F-WAVE

There is some disagreement regarding the exact pathway of the F-wave. Some feel that it is actually a reflex (46), others feel that it is an antidromic motor impulse with backfiring of reexcited motor neurons, and still others feel that it is a combination of both. This text will only study the most popular view, that is the backfiring of reexcited motor neurons (47).

When a nerve is stimulated the impulse travels in both directions, that is antidromically and orthodromically. Routine motor studies only record orthodromic impulses that yield the M-response. The F-wave is elicited when the antidromic motor impulse travels to the spinal cord then reexcites the motor neuron pool, which causes a backfiring of the orthodromic impulse to the muscle recording site (Fig. 4-1). The response caused by this backfiring of the orthodromic impulse is called the F-wave.

Eliciting F-waves on any of the routine motor nerve studies is relatively simple (48, 50). The machine settings are as follows: a slow sweep of 5 to 15 milliseconds per division, sensory filter settings, and a gain of 200 or 500 microvolts. Apply electrodes as in any routine motor study with G1 over the belly of the muscle, G2 over the tendon to that muscle, and G0 between G1 and the stimulating site (see Chapter 3). Stimulate with the cathode (S1) proximal and the anode (S2) distal at any of the routine stimulation sites. Increase the voltage until a maximal M-response is obtained, then superimpose (or stagger) a series of at least ten stimulations. Because each F-wave samples different parts of the motor neuron pool, achieving an

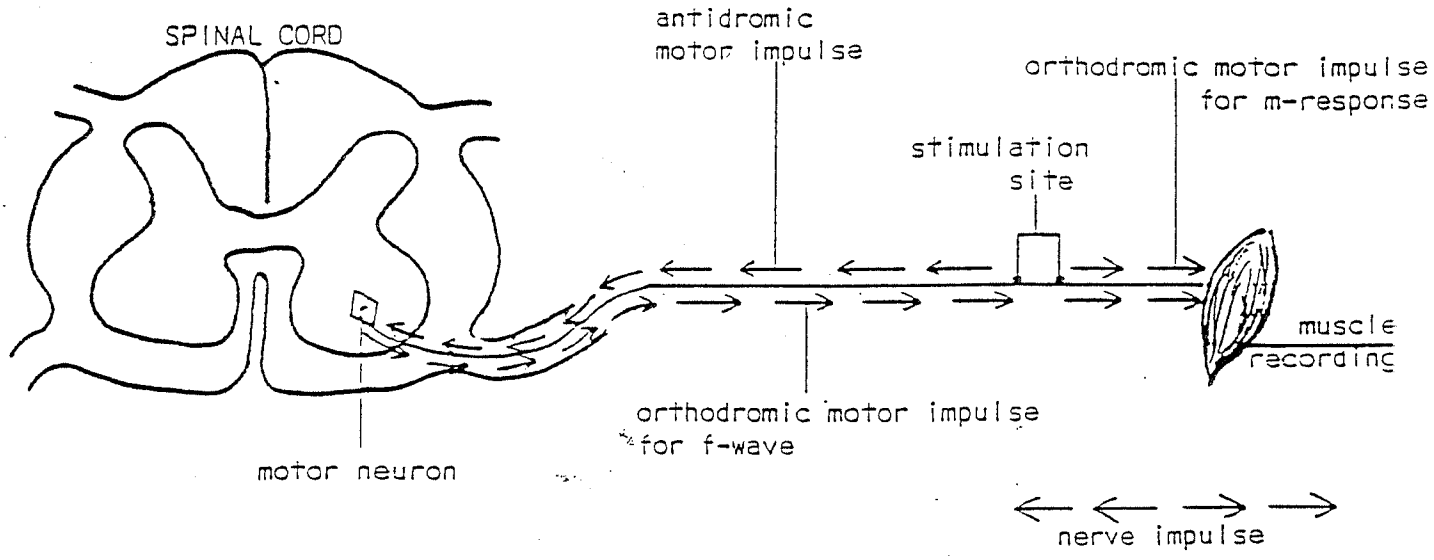

Figure 4-1

adequate sample is important and requires at least ten stimulations (Fig. 4-2a). It is best to use the distal stimulation sites because proximal stimulation sites yield an F-wave with a shorter latency and the response is frequently hidden in the positive aftermath of the M-response (Fig. 4-2b). The F-wave is measured to the shortest and most consistent latency out of a series of at least ten responses. Because sometimes there is considerable variation in the motor neuron pool that is being excited, amplitudes are unreliable. There are different articles in the literature that supply techniques and normal values for F-wave conduction velocities (36, 39) and F-ratios (18, 37), but normals for this manual are based on a side-to-side comparison of latencies, and an estimated F-wave latencies (48).

To figure an estimated F-wave latency

1. Measure distance:
   A. upper extremities—from the sternoclavicular joint to the cathode (S1) in a straight line with the arm at a 90 degree angle from the body.
   B. lower extremity—from the xiphoid process to the cathode (S1) in a straight line.
2. Formula:

$$\frac{2 \times \text{distance}}{\text{conduction velocity} \div 10} + \text{distal latency} = \text{estimated F-wave latency}$$

3. Normal F-wave latency = estimated F-wave latency ± 3 msec.

H-REFLEX

The H-reflex, or Hoffmann reflex, studies the orthodromic sensory and the orthodromic motor pathways, and the connection between them located

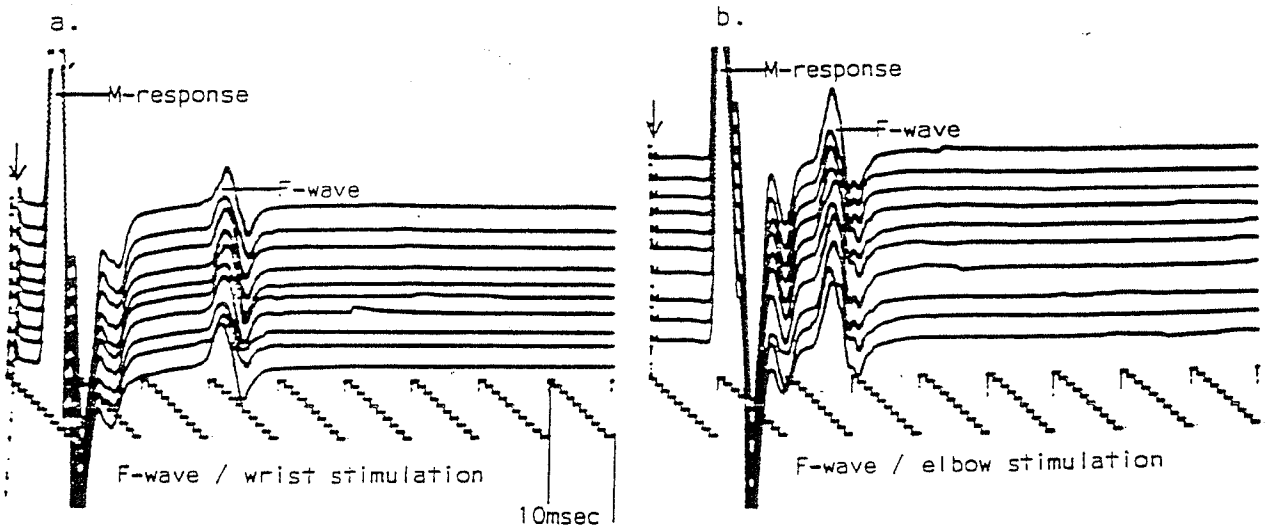

Figure 4-2

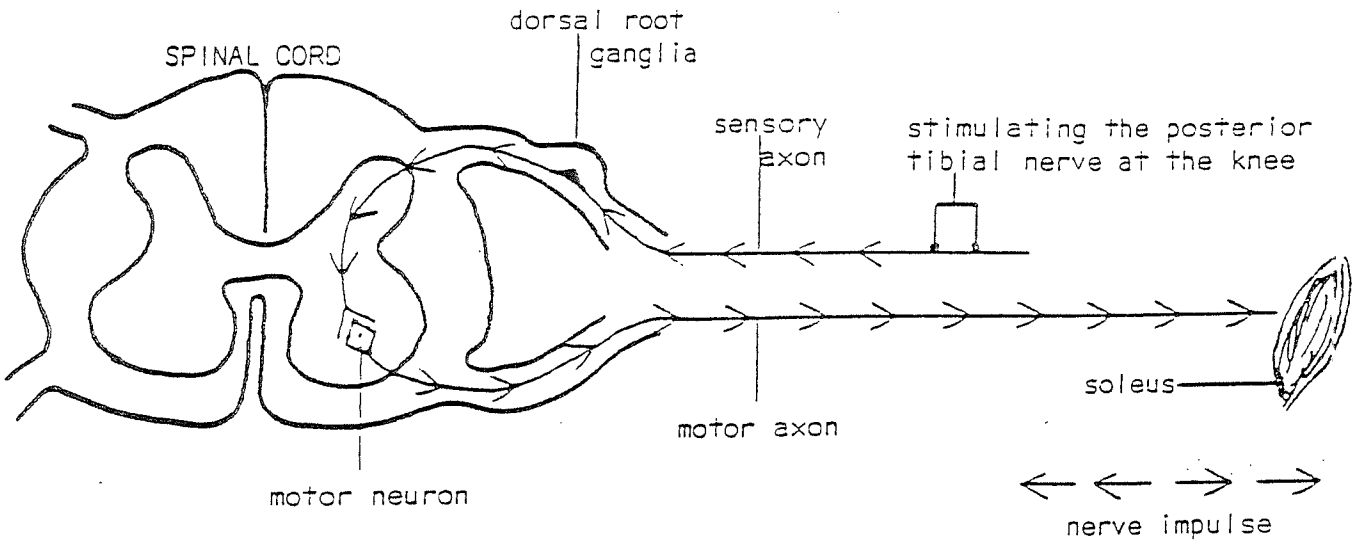

Figure 4-3

in the spinal cord (Fig. 4-3). Although an H-reflex can occasionally be elicited from muscles innervated by various roots, the routine recording site that gives consistent and reproducible results using surface stimulating and recording electrodes is the soleus via the S1 root. There are a number of ways to approach the technical setup of the H-reflex; two of them will be discussed (26, 45, 48, 50).

For the first type, the patient should be prone on the bed with supports under both feet to ensure that the calf muscles are relaxed. With the knee extended, have the patient plantarflex his foot and find the soleus at the point where the heads of the medial and lateral gastronemius separate. The recording electrode (G1) is placed between the separated gastrocnemius muscles, the reference electrode (G2) is placed 10 to 15 cm distal to G1 over the achilles tendon, and the ground (G0) is placed proximal to G1 over the gastroc muscles. When stimulating for the H-reflex, the polarity of the stimulator is reversed, that is, the cathode (S1) is placed more proximally than the anode (S2) (Fig. 4-4).

The second method is performed while the patient is supine on the bed. Again, the foot is plantarflexed while the knee is extended. G1 is placed just distal and anterior to the bulk of the medial gastrocnemius and just posterior to the tibia, G2 is placed 3 to 5 cm proximal to the medial malleolus, the G0 is placed proximal to G1 (Fig. 4-5). Stimulation is performed as indicated in the first example, with cathode (S1) proximal and anode (S2) distal.

In the first example, the landmarks for the placement of G1 are very definite; also, because the patient is in a prone position, the nerve is readily accessible to stimulation. The problem with this method is that the

response frequently has an initial positive deflection or very ambiguous takeoff. This sometimes makes calculating and comparing the latencies difficult. The second method, on the other hand, usually has a higher amplitude and a takeoff that is initially negative and usually very easy to calculate. The problems with this method are that the placement of G1 is sometimes ambiguous and, because the patient is supine, stimulation is much more difficult. Both methods have good reproducible results; for whichever is chosen, the procedure must be rigorously followed in order to assure validity of results and normals, which are based on a side-to-side comparison.

Stimulating techniques and machine settings are the same for both methods. The machine should be set at a slow-sweep speed of 5 to 15 msec per division, a gain of 200 μv to 2 mv, motor filter settings, and a stimulus duration of 1.0 msec (26). Leaving at least three seconds between each shock

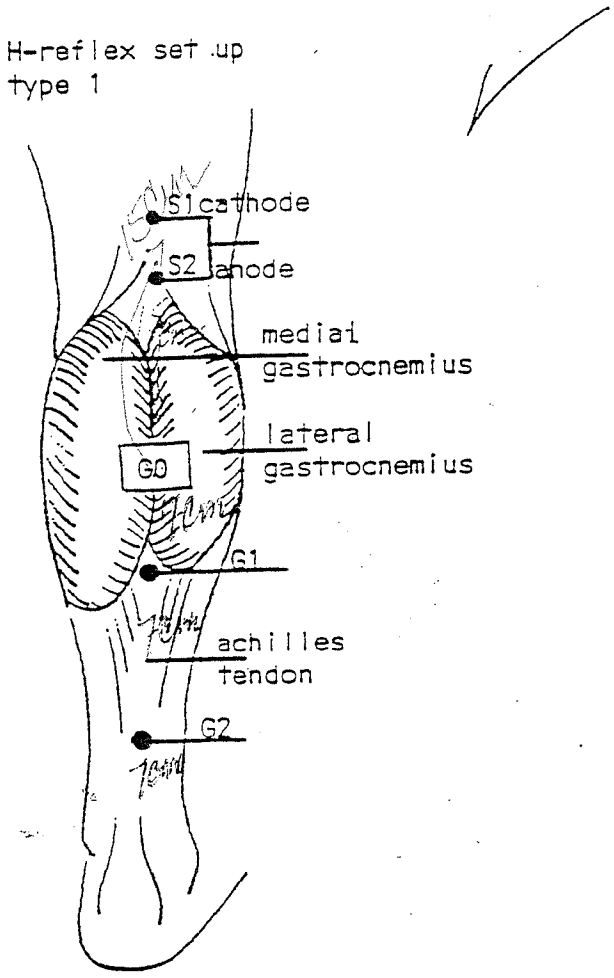

Figure 4-4

and starting with very minimal voltage, increase the voltage in very small increments until the H-reflex starts to appear (Fig. 4-6a). Continue the minimal increase in voltage, leaving at least three seconds between each shock until the maximal H-reflex is obtained (Fig. 4-6b). A series of three shocks at a rate of two per second should be given to produce a decrement of the maximal H-reflex (Fig. 4-6c). This is done to differentiate the H-reflex from the F-wave. Once the maximal H-reflex has been recorded, the voltage should be increased until a maximal M-response is obtained (Fig. 4-6g). Notice that the amplitude of H-reflex decreases as the amplitude of the M-response increases; when a maximal M-response is obtained, the H-reflex is no longer present (4-6d, e, f, g). Because there is a significant difference between the maximal H-reflex amplitude and the maximal M-response amplitude, the gain settings must be changed to include both, as shown in Figures 4-6e and 4-6f, which are the same response at two different gain settings. Usually a gain of 500 microvolts or 1 millivolt can be used for the maximal H-reflex, and a gain of 2 or 5 millivolts can be used for the maximal M-response.

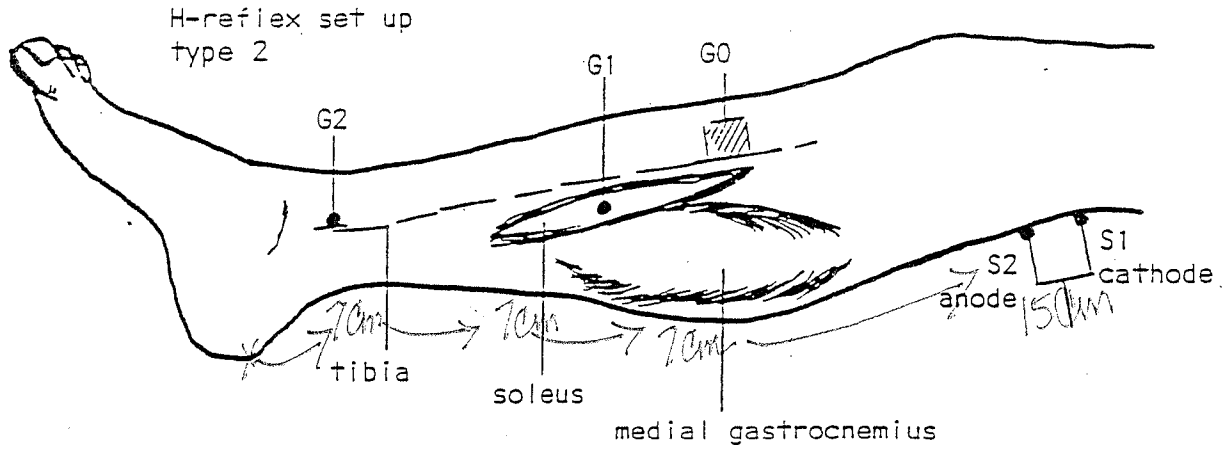

Figure 4-5

H Reflex: (Testing: L5-S1 Roots, Lumbosacral Plexus, Sciatic Nerve, Tibial Nerve- 1A Afferent Sensory Fibers –Alfa Motor Neurons – Afferent Motor Fibres)