5.6	18.0	60
					2.6		
					3.0		
	axilla			12.5	9.4	40.0	59
					2.6		
					6.8		

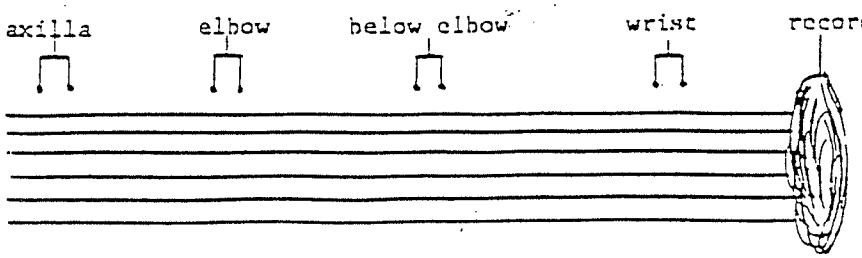
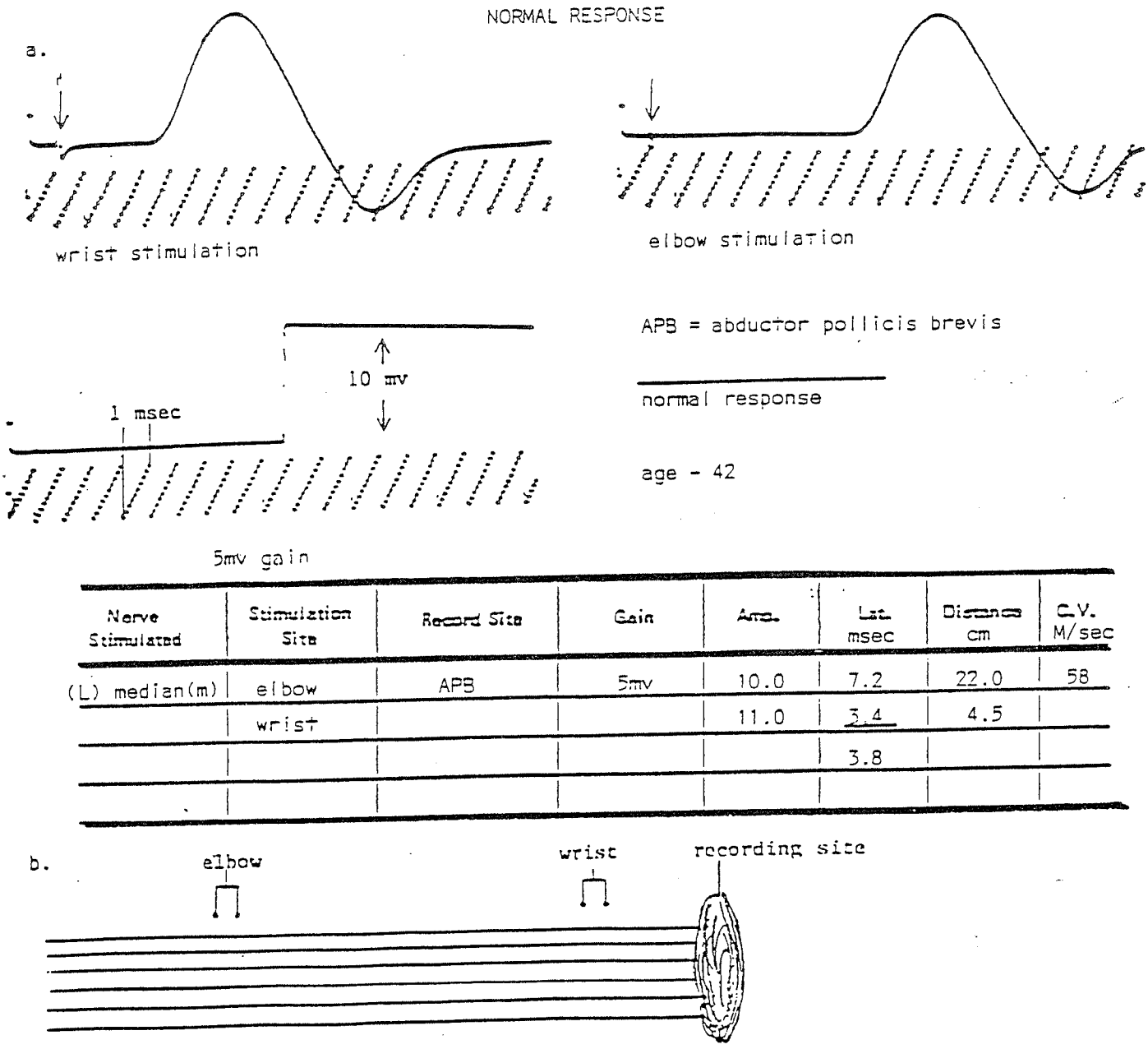


Figure 6-4



Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) median(m)	elbow	APB	5mv	10.0	7.2	22.0	58
	wrist			11.0	3.4	4.5	
					3.8		

Figure 6-5

A normal compound muscle action potential consists of nerve and muscle fibers firing at a certain rate and in a synchronized manner. The fastest nerve fibers depolarize their muscle fibers first, followed by the average conducting fibers, then the slow conducting fibers. The number of nerve and muscle fibers firing and their synchronization (the relationship

beween the rate of firing) produce the amplitude, area, and configuration of the response. In most responses, the majority of nerve fibers have an average or mean conduction; therefore, the amplitude is derived primarily from these fibers. If the number of nerve or muscle fibers decrease, then the amplitude and area decreases. If the synchronization changes, then the configuration of the response, and possibly the amplitude of the response, will change, but the area will remain constant. The fast conducting fibers produce the initial deflection from the baseline and, consequently, are responsible for conduction velocities and motor distal latencies (sensory distal latencies are taken to the peak or mean conducting fibers.) If synchronization is normal, but the overall conduction is slowed, then the conduction velocity and distal latency will be affected. Figure 6-6 illustrates roughly the fast, mean, and slow conducting fibers in a compound muscle action potential.

AXONAL LOSS

Axonal loss is a decrease in the number of viable axons carrying an impulse. If primarily the mean and slow conducting fibers are lost, the distal latency and conduction velocity are within normal limits, but the amplitudes and areas are decreased (Fig. 6-7a). If some of the fast, as well as the mean and slow, conducting fibers are lost, then the distal latency and the conduction velocity may be affected, as well as the amplitude and area (Fig. 6-8a). The motor nerve distal to an axonal lesion generally ceases to conduct nerve impulses after seven days, so amplitudes will stay the same when the nerve is stimulated at any point, providing the recording site remains constant (62). When a nerve is stimulated only the functioning fibers can carry an impulse. Therefore, even if a nerve is stimulated proximal to a

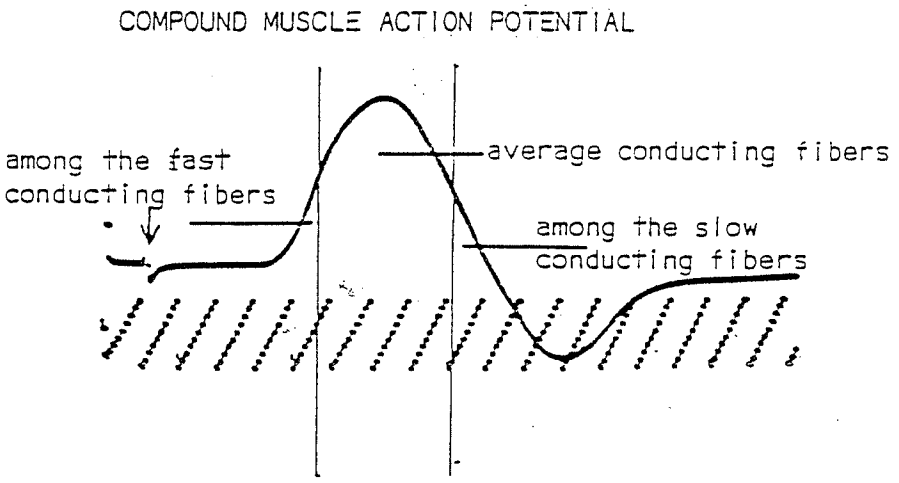
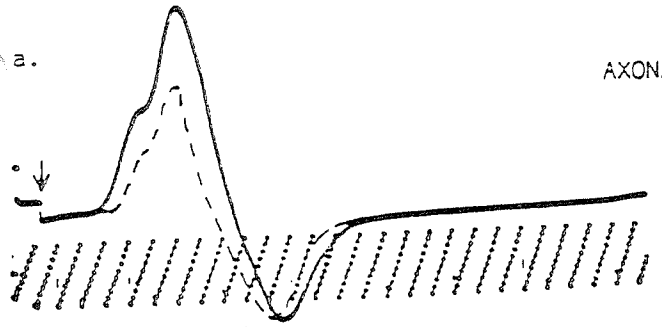


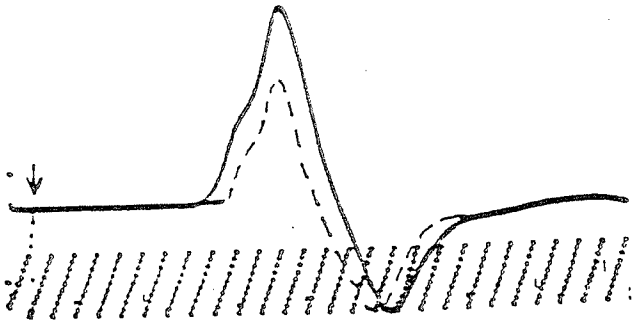
Figure 6-6

a.

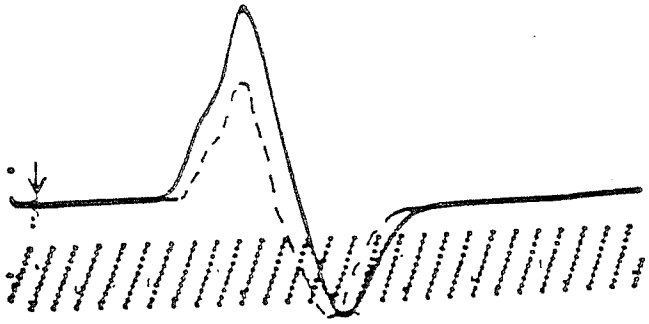
AXONAL LOSS



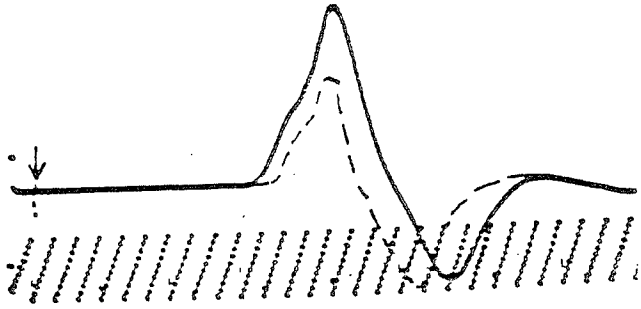
wrist stimulation



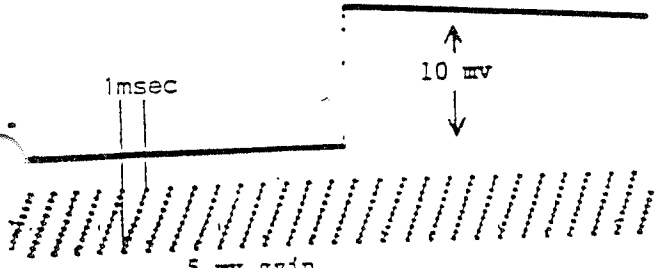
elbow stimulation



below elbow stimulation



axilla stimulation



ADM = abductor digiti minimi

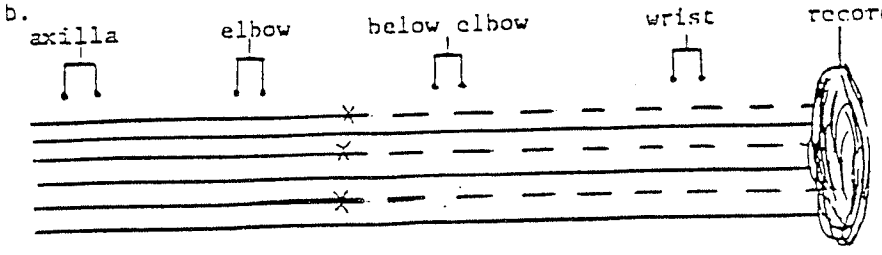
normal response

response with pathology

age - 42

Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) ulnar(m)	elbow	ADM	5mv	8.5	8.5	28.0	55
	wrist			8.5	3.4	4.5	
					5.1		
	below elbow			8.0	6.5	18.0	58
					3.4		
					3.1		
	axilla			7.5	10.4	40.0	57
					3.4		
					7.0		

b.



normal nerve

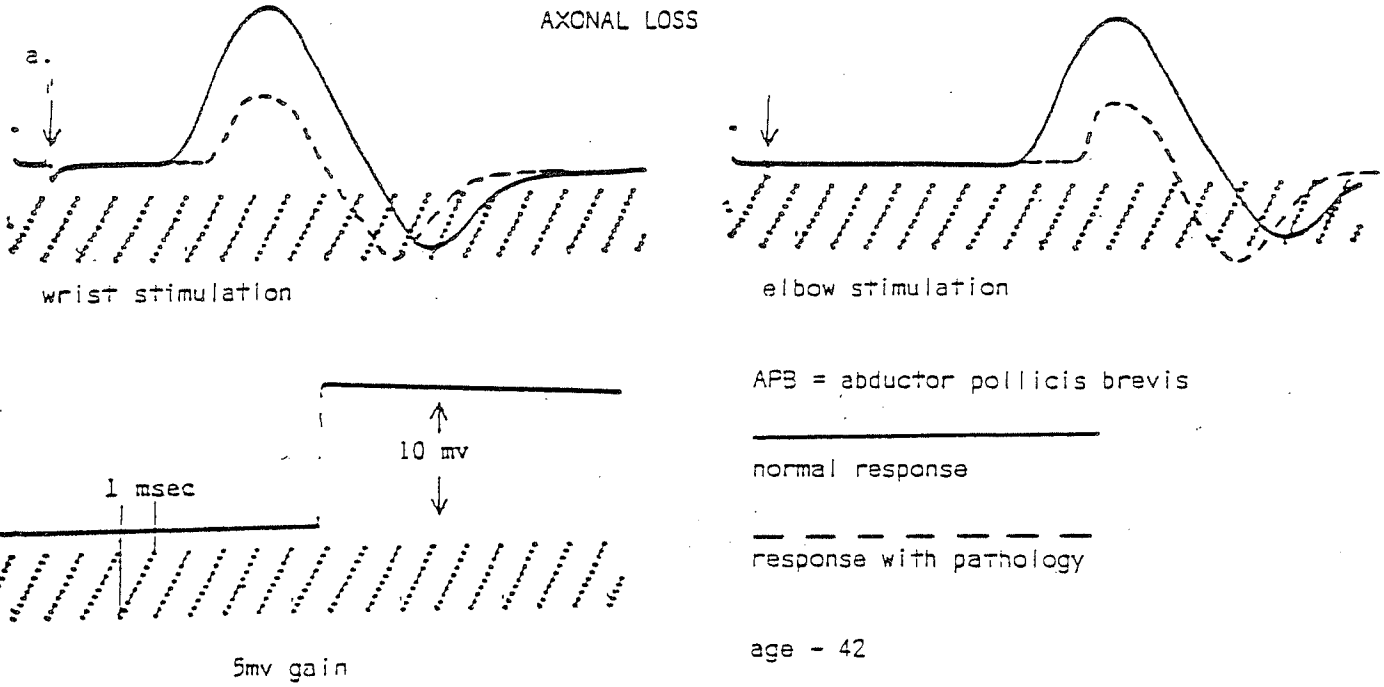
degenerated nerve

= stimulation site

= site of axonal loss

Figure 6-7

lesion (where all axons are intact and therefore stimulated), the response will remain the same as with distal stimulation because depolarization of the damaged fibers stops before the impulse reaches the recording site. Even if a normal segment of the nerve is stimulated only the fibers that are in continuity can carry an impulse to the recording site (Fig. 6-7b and 6-8b).



Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) median(m)	elbow	APB	5mv	4.0	9.1	22.0	49
	wrist			5.0	4.6	4.5	
					4.5		

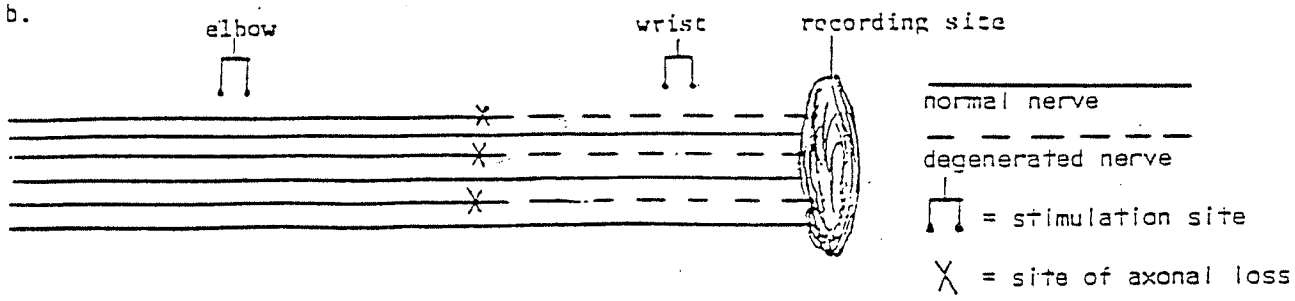


Figure 6-8

SEGMENTAL DEMYELINATION

Focal Slowing

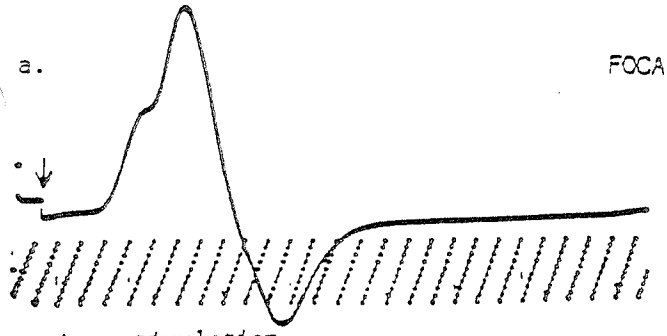
Segmental demyelination can manifest itself in many ways. By definition, segmental demyelination refers to pathology of the myelin sheath that surrounds the nerve axon, the axon itself remaining viable. The electrical manifestation will depend upon the site(s) of the demyelination and how much demyelination has occurred. Focal slowing can occur at one point along a nerve and can be localized to that point. Figure 6-9b illustrates where the segmental demyelination occurs. With stimulation proximal to the lesion, all impulses are slowed because they must pass through this point, and with stimulation distal to the lesion, the impulse can travel normally. The effects of this type of lesion are seen primarily on the conduction velocity. Figure 6-9a shows the changes that are seen in a response with this type of lesion. The amplitude as well as the configuration remains constant, but proximal latencies with elbow and axilla stimulation are affected. The only abnormalities are slowed conduction velocities between the elbow to wrist and axilla to wrist segments. Because the axilla includes a greater percentage of normal nerve, the conduction velocity from the axilla to wrist is slightly faster than the elbow to wrist segment. The conduction velocity between the below elbow and wrist segment is normal. These findings are indicative of focal slowing between the elbow and below elbow segment of the nerve. Figure 6-10b shows focal slowing at a different site along the nerve. This type of lesion will affect both the distal and proximal latencies, but the amplitudes, areas, and configurations remain normal. The lesion is localized to the segment of nerve distal to the distal stimulation point, so prolonged distal latencies and normal conduction velocities are the result (Fig. 6-10a).

Blocks in Conduction

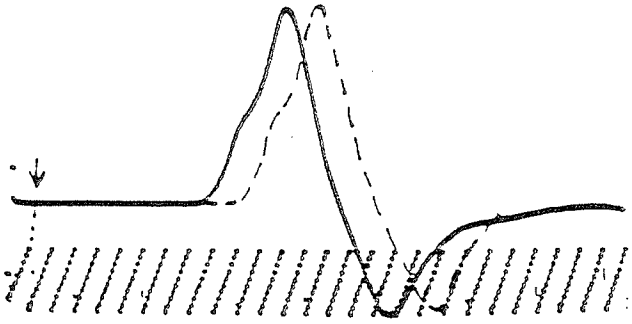
Another manifestation of segmental demyelination is a block in conduction. Usually because of myelin damage, some or all of the nerve impulses are blocked and cannot reach the recording site, but the axon is still in continuity. Figure 6-11b demonstrates a block between the elbow and below elbow stimulation sites. With stimulation at the wrist or below the elbow, the distal latency, amplitude, configuration, area, and conduction velocity are all normal. With elbow and axilla stimulation, the amplitude and area decrease significantly. The proximal latencies are slightly prolonged, due to the block of some of the fast conducting fibers; however, not enough fast fibers are blocked to cause significant slowing of the conduction velocity (Fig. 6-11a). Because there is a drop in the amplitude and a decrease in the area with elbow and axilla stimulation, and

a.

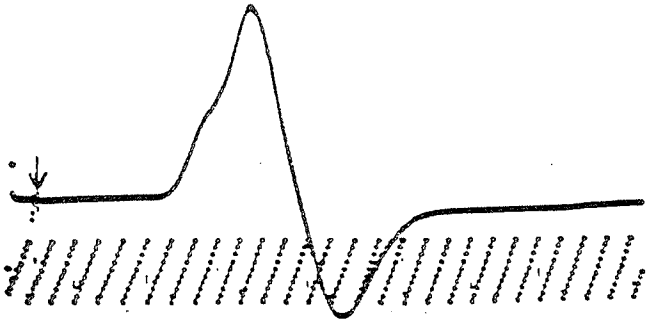
FOCAL SLOWING



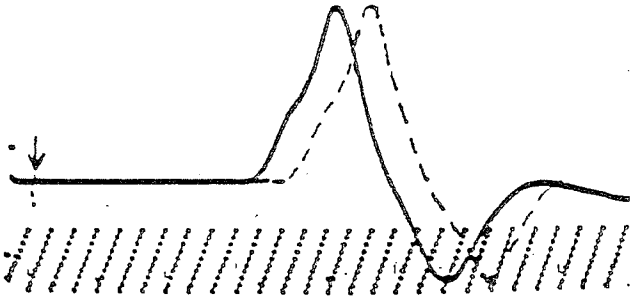
wrist stimulation



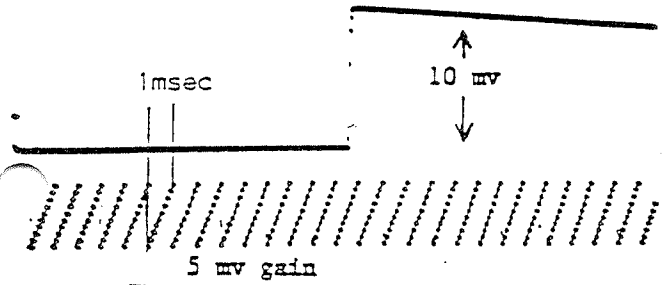
elbow stimulation



below elbow stimulation



axilla stimulation



ADM = abductor digiti minimi

normal response

response with pathology

age - 42

Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) ulnar(m)	elbow	ADM	5mv	14.0	9.0	28.0	44
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					6.4		
	below elbow			13.5	5.6	18.0	60
					2.6		
					3.0		
	axilla			12.5	11.1	40.0	47
					2.6		
					8.5		

b.

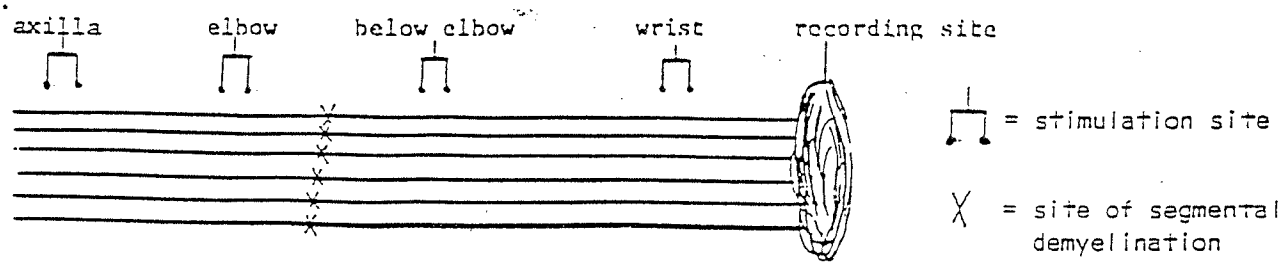
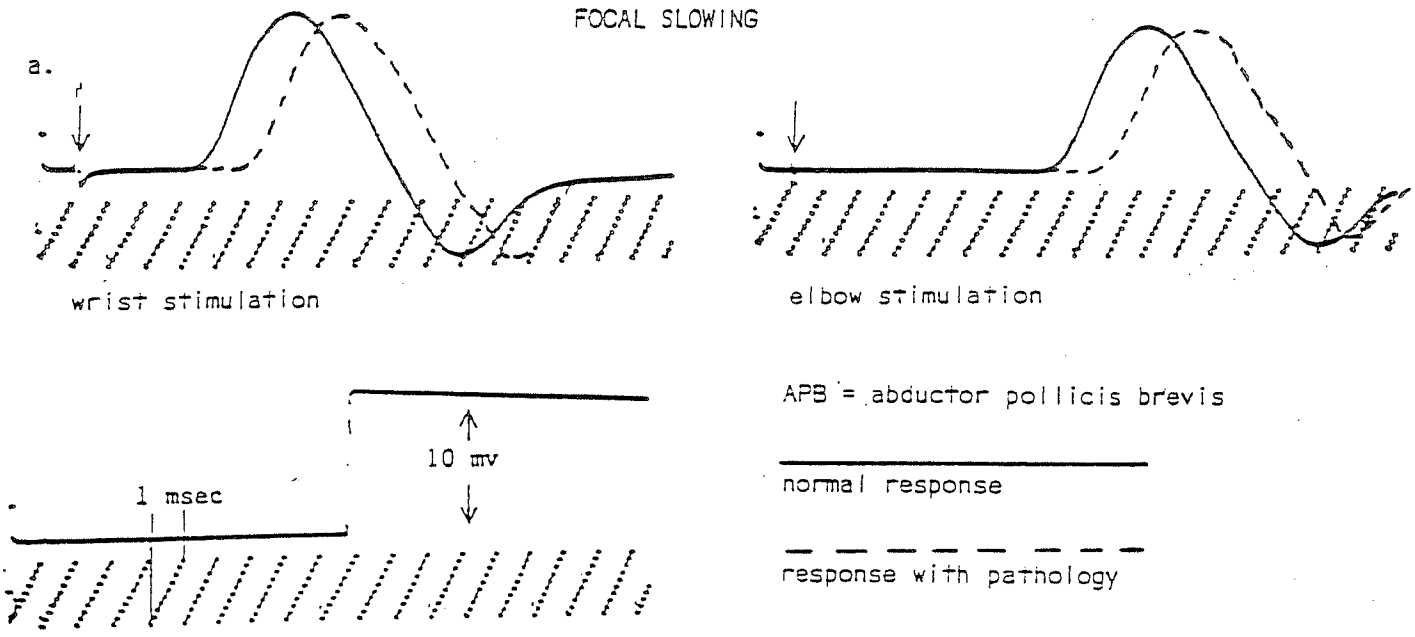


Figure 6-9

normal amplitude and area with below elbow and wrist stimulation, the lesion can be localized to the nerve segment between the elbow and below elbow stimulation sites.



Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) median(m)	elbow	APB	5mv	10.0	8.6	22.0	57
	wrist			11.0	4.7	4.5	
					3.9		

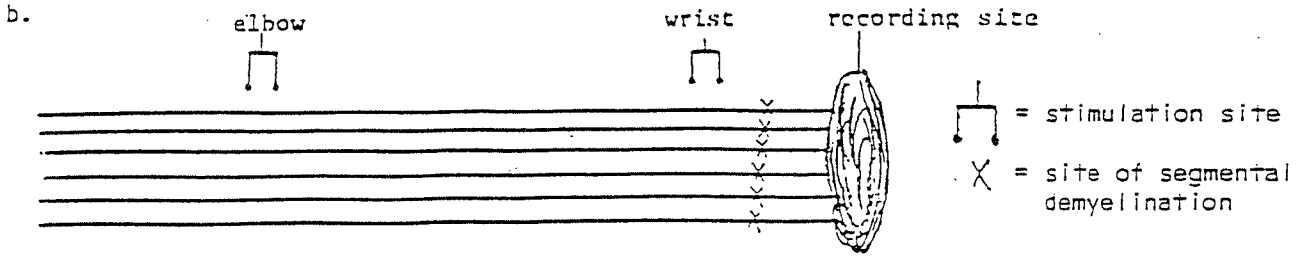
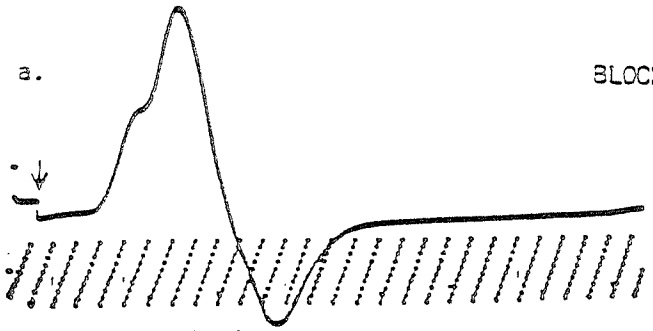


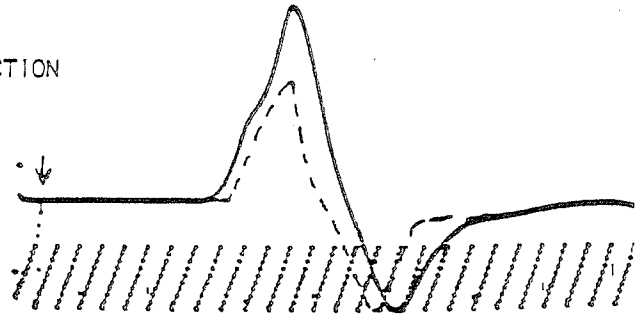
Figure 6-10

a.

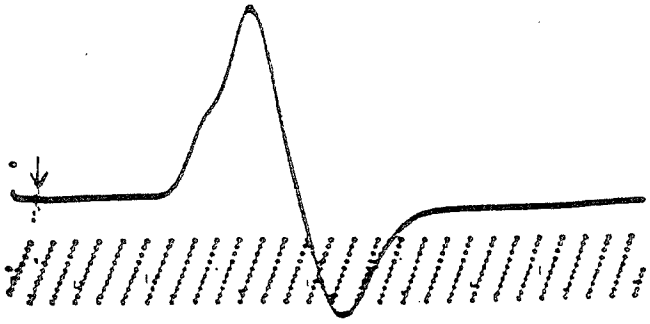
BLOCK IN CONDUCTION



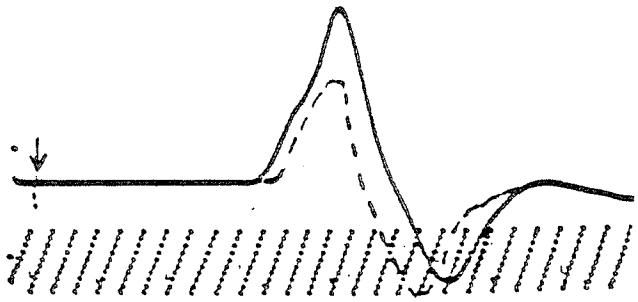
wrist stimulation



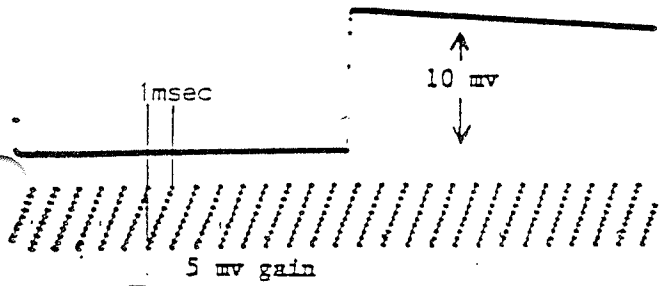
elbow stimulation



below elbow stimulation



axilla stimulation



ADM = abductor digiti minimi

normal response

response with pathology

age - 42

Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) ulnar(m)	elbow	ADM	5mv	8.0	8.3	28.0	49
	wrist			14.0	2.6	4.5	
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	below elbow			13.5	5.6	18.0	60
					2.6		
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	axilla			7.0	10.4	40.0	51
					2.6		
					7.8		

b.

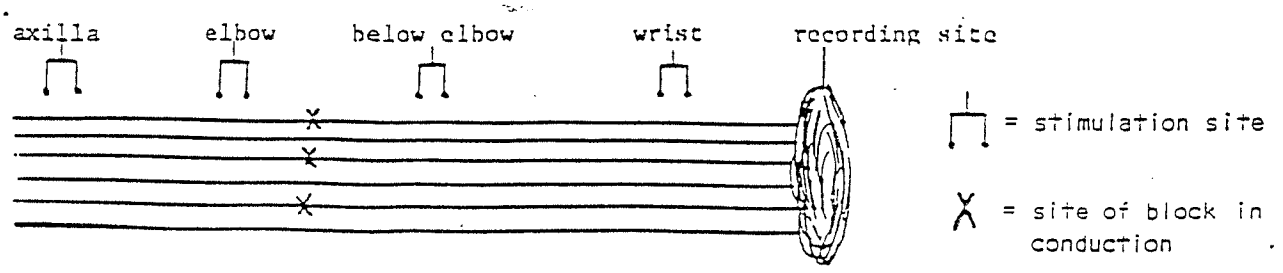


Figure 6-11

Differential Slowing

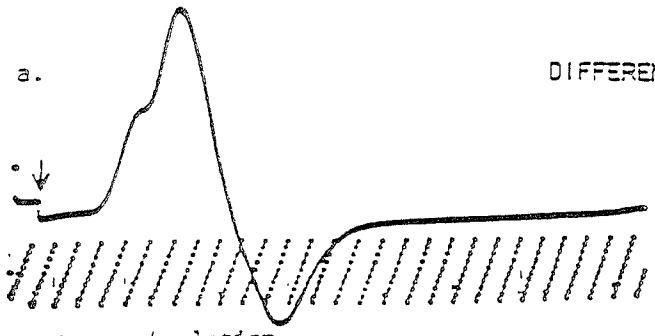
Care has been taken to emphasize the importance of comparing the distal and proximal responses. The configuration of the response and the area of the response are important criteria that should be taken into account when nerve conduction studies are performed. Differential slowing is a type of segmental demyelination where distal to proximal comparison is important. Figure 6-12b illustrates this type of lesion and where it is located. The nerve impulses are being slowed at various sites and to various degrees between the elbow and below elbow stimulation sites. Figure 6-12a shows that, with stimulation below the elbow and at the wrist, the responses are normal. When the nerve is stimulated at the elbow or in the axilla, the amplitude drops; however, the area of the response remains approximately the same. If a conclusion was drawn on the basis of amplitudes alone, these results would look like a block in conduction. Because the duration of the response increases, and therefore the area of the response remains approximately the same, this pathology is causing differential slowing, not blocks in conduction. Another interesting feature of this example is that, while the conduction velocities from the axilla and elbow stimulation sites are slightly slowed, the pathology is affecting predominantly the mean and slow conducting fibers. Because the amount of drop in amplitude remains approximately the same with axilla and elbow stimulation, this lesion can be localized to the nerve segment between the elbow and below elbow stimulation sites.

Generalized Segmental Demyelination

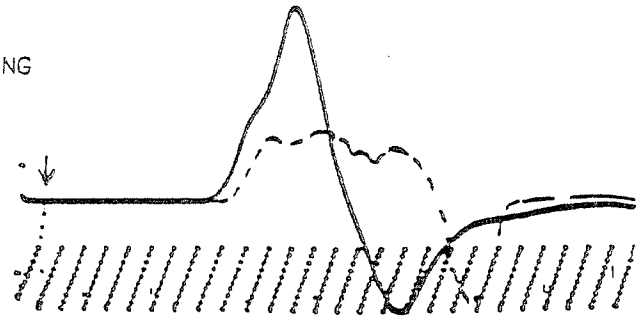
All segmental demyelinating lesions mentioned could be localized to a specific segment of the nerve. If the different types of segmental demyelination already discussed were part of a generalized process, the nerve conduction study results could look quite different. Figure 6-13b illustrates segmental demyelination present at various points along a nerve, and Figure 6-13a shows how this could affect the response. Some of the slowing occurs distal to the distal stimulation sites, so the distal latency is slightly prolonged. At each successive proximal stimulation site, more segmental demyelinated nerve is included with segments of normal nerve. Because of this, the impulse maintains about the same rate of slowing anywhere it is stimulated. This type of abnormality manifests itself as a generalized slowing of the conduction velocity and distal latency, but the amplitude, area, and configuration of the response remains essentially within normal limits. If conduction blocks are part of the generalized process (Fig. 6-14b), they will significantly change the amplitude, area, and configuration of the response at every different stimulation site (Fig. 6-14a). This is unlike localized blocks where the amplitude and area remain constant with

a.

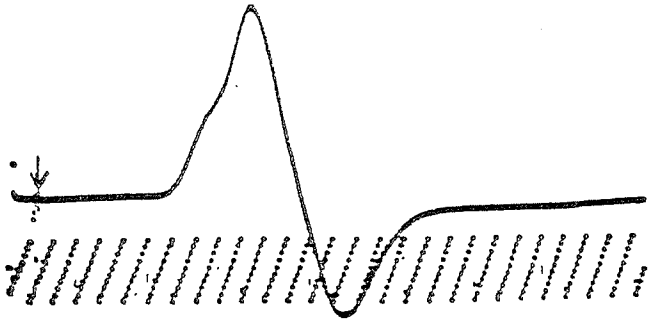
DIFFERENTIAL SLOWING



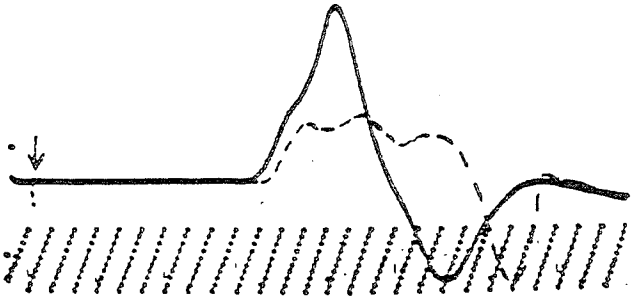
wrist stimulation



elbow stimulation



below elbow stimulation



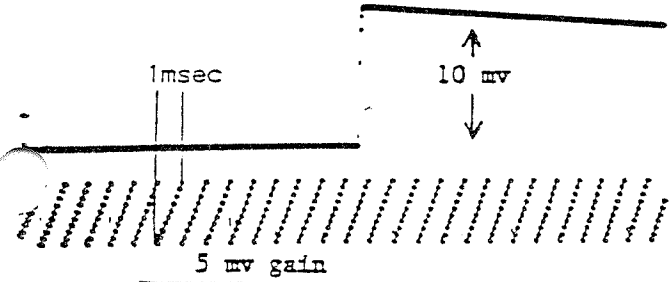
axilla stimulation

ADM = abductor digiti minimi

normal response

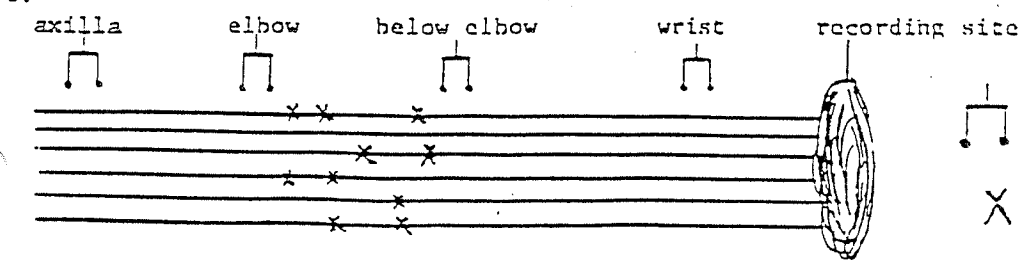
response with pathology

age - 42



Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) ulnar(m).	elbow	ADM	5mv	5.0	8.0	28.0	52
	wrist			14.0	2.6	4.5	--
					5.4		
	below elbow			13.5	5.6	18.0	60
					2.6		
					3.0		
	axilla			5.0	10.2	40.0	53
					2.6		
					7.6		

b.



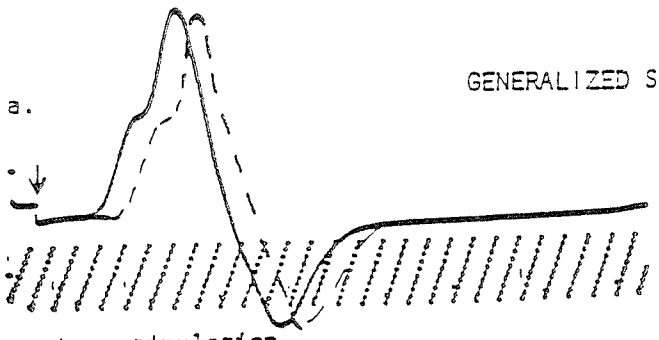
= stimulation site

= sites of segmental demyelination

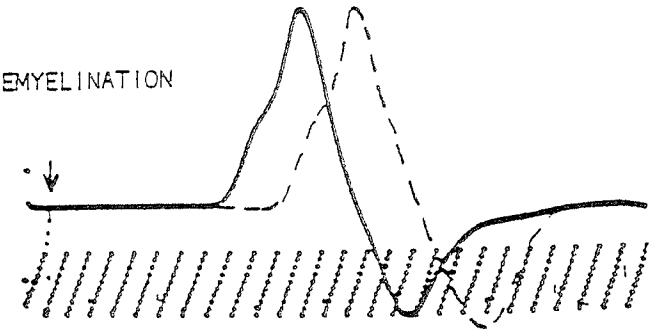
Figure 6-12

a.

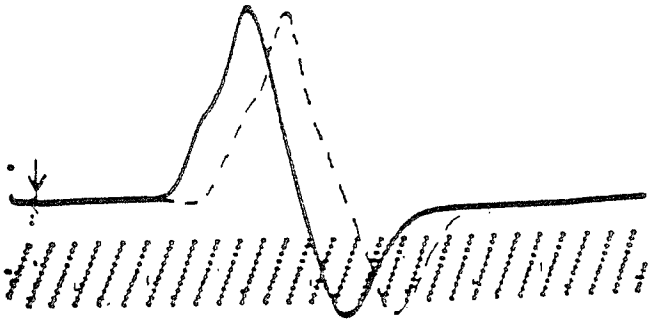
GENERALIZED SEGMENTAL DEMYELINATION



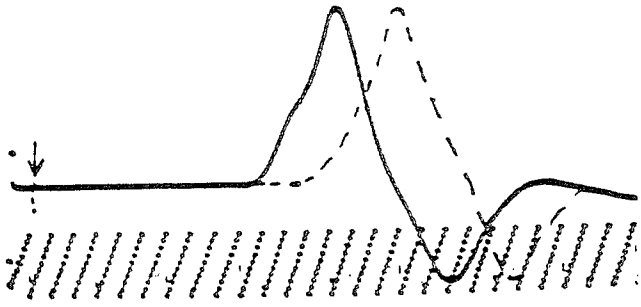
wrist stimulation



elbow stimulation



below elbow stimulation



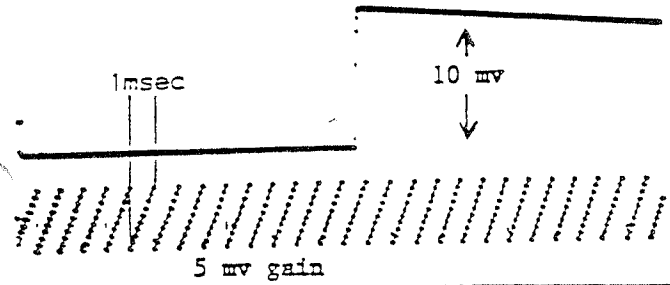
axilla stimulation

ADM = abductor digiti minimi

normal response

response with pathology

age - 42



Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) ulnar(m)	elbow	ADM	5mv	14.0	9.7	28.0	47
	wrist			14.0	3.7	4.5	
					6.0		
	below elbow			13.5	7.1	18.0	53
					3.7		
					3.4		
	axilla			12.5	11.7	40.0	50
					3.7		
					8.0		

b.

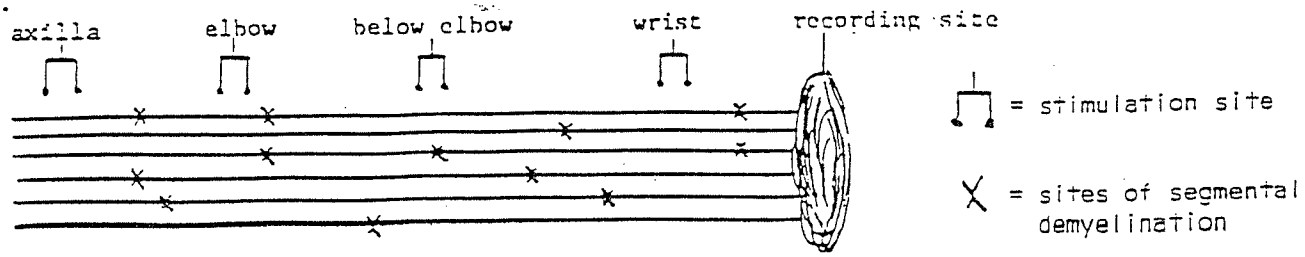
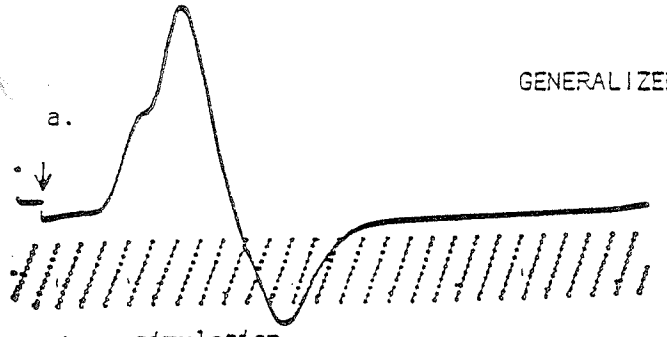


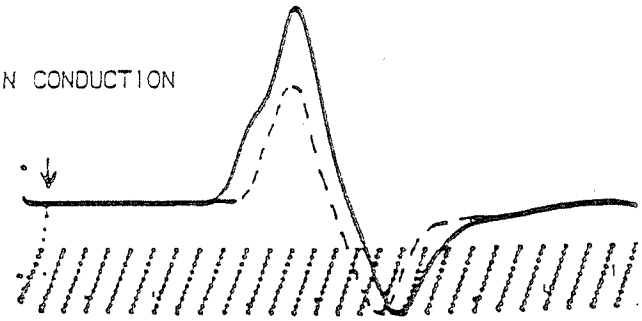
Figure 6-13

GENERALIZED BLOCKS IN CONDUCTION

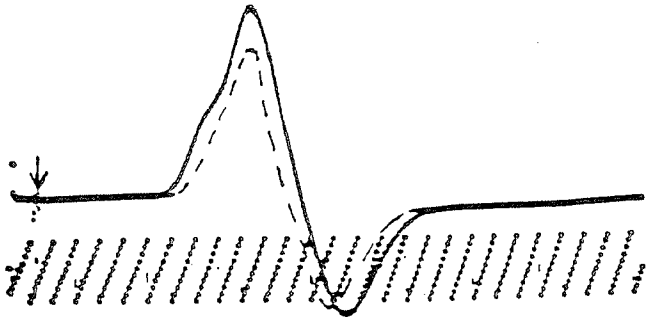
a.



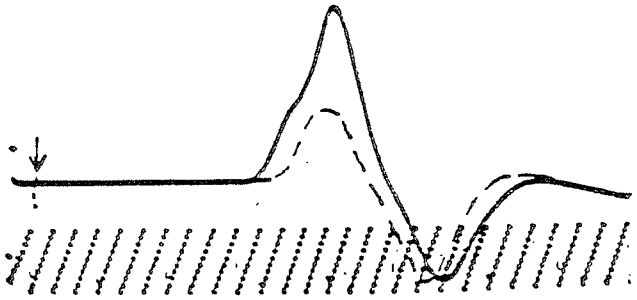
wrist stimulation



elbow stimulation



below elbow stimulation



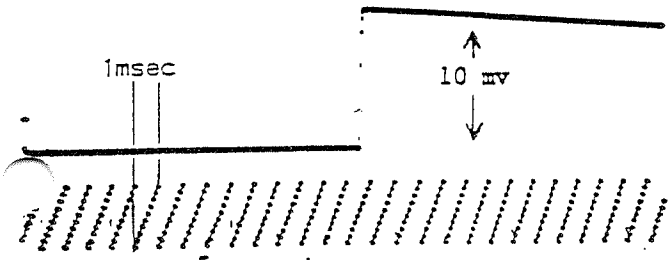
axilla stimulation

ADM = abductor digiti minimi

normal response

response with pathology

age - 42



Nerve Stimulated	Stimulation Site	Record Site	Gain	Amp.	Lat. msec	Distance cm	C.V. M/sec
(L) ulnar(m)	elbow	ADM	5mv	8.0	8.6	28.0	47
	wrist			14.0	2.6	4.5	
					6.0		
	below elbow			10.0	6.2	18.0	50
					2.6		
					3.6		
	axilla			5.0	10.6	40.0	50
					2.6		
					8.0		

b.

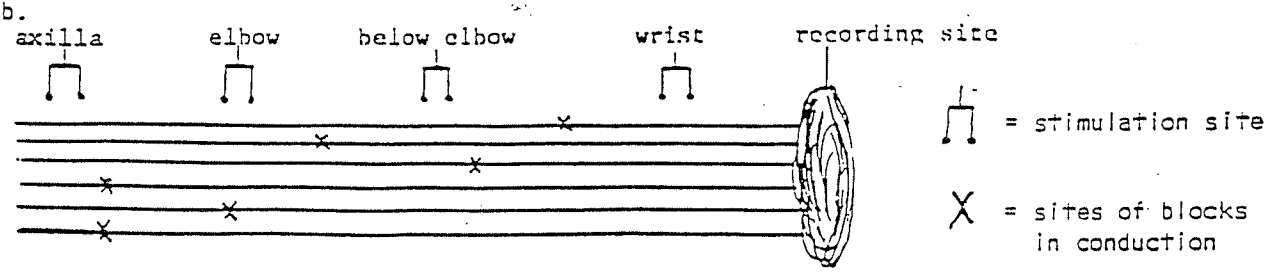


Figure 6-14

stimulation at any point above the lesion. The distal latency, the conduction velocity, or both can be affected in varying degrees, depending upon which of the fibers are blocked and at what sites the blocking occurs.

DEFECTS IN NEUROMUSCULAR TRANSMISSION

Between the terminal branch of the nerve and the muscle fiber (Fig. 6-15a), there is an anatomic entity known as the neuromuscular junction (Fig. 6-15b). The nerve impulse is transmitted across this neuromuscular junction to receptor sites in the muscle fibers by a chemical substance called acetylcholine. A defect in the neuromuscular transmission can be either presynaptic, postsynaptic, or both. Presynaptic refers to a problem in the terminal branch of the nerve, where acetylcholine is synthesized, stored, and released. Postsynaptic refers to a problem in the muscle fiber where the receptor sites for acetylcholine are located. Two clinical diseases associated with defects in neuromuscular transmission are myasthenia gravis and myasthenic syndrome (Lambert-Eaton syndrome). The electrical manifestation in these two diseases are quite different, as are the procedures used to test for them. The physiology of myasthenia gravis is generally accepted to be postsynaptic, and the electrical manifestation of this physiology is quite definite. On a normal subject, repetitive stimulation given at a rate of two shocks per second, times three shocks in a row (written, 2/sec ×3) will yield little or no change in amplitude (Fig. 6-16a). This same study performed on a patient with myasthenia gravis (provided pathology is present at the recording site) will yield a successive drop (a decrement) in the amplitude with each successive stimulation (Fig. 6-16b). If the patient is then exercised for 10 to 15 seconds with repetitive stimulation of 2/sec ×3 administered immediately afterwards, the decrement will disappear or at least improve (Fig. 6-16c). Routine nerve conduction studies are usually within normal limits, provided the interval between each stimulus is long enough to allow the amplitude to return to normal. In contrast, the electrical results seen with myasthenic syndrome are quite different. Routine nerve conduction studies will show low amplitude motor response (Fig. 6-17a) with normal sensory studies. If a muscle is then exercised for 10 seconds followed by a single supramaximal stimulation, the amplitude will increase at least 100 percent (Fig. 6-17b) over the preexercise amplitude. If this same test is performed on a normal subject there may also be an increment, but this is referred to as pseudofacilitation and will not exceed 20 percent of the preexercise response amplitude. Another difference between myasthenia gravis and myastenic syndrome is that with myasthenia gravis, the motor recording sites that reveal a decrement are very patchy, while myasthenic syndrome shows an increment of at least 100 percent on almost all motor recording sites tested.

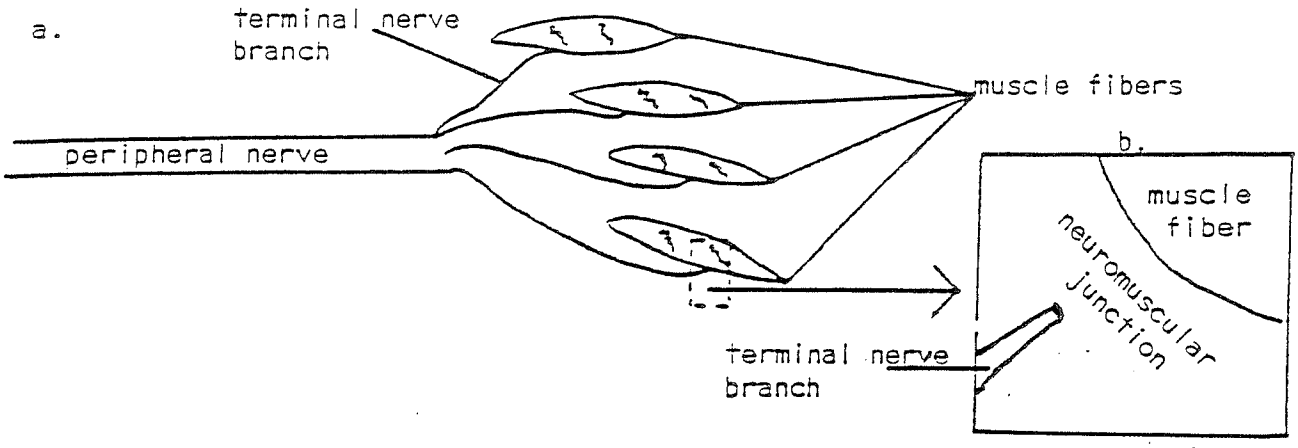


Figure 6-15

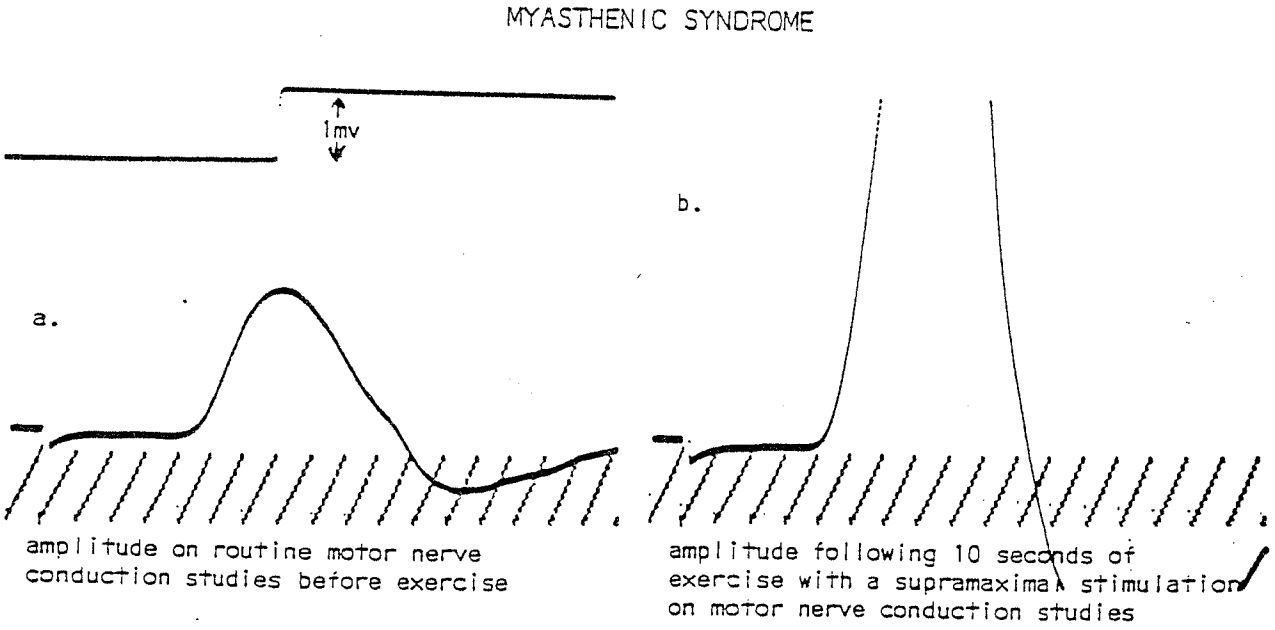
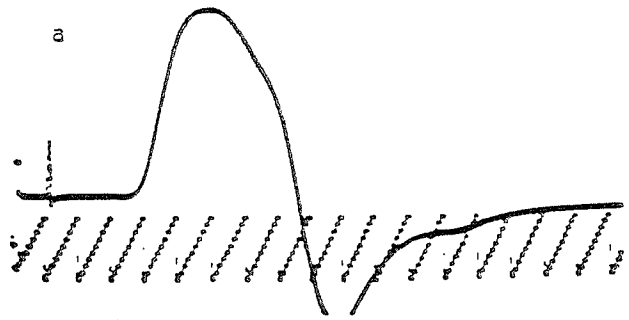
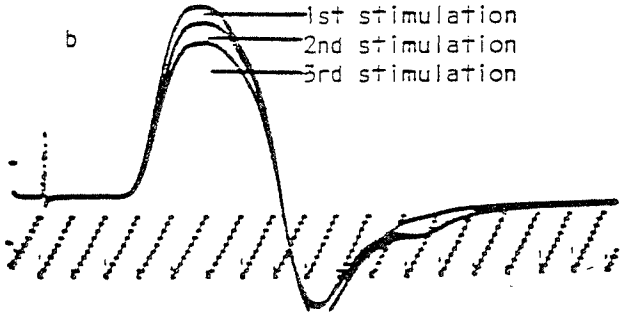


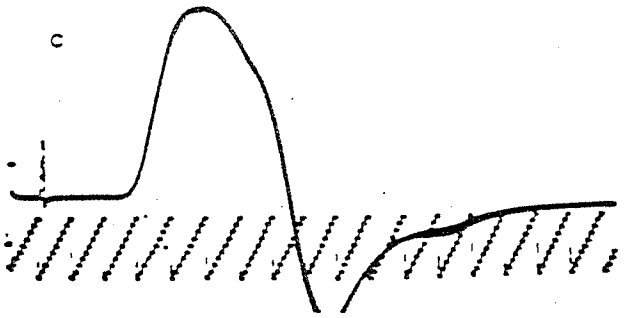
Figure 6-16



normal study with repetitive stimulation at a rate of 2/sec X3



Myasthenia Gravis with repetitive stimulation at a rate of 2/sec X3



Myasthenia Gravis with repetitive stimulation at a rate of 2/sec X3 after 15 seconds of exercise

Figure 6-17

Chapter 7

NERVE CONDUCTION STUDY WORKUPS

NERVE CONDUCTION STUDY workups will vary from one patient to another. Adequate nerve study testing compliments the needle part of the EMG examination, and both normal and abnormal nerve conduction studies can give valuable information that will frequently decrease the amount of testing needed on the needle part of the examination. The following workups are suggested because they cover a number of clinical problems that have similar symptoms, and yet they remain practical in both the time necessary to complete a study and the amount of patient discomfort. One of these four basic workups is usually performed on every patient.

BASIC NERVE CONDUCTION STUDY WORKUPS

Basic Search in the Upper Extremity

A. Median sensory recording index finger, single point stimulation at the wrist.
B. Ulnar sensory recording fifth finger, single point stimulation at the wrist.
C. Radial sensory recording dorsum of the hand, single point stimulation distally.
D. Median motor recording abductor pollicis brevis, two point stimulation at the wrist and elbow, with a conduction velocity.
E. Ulnar motor recording, abductor digiti minimi, two point stimulation at the wrist and elbow, with conduction velocity.

Basic Search in the Lower Extremity

A. Sural sensory recording lateral malleolus, single point stimulation.
B. Peroneal motor recording, extensor digitorum brevis, two point stimulation at the ankle and knee, with conduction velocity.
C. Posterior tibial motor recording abductor hallucis, two point stimulation at the ankle and knee, with conduction velocity.

Myopathy

A. Sural sensory recording lateral malleolus, single point stimulation.
B. Peroneal motor recording, extensor digitorum brevis, two point stimulation at the ankle and knee, with conduction velocity.
C. Median sensory recording index finger, single point stimulation at the wrist.
D. Median motor recording, abductor pollicis brevis, two point stimulation at the wrist and elbow, with conduction velocity.

Generalized Peripheral Polyneuropathy

A. Sural sensory recording lateral malleolus, single point stimulation at pt. B (if possible, 3 pt. stimulation at pts. A, B, and C with a conduction velocity).
B. Peroneal motor recording, extensor digitorum brevis, two point stimulation at the ankle and knee, with conduction velocity.
C. Posterior tibial motor recording abductor hallucis, two point stimulation at the ankle and knee, with conduction velocity.
D. Median sensory recording index finger, two point stimulation at the wrist and elbow, with conduction velocity.
E. Ulnar sensory recording fifth finger, single point stimulation at the wrist.
F. Radial sensory recording, dorsum of the hand, single point stimulation distally.
G. Median motor recording, abductor pollicis brevis, two point stimulation at the wrist and elbow, with conduction velocity.
H. Ulnar motor recording abductor digiti minimi, two point stimulation at the wrist and elbow, with conduction velocity.

NERVE CONDUCTION STUDY WORKUPS FOR REFERRING CLINICAL DIAGNOSIS

Bell's Palsy

I. Workups
   A. Symptomatic side
      1. Facial nerve recording the quadratus labii superioris muscle.
   B. Other side
      1. Facial nerve recording the quadratus labii superioris muscle.
   C. Blink reflex studies stimulate the supraorbital nerve.
II. Projected Results
   A. Decreased amplitude of the facial nerve when compared to the other side.
   B. Increased distal latency when compared to the other side (rare).
   C. Blink reflex studies:

1. If the facial motor responses are absent, severely decreased, or the distal D.L. prolonged on the (L) with a normal facial response on the (R) then the blink reflex studies are as follows:

Nerve Stim.	*Side Stim.*	*Side Record*	*R1*	*R2*
Supraorbital	(L)	(L)	Abnormal	Abnormal
		(R)		Normal
Supraorbital	(R)	(R)	Normal	Normal
		(L)		Abnormal

2. If a block is present proximal to the routine stimulation site for the facial motors on the (L) side, as is usually the case with Bell's palsy that recovers quickly, the routine facial motor will be normal and the blink reflex studies will show the same abnormality as above.

III. Variations and Remarks

A. Because normals are based on a side-to-side comparison, placement of G1 is critical and must be symmetrical from side to side.

Brachial Plexus Lesions ("True" Thoracic Outlet Syndrome)

I. Workups

A. Symptomatic side:

1. Basic search in the upper extremity.
2. Median sensory recording the thumb, single point stimulation.
3. Four point stimulation on the ulnar nerve recording abductor digiti minimi (wrist, elbow, axilla, Erb's point).
4. F-waves on the APB and ADM.

B. Other side:

1. Median sensories recording the thumb index and middle fingers, single point stimulation.
2. Ulnar sensory recording fifth finger, single stimulation.
3. Radial sensory recording, dorsum of the hand, single point stimulation.
4. Single point stimulation of the median motor recording APB and ulnar motor recording ADM with F-waves to both.

II. Projected Results

A. Upper Trunk

1. Median sensory amplitudes recording the thumb and index finger are decreased.
2. Radial sensory amplitude recording dorsum of hand may be decreased.
3. Normal ulnar motor (ADM), median motor (APB), ulnar sensory (fifth finger), and median sensory (middle finger).

B. Middle Trunk
   1. Median sensory amplitudes recording the index and middle fingers and, the radial sensory recording the dorsum of the hand are decreased.
   2. Median sensory amplitude recording the thumb may be decreased.
   3. Normal ulnar motor (ADM), median motor (APB), and ulnar sensory (fifth finger).

C. Lower Trunk
   1. Ulnar motor recording ADM, median motor recording APB, and ulnar sensory recording fifth finger are decreased in amplitude.
   2. Normal median sensories (thumb, index and middle fingers), and radial sensory (dorsum of hand).

D. Lateral Cord
   1. Median sensory amplitudes recording the thumb, index and middle fingers are decreased.
   2. Normal median motor (APB), ulnar motor (ADM), and radial sensory (dorsum of hand).

E. Posterior Cord
   1. Radial sensory amplitude recording dorsum of hand is decreased.
   2. Normal median motor (APB), ulnar motor (ADM), median sensories (thumb, index and middle fingers), and ulnar sensory (fifth finger).

F. Medial Cord ("True" Thoracic Outlet Syndrome)
   1. Median motor recording APB, ulnar motor recording ADM, and ulnar sensory recording fifth finger are decreased in amplitude.
   2. Normal median sensories (thumb, index and middle fingers), and radial sensory (dorsum of hand).

III. Variations and Remarks

A. Usually one of the three sensory nerves studied routinely will be involved.

B. If the brachial plexus lesion is demyelinating, the F-waves may be prolonged.

C. Brachial plexus lesions usually cause axonal loss, so:
   1. Involved nerves will show decreased amplitudes on conduction studies.
   2. Conduction velocities will be normal or within the normal range for axonal loss (not more than a 30% drop from normal).
   3. F-wave studies are usually normal.

D. Because the root and plexus innervation varies between individuals, there may be some variation in these results.

Carpal Tunnel Syndrome (Median Neuropathy at the Wrist)

I. Workups
   A. Symptomatic (or more symptomatic) limb:
      1. Basic search in the upper extremity.
      2. Median sensory recording middle finger, single point stimulation at the wrist.
   B. Contralateral limb:
      1. Median sensory recording, index and middle fingers, single point stimulation at the wrist.
      2. Median motor recording abductor pollicis brevis, single point stimulation at the wrist.

II. Projected Results
   A. The distal latencies for the median sensories and/or motors can be prolonged with conduction velocities that are within normal limits; sensory changes usually preceed motor changes.
   B. Median sensory amplitudes are frequently decreased or absent.
   C. All other studies should be within normal limits.

III. Variations and Remarks
   A. A decreased amplitude and a slight slowing of the median motor conduction velocity can be seen with a severe median neuropathy at the wrist that is causing axonal loss.
   B. Other criteria for diagnosis of median neuropathy at the wrist are:
      1. if the median sensory distal latencies are greater than 0.5 msec longer than those in the contralateral hand;
      2. if the median motor distal latency is greater than 1.0 msec longer than those in the contralateral hand;
      3. if the median motor distal latency is 1.8 msec longer than the ulnar motor distal latency on the ipsilateral hand.
   C. If routine median studies are within normal limits, palmar studies of the median and ulnar nerves should be performed.

Cervical Radioculopathy, Thoracic Radiculopathy, Cervical Spondylosis

I. Workups
   A. Basic search in the upper extremity.
   B. F-waves to the APB and ADM.

II. Projected Results

A. Sensory responses must be within normal limits.
B. Motor responses usually within normal limits.
C. F-waves may have prolonged latencies.

III. Variations and Remarks
A. Decreased motor amplitudes may occur with severe, multiple cervical radiculopathies involving C8/T1 roots.
B. F-waves with root lesions causing axonal loss will usually be normal.
C. Any abnormality that occurs must be followed up as a separate study, i.e., if a carpal tunnel syndrome is found then the median motor and median sensory should be checked on the other side.

Femoral Neuropathy

I. Workups
A. Symptomatic side:
1. Basic search in the lower extremity.
2. Femoral motor recording rectus femoris, single point stimulation.
B. Other side:
1. Femoral motor recording, rectus femoris, single point stimulation.

II. Projected Results
A. Decreased amplitude on femoral motor recording rectus femoris when compared to the other side.
B. Rarely, prolonged distal latency of the femoral motor recording rectus femoris when compared to the other side.

III. Variations and Remarks
A. Be sure the same distances are used for the stimulation sites from side to side.
B. Be sure G1 has the same placement bilaterally.

Friedreich's Ataxia

I. Workups
A. Symptomatic side:
1. Peripheral neuropathy workup.

II. Projected Results
A. Usually normal motor studies.
B. Occasionally mild slowing on motor conduction velocities.
C. Absent or decreased amplitudes on all sensory studies.

Generalized Acquired Peripheral Polyneuropathy (Uremic Neuropathy, Diabetic Neuropathy, etc.)

I. Workups
  A. More symptomatic side:
    1. Peripheral neuropathy workup. Ulnar, Femoral, Tibial, Median motor & sensory
II. Projected Results
  A. Decreased amplitudes on sensory studies, lower extremities more affected than upper extremities.
  B. Decreased amplitudes on motor studies, lower extremities more affected than upper extremities.
  C. Slowed conduction velocities with prolonged distal latencies on sensory studies, lower extremities more affected than the upper extremities.
  D. Slowed conduction velocities with prolonged distal latencies on motor studies, lower extremities more affected than the upper extremities.
  E. Mixture of any of the above.
III. Variations and Remarks
  A. Usually the sensory studies are affected before and more severely than the motor studies.
  B. Usually lower extremity studies are more involved than upper extremity studies.
  C. Frequently there are superimposed mononeuropathies, and testing procedures for each should be completed.

Generalized Hereditary Peripheral Polyneuropathy (Charcot-Marie-Tooth Disease, Dejerine-Sottas Disease, Metachromatic Leukodystrophy, etc.)

I. Workups
  A. More symptomatic side:
    1. Peripheral neuropathy workup. Ulnar, Peroneal, Tibial, Median motor & sensory
II. Projected Results
  A. Sensory studies usually absent, both lower and upper extremities.
  B. Motor conduction velocities severely decreased.
  C. Motor distal latencies severely prolonged.
  D. Decreased amplitudes on motor studies, lower extremities more affected than upper extremities.
III. Variations and Remarks
  A. If sensory responses are present, amplitudes will be low, distal latencies will be prolonged, and conduction velocities decreased.
  B. Frequently the nerves will be very difficult to stimulate so an

increased stimulus (both duration and voltage) should be used to insure supramaximal stimulation.

Guillain-Barre Syndrome (Acute Infectious Polyneuritis, Polyradiculoneuropathy)

I. Workups
  A. More symptomatic side
    1. Peripheral neuropathy workup. Sural, Peroneal, Tibial SCFS
    2. H-reflex study. Ulnar FS
    3. F-waves on all motor studies.
    4. Four point stimulation on the ulnar motor recording ADM (wrist, elbow, axilla, and Erb's point).

II. Projected Results
  A. Decreased amplitudes on sensory and motor studies; sural often spared.
  B. Slowed conduction velocities on sensory and motor studies.
  C. Increased latencies on F-wave studies and/or increased latencies or absent H-reflex studies.
  D. Proximal and/or distal physiologic blocks in conduction.
  E. Normal distal studies with increased latencies on F-wave studies and/or increased latency or absent H-reflex study.
  F. Mixture of any of the above.

III. Variations and Remarks
  A. Results will depend on the site and type of pathology present.
  B. Results will depend on the length of time that has elapsed since the onset of the illness.

Lumbar Radiculopathy, Sacral Radiculopathy, Lumbosacral Radiculopathy, Lumbar Canal Stenosis, Cauda Equina

I. Workups
  A. Symptomatic side:
    1. Basic search in the lower extremity. Sural, Peroneal, Tibial
    2. H-reflex study.
    3. F-wave to the EDB.
  B. Other side:
    1. Peroneal motor recording extensor digitorum brevis, single point stimulation at the ankle with F-wave.
    2. Posterior tibial motor recording abductor hallucis, single point stimulation at the ankle.
    3. H-reflex study.

II. Projected Results
  A. Sensory studies must be within normal limits.

B. Motor studies are usually within normal limits.
C. Possible decreased amplitude on motor studies with severe and/or multiple roots lesions involving L5, S1, and S2 roots.
D. Possible absent H-reflex, decreased H-reflex amplitude or increased H-reflex latency with involved S1 root.
E. F-waves may have a prolonged latency.

III. Variations and Remarks
A. Any abnormality that occurs must be followed out as a separate study.
B. F-waves with root lesion causing axonal loss will usually be normal.

Motor Neuron Disease, Anterior Horn Cell Disease, Polio, ALS, Syringomyelia

I. Workups
A. Symptomatic side:
1. Peripheral neuropathy workup. Sural, Peroneal, Tibial

II. Projected Results
A. Sensories within normal limits.
B. Often decreased motor amplitudes usually greatest in the most symptomatic limbs.

III. Variations and Remarks
A. Patients are very subject to cold so sensory distal latencies may be prolonged and conduction velocities may be slowed if limbs are not warmed.
B. Even in the presence of normal limb temperature, distal latencies and conduction velocities of the motor studies may be slightly slow due to the loss of the fastest conducting axons.
C. Because motor neuron disease does not always have a lower extremity-upper extremity or distal-proximal gradient, one extremity may be much more involved than the others even though it is a generalized process.
D. Because results of routine studies with severe cases may be similar to those seen with myasthenic syndrome, 10 seconds of exercise followed by a single supramaximal stimulation should be performed on at least two motor studies.

Myasthenia Gravis

I. Workups
A. Either side:
1. Myopathy workup.
2. Repetitive stimulations should be done on at least four nerves. Median motor Distal / Trapezius / Accessorius occuli " Oris Nasalis

(peroneal motor recording tibialis anterior, median motor recording abductor pollicis brevis, ulnar motor recording abductor digiti minimi, musculocutaneous motor recording biceps, and/or axillary motor recording deltoid).

II. Projected Results
  A. Routine nerve conduction studies will be normal.
  B. Mild:
    1. Initial repetitive stimulation at 2/sec ×3 will reveal no decrement of the response.
    2. After one minute of exercise, repetitive stimulation at 2/sec ×3 will reveal a decrement of the response two to three minutes post exercise.
  C. Moderate to Severe:
    1. Repetitive stimulation studies will reveal a decrement of the response with initial stimulation of 2/sec ×3.
    2. This decrement will correct or improve with 15 seconds of exercise.
    3. The decrement will then reappear between 30 sec and 1.5 minute after exercise.

III. Variations and Remarks
  A. Myasthenia gravis may have a patchy distribution, which will show a decrement at some recording sites and will be normal at other recording sites.
  B. Although proximal stimulation sites are technically more difficult because of unstable baselines, they are more likely to show a decrementing response.

Myasthenic Syndrome (Lambert-Eaton Syndrome)

I. Workups
  A. Symptomatic side:
    1. Peripheral neuropathy workup.
    2. Ten seconds of exercise followed by a single supramaximal stimulation on all motor studies.

II. Projected Results
  A. All sensory studies will be normal.
  B. All motor studies will have decreased amplitudes with normal or near-normal conduction velocities and distal latencies.
  C. Ten seconds of exercise followed by a single supermaximal stimulation will show an increase over 100 percent in all motor amplitudes.

III. Variations and Remarks
  A. If the patient is not strong enough to adequately exercise the

muscle being tested, fast repetitive stimulation of 20 to 30 stimuli per second may be used to demonstrate an incrementing response.

Myopathy (Polymyositis, Steroid Myopathy, Muscular Dystrophy)

I. Workups
  A. Symptomatic side:
    1. Myopathy workup. Sural, Peroneal, Median motor & Sensory
II. Projected Results
  A. Sensory studies must be within normal limits.
  B. Motor studies usually within normal limits.
III. Variations and Remarks
  A. Most myopathies have a proximal distribution, and because routine nerve conduction is recorded from distal muscles, abnormalities are rarely seen.
  B. In cases of very severe proximal myopathies or distal myopathies, low amplitude motor responses with normal sensories may be seen.
  C. If low motor amplitudes are seen on nerve conduction studies, a peripheral neuropathy workup with a myasthenic syndrome test should be done because of the possibility of a different problem (i.e. motor neuron disease or myasthenic syndrome).

Peroneal Neuropathy at the Fibular Head (Foot drop, Peroneal Palsy)

I. Workups
  A. Symptomatic side:
    1. Basic search in the lower extremity.
    2. Peroneal motor recording tibialis anterior, two point stimulation at the knee and fibular head.
  B. Other side:
    1. Peroneal motor recording extensor digitorum brevis, two point stimulation at the knee and at the ankle with conduction velocity.
    2. Peroneal motor recording tibialis anterior, two point stimulation at the knee and at the fibular head with conduction velocity.
II. Projected Results
  A. Localizable lesion.
    1. Normal amplitude on the peroneal motor recording EDB with ankle stimulation, decreased amplitude with knee stimulation, and normal amplitude with below fibular head stimulation.
    2. Normal amplitude on the peroneal motor recording anterior tibial with fibular head stimulation, and decreased amplitude

with knee stimulation.

3. Slowed conduction velocity on the peroneal motor recording EDB with stimulation at the knee, and normal conduction velocity with stimulation below the fibular head. (Fibular head stimulation must increase 10 m/sec.)

B. Nonlocalizable lesion.

1. Decreased amplitude of the peroneal motor recording EDB with ankle, knee, and below fibular head stimulation.
2. Decreased amplitude of the peroneal motor recording anterior tibial with ankle and knee stimulation.
3. Slowed conduction velocity of the peroneal motor recording EDB with below fibular head and knee stimulation.
4. Slowed conduction velocity of the peroneal motor recording anterior tibial.

III. Variations and Remarks

A. Conduction velocities from the peroneal motor recording anterior tibial can be spuriously fast because of the short distances being used, but if careful measurements are made, side-to-side comparisons should be accurate.

B. If a patient is sent to the laboratory with the diagnosis of "peroneal palsy" and the peroneal amplitudes recording EDB with ankle and knee stimulation are the same, stimulate posterior to the lateral malleolus to be sure a physiologic block at the fibular head is not being camouflaged by an accessory peroneal nerve.

Pronator Syndrome, Ligament of Struthers

I. Workups

A. Symptomatic side:

1. Basic search in the upper extremity.
2. Median sensory recording index and middle fingers, two point stimulation at the wrist and elbow with conduction velocity.

B. Other side:

1. Median sensory recording index and middle fingers, two point stimulation at the wrist and elbow with conduction velocity.

II. Projected Results

A. Localizable

1. Median sensories recording the index and middle fingers may have slowed conduction velocities with stimulation at the routine elbow site but will be normal with stimulation distal to the elbow in the forearm.
2. Median motor recording APB may have a slowed conduction

velocity with stimulation at the routine elbow site but will be normal with stimulation distal to the elbow in the forearm.

B. Not able to localize the lesion:
   1. Median motor (APB) and/or sensories (index and middle fingers) have slowed conduction velocities at the elbow that do not increase with forearm stimulation.
   2. Median motor (APB) and/or median sensories (index and middle fingers) have low amplitudes and normal distal latencies with wrist stimulation.

III. Variations and Remarks
   A. In order to be above the site of the lesion, the elbow stimulation site must be at least 3 cm above the elbow crease.
   B. If median motor (APB) and/or median sensories (index and middle fingers) have decreased amplitudes, a median neuropathy at the wrist should be ruled out.

Radial Neuropathy (Wrist Drop, Posterior Interosseous Syndrome)

I. Workups
   A. Symptomatic side:
      1. Basic search in the upper extremity.
      2. Radial motor recording extensor digitorum communis, with four point stimulation (elbow, spiral groove, axilla, Erb's point).
   B. Other side:
      1. Radial sensory recording on dorsum of the hand, single point stimulation.
      2. Radial motors recording, extensor digitorum communis, four point stimulation (elbow, spiral groove, axilla, Erb's point).

II. Projected Results
   A. Localizable to spiral groove.
      1. Stimulation of the radial nerve recording extensor digitorum communis will show a normal amplitude with stimulation at the elbow, and a drop of more than 2 mv with stimulation above the spiral groove, and normal amplitude with stimulation just below the spiral groove.
   B. Nonlocalizable.
      1. Radial motor conduction velocity is slowed at all stimulation sites when compared to the radial motor conduction velocity on the other side.
      2. All radial amplitudes, both motor and sensory, are decreased when compared to the radial motor and sensory on the other side.

C. Localizable to the posterior interosseous branch
1. Amplitude on the radial motor recording EDC is decreased.
2. Amplitude on the radial sensory recording the dorsum of the hand is normal.

III. Variations and Remarks
A. Because of short distances and technical problems in measurement, the radial conduction velocity is unreliable and nondiagnostic unless a substantial difference occurs when compared to the contralateral side.
B. If there is a block at the spiral groove, this can usually be localized by stimulating, progressively more distal, along the course of the radial nerve until a normal amplitude is obtained.

Sacral Plexus, Lumbar Plexus, Lumbosacral Plexus

I. Workups
A. Symptomatic side:
1. Basic search in the lower extremity.
2. Peroneal sensory recording the dorsum of the foot.
3. F-wave to the EDB.
4. H-reflex study.
B. Other side:
1. Peroneal sensory recording the dorsum of the foot.
2. Single point stimulation of the peroneal motor (EDB) with F-wave.
3. Single point stimulation of the posterior tibial motor (AH).
4. H-reflex study.

II. Projected Results
A. If there is a sacral plexus, decreased motor and sensory amplitudes in all nerves studied on the affected limb.
B. If there is a lesion in the lumbar plexus, all of the routine studies should be normal.

III. Variations and Remarks
A. The decreased amplitudes found with a sacral plexus lesion do not localize the problem to the sacral plexus. This could also be multiple mononeuropathies of the peroneal, posterior tibial, and sural nerves, or a sciatic neuropathy.
B. Sacral plexus lesions, unlike sciatic neuropathies, usually affect all of the distal nerves equally.
C. In severe lumbar plexus lesions, the femoral motor (rectus femoris) will have a decreased amplitude but this finding cannot be differentiated from a femoral mononeuropathy.

Sciatic Neuropathy

I. Workups
  A. Symptomatic side:
    1. Basic search in the lower extremity.
    2. Peroneal sensory recording the dorsum of the foot.
    3. F-wave on the EDB.
    4. H-reflex study.
  B. Other side:
    1. Peroneal sensory recording the dorsum of the foot.
    2. Single point stimulation at the ankle of the peroneal motor (EDB) with F-wave.
    3. Single point stimulation of the posterior tibial motor (AH).
    4. H-reflex study.

II. Projected Results
  A. Decreased motor and sensory amplitudes in all nerve studies on the affected limb.

III. Variations and Remarks
  A. The decreased amplitudes found with sciatic nerve lesions do not localize the problem to the sciatic nerve. This could also be multiple mononeuropathies of the peroneal, posterior tibial, and sural nerves, or a sacral plexus lesion.
  B. Sciatic neuropathies may not affect all of the distal nerves equally, i.e. posterior tibial recording AH may have normal or near normal amplitudes while the peroneal recording EDB may have very decreased amplitudes. Generally, the sural and posterior tibial motor responses tend to be affected together, while the superficial peroneal sensory and peroneal motor tend to be affected together.

Tarsal Tunnel Syndrome
(Posterior Tibial Neuropathy at the Ankle)

I. Workups
  A. Symptomatic limb:
    1. Basic search in the lower extremity.
    2. Posterior tibial motor recording, abductor digiti quinti pedis, two point stimulation at the ankle and at the knee with conduction velocity.
  B. Contralateral limb:
    1. Posterior tibial motor recording, abductor hallucis, single point stimulation at the ankle.
    2. Posterior tibial motor recording, abductor digiti quinti pedis, single point stimulation at the ankle.

II. Projected Results
  A. Localized:
    1. Prolonged distal latency on posterior tibial motor recording hallucis and/or abductor digiti quinti pedis with normal conduction velocities.
  B. Not localized:
    1. Decreased amplitude on posterior tibial motors recording abductor hallucis and/or abductor digiti quinti pedis.

III. Variations and Remarks
  A. Because of the side-to-side comparison, the same distal distance should be used when performing the study of the contralateral limb.

Thoracic Outlet Syndrome

I. Workups
  A. Symptomatic side:
    1. Basic search in the upper extremity.
    2. Four point stimulation on the ulnar motor recording ADM (wrist, elbow, axilla, Erb's point).
    3. F-waves on the APB and ADM.
  B. Other side
    1. Ulnar sensory recording fifth finger, single point stimulation at the wrist.
    2. Ulnar motor recording ADM and median motor recording APB, single point stimulation at the wrist with F-waves on both.

II. Projected Results
  A. Conduction velocity may be slowed with stimulation of the ulnar motor (ADM) at Erb's point and will be normal at all other stimulation sites.
  B. Routine conduction velocities of the ulnar motor (ADM) and median motor (APB) at the elbow will be normal but F-waves to these muscles may be prolonged on the symptomatic side and normal on the contralateral side.

III. Variations and Remarks
  A. If any of the routine motor or sensory responses have low amplitudes, a brachial plexus workup should be done to look for a "true" thoracic outlet syndrome or some other brachial plexus lesion.

Ulnar Neuropathy

I. Workups

A. Symptomatic side:
   1. Basic search in the upper extremity.
   2. Four point stimulation on the ulnar motor recording ADM (wrist, elbow, axilla, Erb's point).
   3. Ulnar sensory recording fifth finger, two point stimulation at wrist and at elbow with conduction velocity.
   4. Ulnar motor recording first dorsal interosseous, two point stimulation at wrist and elbow with conduction velocity.
   5. Ulnar sensory recording dorsum of the hand with single point stimulation at the wrist.

B. Other side:
   1. Ulnar sensories* recording fifth finger and dorsum of the hand, single point stimulation at the wrist.
   2. Ulnar motor recording, first dorsal interosseous and abductor digiti minimi, stimulation at two sites (wrist and elbow) with conduction velocity.

II. Projected Results

A. Lesions at the elbow
   1. Motor and sensory conduction velocity may be slowed with stimulation above the elbow and increase 10 m/sec with stimulation below the elbow.
   2. Motor amplitude may be normal at the wrist, drop more than 2 mv with stimulation above the elbow, and will again be normal with stimulation below the elbow.
   3. Ulnar sensory amplitudes are often decreased.

B. Lesions at the wrist.
   1. Amplitude may be decreased and/or the distal latency prolonged, with normal conduction velocities when stimulating the ulnar nerve and recording the first DI and ADM.
   2. The amplitude may be decreased and/or the distal latency prolonged on the ulnar sensory recording the fifth finger, with a normal conduction velocity.
   3. Ulnar sensory recording dorsum of the hand will be normal.

C. Lesions distal to the wrist.
   1. The amplitude may be decreased and/or the distal latency prolonged on the ulnar motors recording first DI, with a normal conduction velocity.
   2. The ulnar sensory recording the fifth finger and the ulnar motor recording ADM should be within normal limits.
   3. Ulnar sensory recording dorsum of the hand will be normal.

D. Not able to localize lesion.

*Ulnar sensory recording dorsum of hand is most helpful when trying to localize a lesion to the wrist.

1. Ulnar motor and sensory amplitudes decreased with normal median motor and sensory studies.
2. Ulnar motor and sensory conduction velocities slowed at several stimulation sites, with normal median motor and sensory studies.

III. Variations and Remarks

A. An ulnar neuropathy localized to the elbow must:
   1. Have a conduction velocity that is slow with elbow stimulation and increase by 10 m/sec with below the elbow stimulation, or
   2. Have amplitudes that are normal with wrist and below elbow stimulation and decrease with elbow and axilla stimulation.

B. A complete ulnar workup is necessary because each ulnar recording site can be affected differently as to the type and amount of pathology present.

SUBJECT INDEX

NAME INDEX