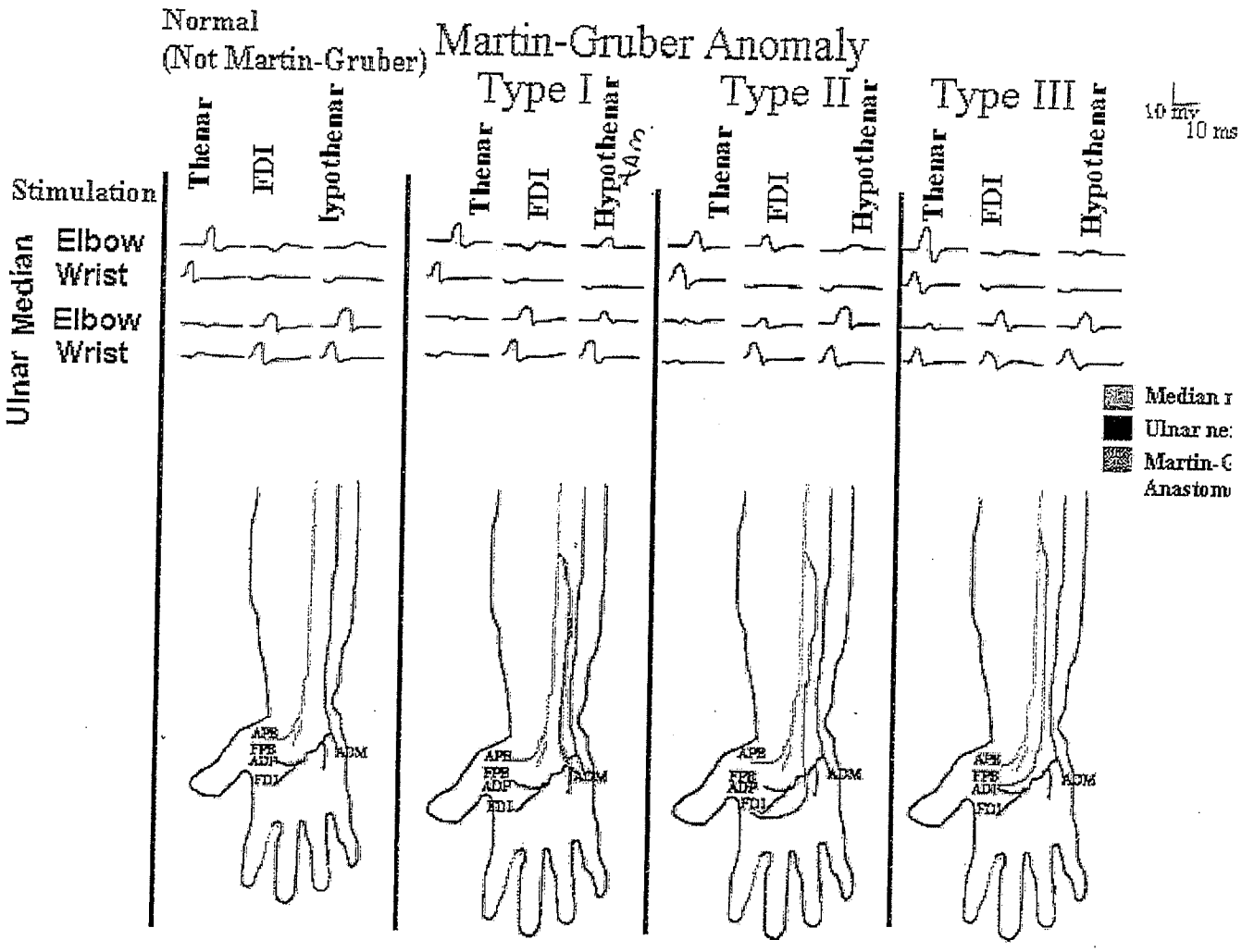

Normal
(Not Martin-Gruber)
Martin-Gruber Anomaly
Type I
Type II
Type III
Thenar
FDI
Hypothenar
Stimulation
Median
Ulnar
Elbow
Wrist
Elbow
Wrist
10 mV
10 ms
APB
FPB
ADP
FDI
ADM
Median r
Ulnar ne:
Martin-G
Anastomo

and deep branches so both are being stimulated at the knee; with routine ankle stimulation, only the deep branch is being stimulated. To find the fibers that are taking a superficial course, stimulate posterior to the lateral malleolus parallel with the ankle stimulation site. A combination of ankle and lateral malleolus stimulation should yield a normal distal response (Fig. 5-2b). To calculate, add the amplitudes (and/or area) of the responses obtained with ankle and lateral malleolus stimulation and compare this to the response obtained with knee stimulation. Once the distal amplitudes are combined, distal to proximal amplitude comparisons can be made. The distal latency and conduction velocity are calculated from the responses obtained at the routine stimulation sites. Because of the slightly longer distance, the latency obtained with lateral malleolus stimulation should be the same or slightly longer than the latency obtained with routine ankle stimulation. Also, this type of anomaly may cause studies with physiologic blocks at the fibular head to appear normal. For this reason, stimulation posterior to the lateral malleolus should be performed whenever a peroneal palsy is suspected.

MEDIAN TO ULNAR CROSSOVERS (10, 63)

Fibers in the upper extremity crossing from the median nerve to the ulnar nerve in the forearm cause anomalous innervation of some of the hand muscles. Although there is some discussion in the literature regarding other anomalies in the upper extremity (such as an ulnar to median crossover), this section will deal solely with the median to ulnar communication.

The ulnar and median peripheral nerves follows separate anatomic courses after they leave the brachial plexus and, in 70 to 85 percent of the population, they maintain this separate course. In 15 to 30 percent of the population, fibers from the median nerve cross to the ulnar nerve in the forearm. Because the fibers always cross from the median to the ulnar, they are detected (directly or indirectly) from ulnar innervated muscles (or muscle groups). There are three types of crossover presentations, and each can be found separately or in combination. Even when more than one presentation is present, each should be thought of as a separate study.

Type I—Hypothenar Presentation

The most frequently detected crossing fibers are to the hypothenar muscle group. Because the crossing fibers terminate in the hypothenar (Fig. 5-3), this crossover manifests itself during routine ulnar motor studies recording from the abductor digiti minimi. Figure 5-4a illustrates what is usually seen with stimulation of both the median and ulnar nerves when the recording site is the abductor digiti minimi (hypothenar group). Distal to proximal comparison of both the amplitude and configuration is normal with

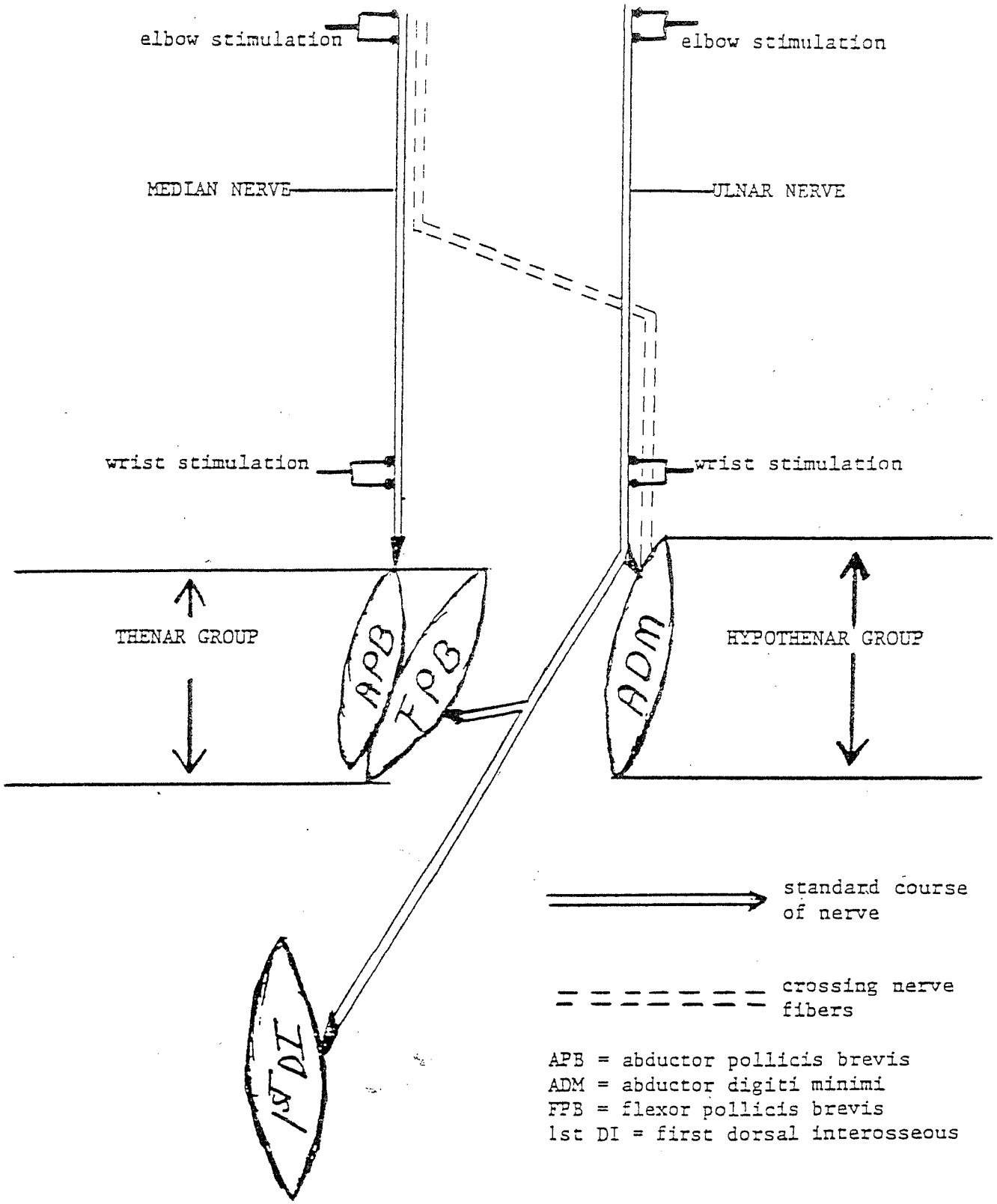
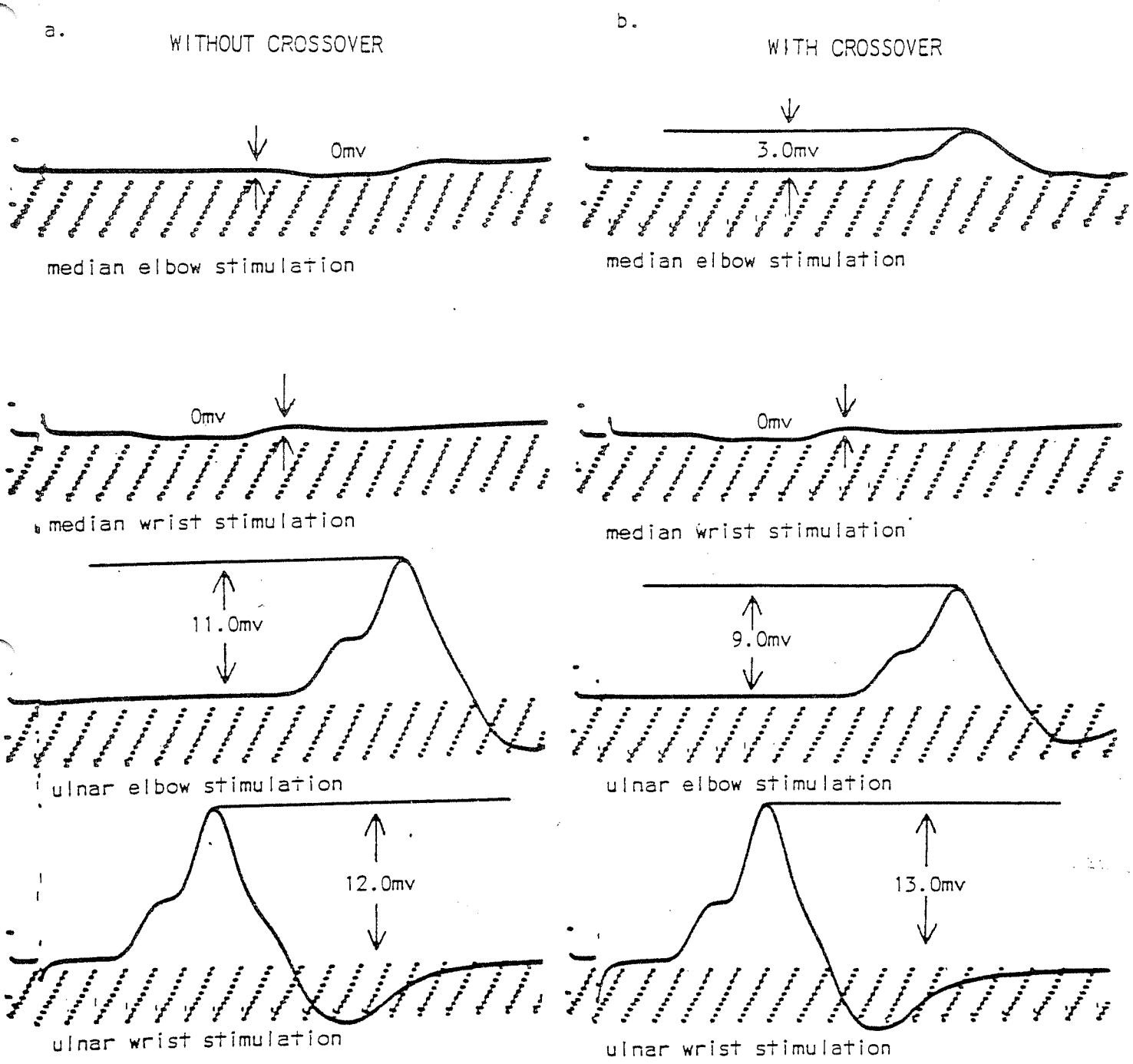

elbow stimulation
elbow stimulation
MEDIAN NERVE
ULNAR NERVE
wrist stimulation
wrist stimulation
THENAR GROUP
HYPOTHENAR GROUP
APB
FPB
ADM
1ST DI
standard course of nerve
crossing nerve fibers
APB = abductor pollicis brevis
ADM = abductor digiti minimi
FPB = flexor pollicis brevis
1st DI = first dorsal interosseous

Figure 5-3

RECORDING ABDUCTOR DIGITI MINIMI (HYPOTHENAR GROUP)



3.0mv	median elbow stimulation	
-0.0mv	median wrist stimulation	
3.0mv	crossing fibers	
9.0mv	ulnar elbow stimulation	
+3.0mv	crossing fibers	
12.0mv	actual ulnar elbow amplitude	
13.0mv	ulnar wrist amplitude	normal amplitude variation
12.0mv	ulnar elbow amplitude	

Figure 5-4

stimulation of the ulnar nerve at the elbow and wrist sites. When the median nerve is stimulated at the elbow and wrist, the response is a long, shallow, positive dip. This dip indicates that none of the stimulated fibers are reaching the recording site. Figure 5-4b illustrates what is seen when fibers, that are following a median nerve course at the elbow, cross in the mid forearm and then follow an ulnar nerve course and innervate the hypothenar muscle group. With stimulation of the ulnar nerve at the wrist, a response with a normal amplitude and configuration is seen. When the ulnar nerve is stimulated at the elbow, the amplitude and area of the response decrease more than the normal amount. Stimulation of the median nerve at the elbow locates the crossing fibers, while stimulation of the median nerve at the wrist reveals the shallow, positive dip seen routinely.

Because the routine stimulations performed with this type of crossover look exactly alike a physiologic block in conduction at the elbow (see Chapter 6), calculating crossover results are important to insure that there is no additional underlying pathology. This is done by adding the amplitudes (and/or areas) of the responses obtained with proximal stimulation of the ulnar and median nerves, then comparing this to the response obtained with distal ulnar stimulation. Once the amplitudes with proximal, median, and ulnar stimulation are added, the standard rule for amplitude variation takes effect.

Type II—First Dorsal Interosseous Presentation

The second type of crossover innervates the first dorsal interosseous (Fig. 5-5). When recording from the first dorsal interosseous, if no crossover is present, distal to proximal comparison of the responses obtained with routine stimulation of the ulnar nerve will be normal. When the median nerve is stimulated a response is obtained, but it will also have a normal distal to proximal comparison (Fig. 5-6a). This response obtained with median nerve stimulation is a volume conducted response from the surrounding median innervated muscles, such as the first and second lumbrical or the oppenens pollicis; it is not caused by routine median innervation of the first dorsal interosseous muscle. If a crossover is present (Fig. 5-6b), stimulation of the ulnar nerve at the wrist provides a response that is normal in configuration and amplitude, whereas stimulation of the ulnar nerve at the elbow yields a response that is decreased in amplitude and area. Stimulation of the median nerve at the elbow yields a response that is higher in amplitude than the response obtained with median nerve stimulation at the wrist.

To calculate the crossing fibers, subtract the median wrist amplitude from the median elbow amplitude, then add the difference between the median amplitudes to the ulnar amplitude at the elbow. Once this is completed, the standard rule for amplitude variation takes affect.

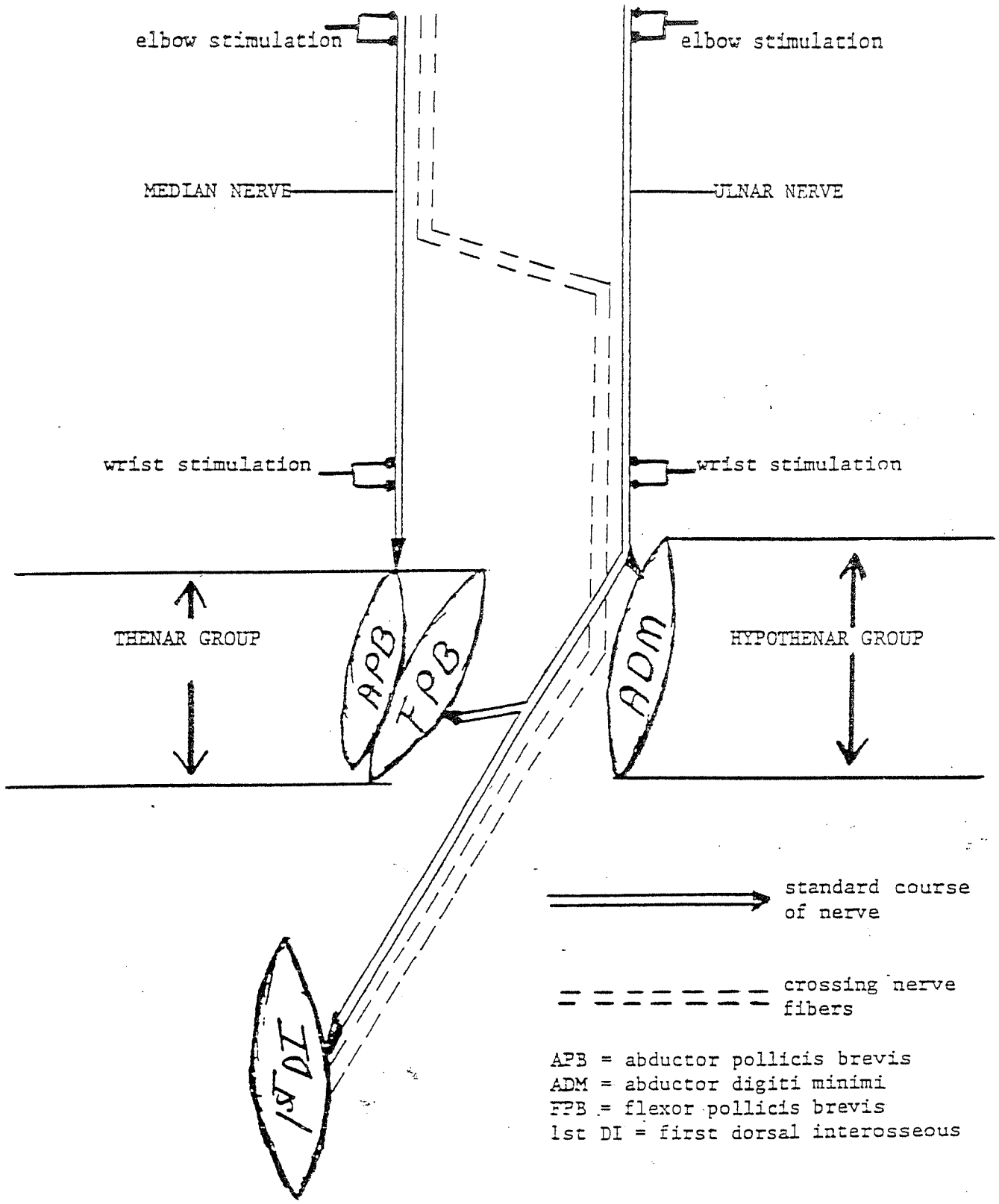
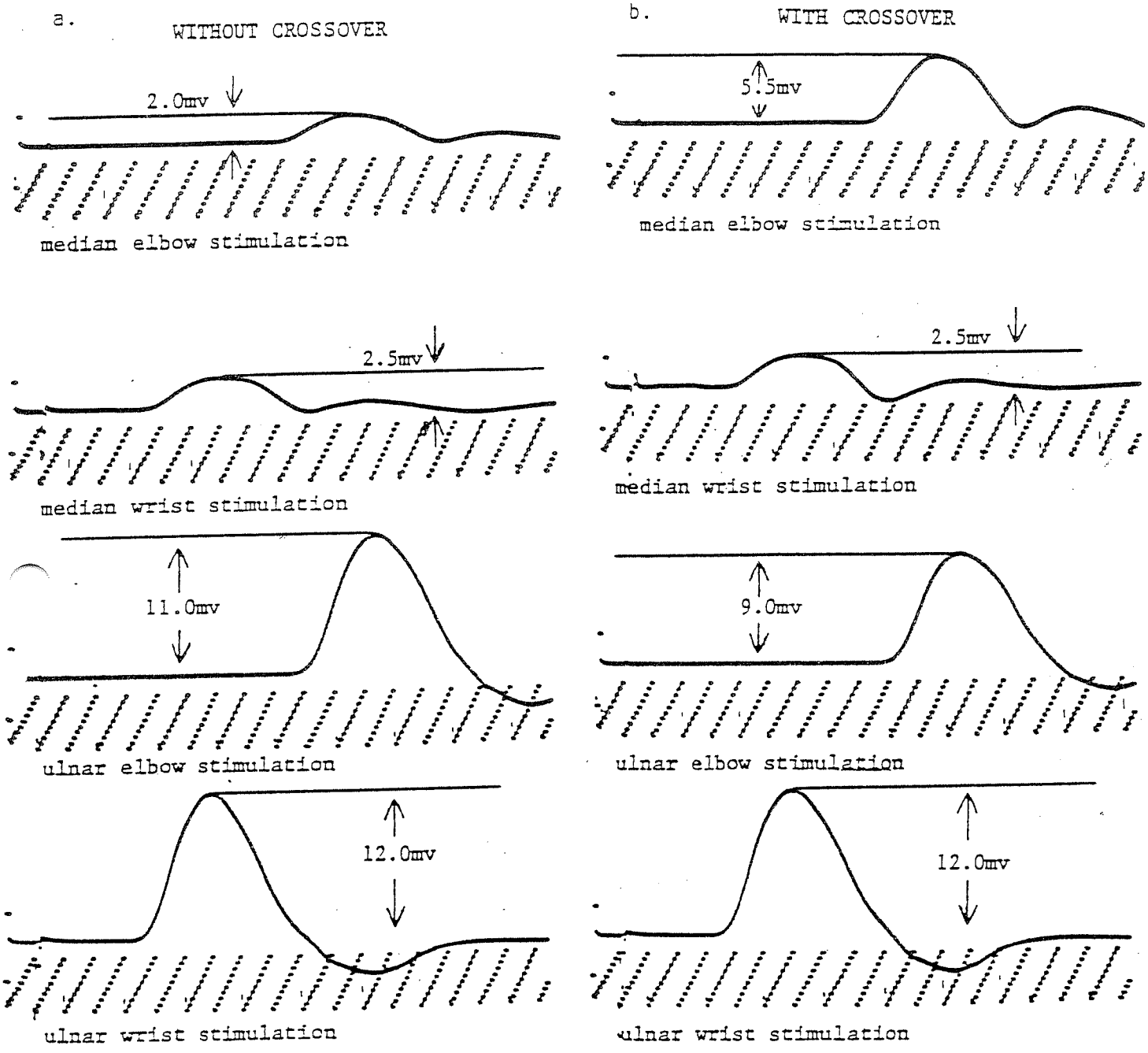

elbow stimulation
elbow stimulation
MEDIAN NERVE
ULNAR NERVE
wrist stimulation
wrist stimulation
THENAR GROUP
HYPOTHENAR GROUP
APB
FPB
ADM
1st DI
standard course of nerve
crossing nerve fibers
APB = abductor pollicis brevis
ADM = abductor digiti minimi
FPB = flexor pollicis brevis
1st DI = first dorsal interosseous

Figure 5-5

RECORDING FIRST DORSAL INTEROSSEOUS



5.5mv median elbow stimulation
−2.5mv median wrist stimulation
3.0mv crossing fibers

).0mv ulnar elbow stimulation
+3.0mv crossing fibers
?.0mv actual ulnar elbow amplitude

12.0mv ulnar wrist amplitude
12.0mv ulnar elbow amplitude
} normal amplitude variation

Figure 5-6

Type III—Thenar Presentation

The third type of crossover innervates the ulnar muscle in the thenar muscle group (Fig. 5-7). This crossover manifests itself on routine median motor studies recording from the abductor pollicis brevis (thenar muscle group), and it is the hardest type to recognize and document. Figure 5-8a illustrates what is usually seen with median and ulnar stimulation when the recording site is the thenar. Distal to proximal comparison of amplitudes and configurations are normal with median nerve stimulation. The response obtained with ulnar nerve stimulation usually has a biphasic configuration and is preceded by a positive dip. This is a volume conducted response from the ulnar innervated muscle in the thenar muscle group. The positive dip occurs because the recording electrode (G1) is not over the motor point of this muscle. It is important to remember that, even though the thenar muscle group is routinely used with median motor studies, it also contains ulnar muscles that are the recipient of the crossing fibers. When a crossover is present (Fig. 5-8b), routine stimulation of the median nerve will reveal a higher amplitude at the elbow than at the wrist. Stimulation of the ulnar nerve produces a response that is higher distally at the wrist than proximally at the elbow.

To calculate the crossing fibers, subtract the proximal ulnar amplitude from the distal ulnar amplitude and add this difference to the distal median response. Once this is completed, the standard rule for normal amplitude variations takes effect.

Another way this crossover will manifest itself is when it is seen in conjunction with a median neuropathy at the wrist (carpal tunnel syndrome). When this occurs, distal stimulation of the median nerve will reveal a takeoff that is sharply negative and a distal latency that is prolonged. Proximal median nerve stimulation will reveal a positive dip preceding the response with an amplitude that is higher and/or an area that is greater (i.e. increased duration of the response) than that seen at the wrist. This positive dip is caused by the crossing ulnar fibers. It precedes the median response because the fibers are not passing through the carpal tunnel and therefore are not being delayed. In this case, the response obtained with stimulation of the median nerve at the elbow will yield a latency that is very short and will produce a conduction velocity that is spuriously fast.

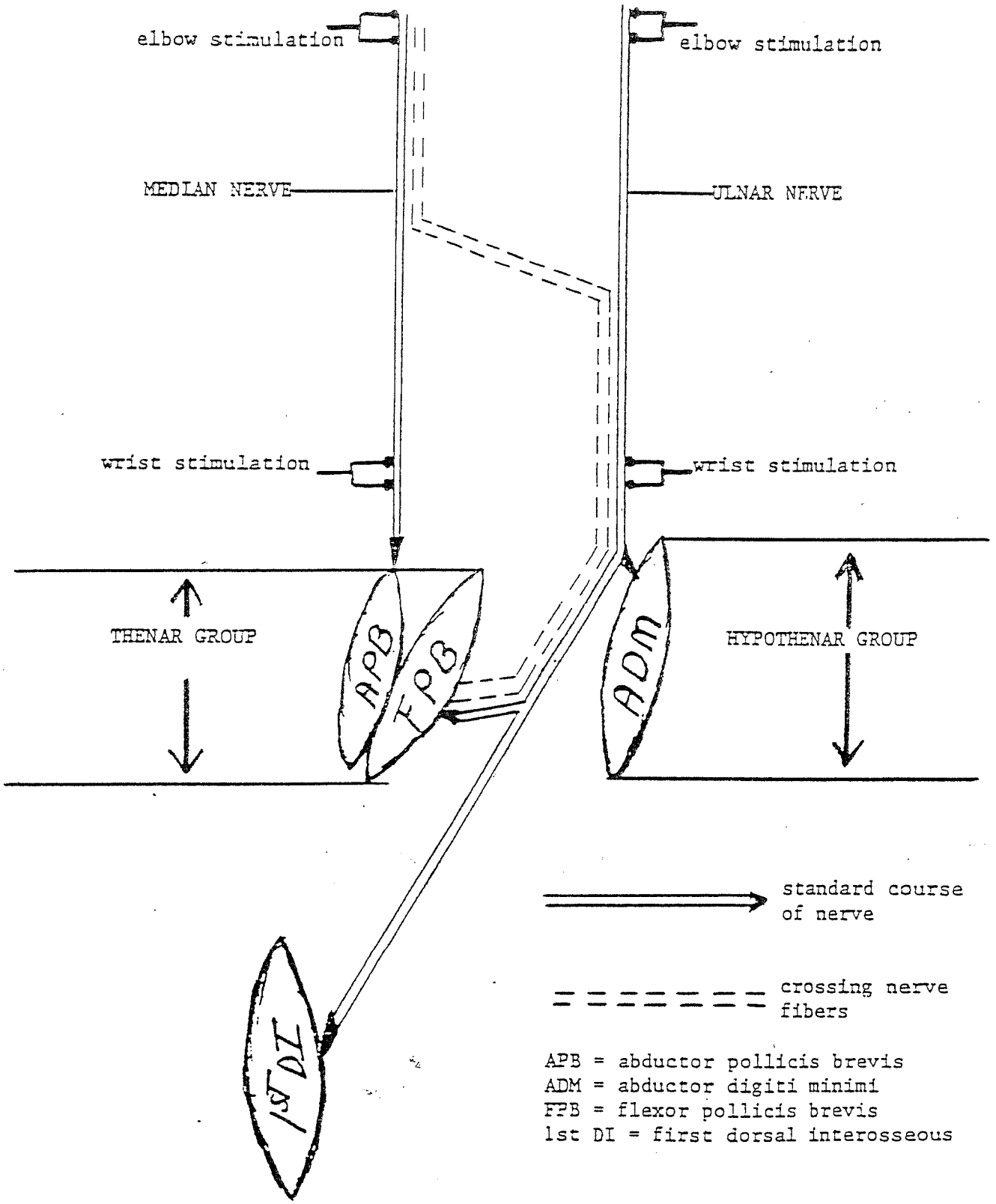
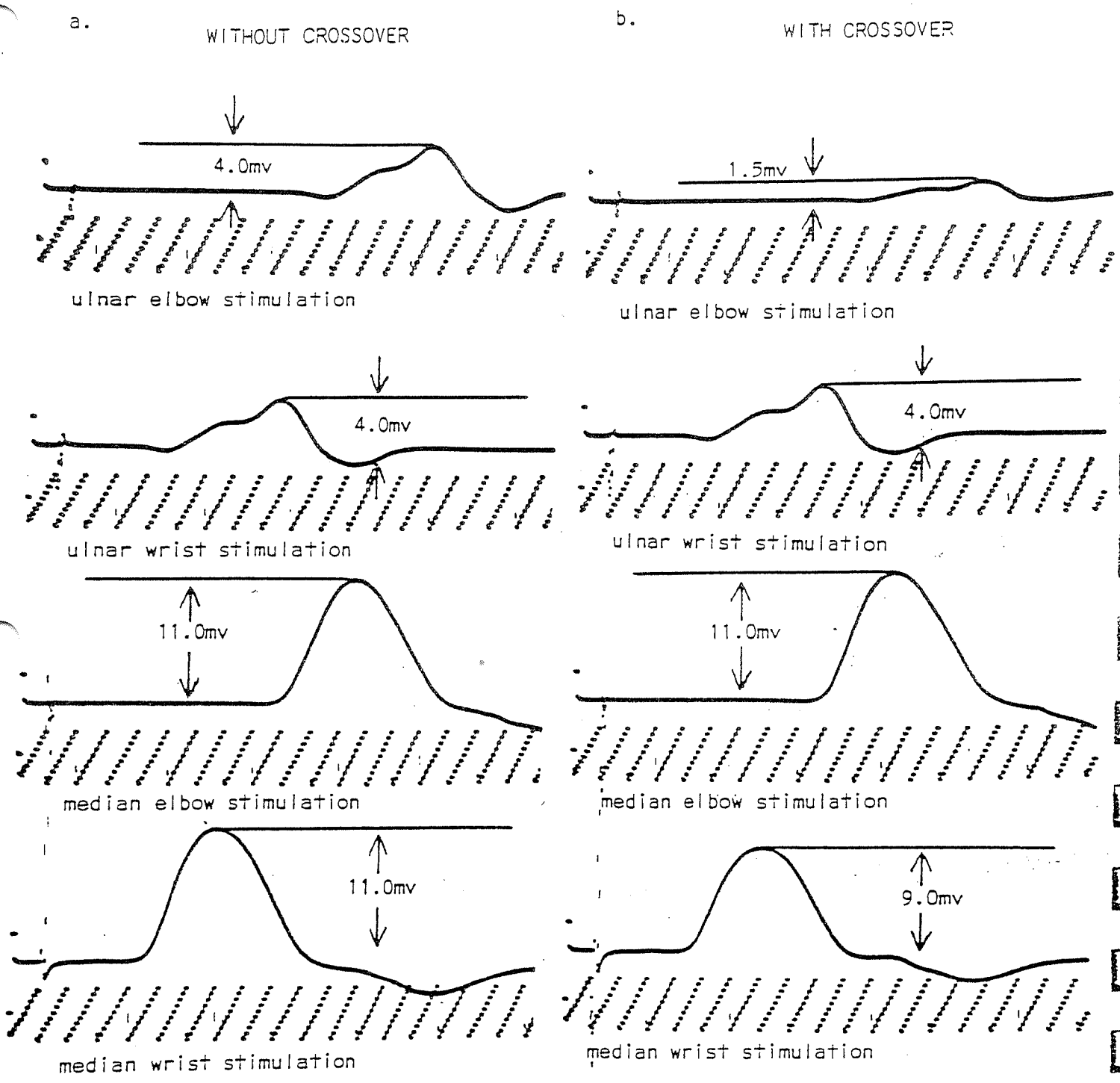

elbow stimulation
elbow stimulation
MEDIAN NERVE
ULNAR NERVE
wrist stimulation
wrist stimulation
THENAR GROUP
HYPOTHENAR GROUP
APB
FPB
ADM
1ST DI
standard course of nerve
crossing nerve fibers
APB = abductor pollicis brevis
ADM = abductor digiti minimi
FPB = flexor pollicis brevis
1st DI = first dorsal interosseous

Figure 5-7

RECORDING ABDUCTOR POLLICIS BREVIS (THENAR GROUP)



4.0mv ulnar wrist stimulation
−1.5mv ulnar elbow stimulation
2.5mv crossing fibers

9.0mv median wrist amplitude
+2.5mv crossing fibers
11.5mv actual median wrist amplitude

11.5mv median wrist amplitude
11.0mv median elbow amplitude
} normal amplitude variation

Figure 5-8