The study of F wave in the patients with intervertebral disc herniations

Yasumasa Shirai, Tadaatsu Ito, Sumio Kota, Junichi Yamaguchi,
and Toshitsugu Takeuchi

Department of Orthopedics, Nippon Medical School

In 1950, Magladery and McDougel described a potential which was recorded at a latency greater than that of the direct motor response in small hand or foot muscles in man when the mixed peripheral nerve to the muscle was electrically stimulated. This response was called F wave. F wave in man is due to the recurrent discharges of a few motoneurons produced by an antidromic volley.

The purpose of this paper is to know the extent of the motor disfunction in the patients with L4-5 intervertebral disc herniations (I.D.H.) by means of measuring the latency of F wave and the conduction velocity of the nerve responsible for producing F wave.

The subjects examined were 23 patients with L4-5 I.D.H. and 20 normal subjects as controls. All of these 43 subjects showed the typical F wave following the supramaximal stimuli (0.5~1.0 msec pulses) delivered to the nerve at 1/sec. Their ages were between 23

Fig. 1 Stimulation of the peroneal N. at the ankle

Table 1 Latency and conduction velocity of F wave
Latency of the shortest and longest F wave

Stimulated Nerve	Shortest		Longest	
	L 4-5 I.D.H. (m/sec)	Control (m/sec)	L 4-5 I.D.H. (m/sec)	Control (m/sec)
T.N.	mean : 41.60 ± 4.54 (36-49)	mean : 43.60 ± 4.14 (36-49)	mean : 48.67 ± 4.32 (42-57)	mean : 48.03 ± 3.6 (40-54)
P.N.	mean : 38.87 ± 3.90 (33-41)	mean : 38.5 ± 4.2 (31-45)	mean : 45.50 ± 5.18 (38-52)	mean : 42.95 ± 3.22 (39-50)

Stimulated Nerve	maximum		minimum	
	L 4-5 I.D.H. (m/sec)	Control (m/sec)	L 4-5 I.D.H. (m/sec)	Control (m/sec)
T.N.	mean : 54.63 ± 4.74 (46.2-62.2)	mean : 54.86 ± 3.89 (50.0-61.5)	mean : 46.22 ± 3.76 (39.2-53.6)	mean : 47.86 ± 3.83 (42.3-54.7)
P.N.	mean : 49.05 ± 6.01 (41.5-60.0)	mean : 55.96 ± 5.48 (43.7-65.0)	mean : 41.58 ± 6.60 (34.8-55.2)	mean : 46.98 ± 2.73 (42.0-51.0)

and 55 years. Surface electrodes were placed on the knee (the popliteal fossa) for stimulation of the peroneal nerve and on the ankle (the medial malleolus) for stimulation of the tibial nerve. The responses were displayed on the cathode-ray oscilloscope and recorded with X-Y recorder (**Fig. 1**). Ninety-six F waves evoked consecutively were obtained from the abductor hallucis muscle by stimulating the tibial nerve. Another 96 F waves were obtained from the extensor digitorum brevis muscles by stimulating the peroneal nerve. The latencies of F wave were measured from the onset of the stimulus artifact to the start of the response. The latencies of F wave following 96 consecutive supramaximal stimuli varied even in the same subject. Consequently, all the latencies were measured.

In normal subjects, the mean value of F wave with the shortest latency was 38.5 ± 4.2 msec (conduction velocity; 55.96 ± 5.48 m/sec) when the peroneal nerve was stimulated, and 43.6 ± 4.14 msec (54.86 ± 3.89 m/sec) when the tibial nerve was stimulated. On the other hand, in the patients with I.D.H. the mean value of the shortest latencies of F wave was 38.8 ± 3.90 msec (49.05 ± 6.01 m/sec) when the peroneal nerve was stimulated, and 41.60 ± 4.54 msec (54.63 ± 4.74 m/sec) when the tibial nerve was stimulated. There was no difference in the mean value of the shortest latency of F wave between normal subjects and patients with I.D.H.

In F wave with the longest latency, that is, F wave with minimum conduction velocity, the mean value was 42.95 ± 3.22 msec, (46.98 ± 2.73 m/sec) when the peroneal nerve was stimulated and 48.03 ± 3.6 msec (47.86 ± 3.83 m/sec) when the tibial nerve was stimulated in normal persons (**Table 1**). On the other hand, in the patients with I.D.H., it was 45.50 ± 5.18 msec (41.58 ± 6.60 m/sec) when the peroneal nerve was stimulated whereas 48.67 ± 4.32 msec (42.67 ± 3.76 m/sec) when the tibial nerve was stimulated. In comparison with normal subjects, the longest latency of F wave in the patients with I.D.H. was significantly prolonged (**Table 1**).

The experimental evidence that F wave is due to the antidromic activation of the spinal motoneurons (Dawson and Merton, 1956)¹⁾ was furnished by McLeod and Wray (1966)⁹⁾.

These authors succeeded in recording the response from the small muscles of the hand of baboon which had properties characteristic of F wave and which was believed to have been elicited via the spinal cord after complete deafferentation of the limb. This interpretation was confirmed in man by Mayer and Feldman (1967)⁵⁾ who studied F wave in a patient after posterior rhizotomy and in other patients suffering from different disorders of the posterior roots. Thus the antidromic activation of motoneurons is responsible for the main component of F wave.

Recently more reports have been published^{2,4,7-9)} which dealt with the latency of F wave in patients with the nerve root damages with special reference to the shortest latency, that is, the maximum conduction velocity of F wave. It is thought that mainly the L5 nerve root is damaged in the patients with L4-5 I.D.H.. The sciatic nerve consists of the L4, L5 and S1 nerve roots (multisegmental innervation) and branches into two nerves peripherally, that is, the peroneal nerve, having more L5 root-component than L4 and S1 root-component, and the tibial nerve, having more S1 root-component than L4 and L5 root-component. Consequently, in the patients with L4-L5 I.D.H., stimulation of the peroneal nerve is more informative than that of the tibial nerve. In other words, in the patients with L4-L5 I.D.H. the former can obviously scan the damaged nerve root whereas the latter cannot.

As far as the maximum conduction velocity was concerned, there was no difference between the patients with I.D.H. and normal subjects. On the other hand, the minimum conduction velocity showed a marked prolongation in the patients. From these results it is inferred that the damage occurred in the smaller rather than larger motor nerve fibers.

The mechanism as to how the prolongation occurs needs further investigation.

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