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Case report

Are nerve conduction studies altered in functional neurological disorders?

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ABSTRACT

Background: Functional neurological disorders represent conditions without a readily identifiable origin or laboratory-supported diagnostic. We report a case of functional neurological disorder, presenting with muscle weakness with alterations in F-waves on the affected side.

Case report: A retrospective case review of a patient seen in clinic. Electrophysiological evaluation included nerve conduction studies, including recording of F-waves in lower limbs, and needle EMG. A patchy sensory loss and unilateral muscle weakness of the left lower limb persisted nine days after a 40-year-old female patient developed bilateral lower limb weakness following a laparoscopic surgery. MRI was negative for radicular compression, myelopathy, or lumbosacral plexopathy. F-waves of the peroneal and tibial nerves on the left were absent or of reduced persistence and amplitude compared to the asymptomatic right side.

Significance: The observation of unilateral alterations of F-wave parameters could be interpreted as an asymmetrical decrease of alpha motor neuron excitability on L4 – S2 segments. In the absence of peripheral nervous system dysfunction or a structural lesion, the results here suggest a central control dysfunction or point to a more complex peripheral role. Further research is necessary to determine the frequency of these findings in a larger group of patients while incorporating other late responses, such as H (Hoffman) reflex, and measures of cortical excitability.

1. Introduction

Functional neurological disorders (FND) represent an increasingly frequent cause of disability and reduced independence; primary FND and functional symptoms overlapping with other neurological diseases are diagnosed in 5% and 30% of cases, respectively (Stone et al., 2010). Functional magnetic resonance imaging (fMRI) studies have suggested impaired top-down regulation of action selection, but pathophysiology of FND is still debated (Voon et al., 2011). Establishing the correct diagnosis is often delayed, leading to unnecessary, costly and iatrogenic consequences. In clinical practice, functional muscle weakness (also referred to as motor conversion disorder, dissociative motor disorder or 'psychogenic' paralysis) describes genuinely experienced paralysis in the absence of neurological disease, manifested by classical symptoms such as: Hoover's sign, hip abductor sign, drifting without pronation, dragging gait, or give-way weakness and co-contraction (Stone et al., 2010). However, the diagnosis of motor FND is not always straightforward; consequently, electrophysiology plays an important role in the differential diagnosis in patients with various patterns of muscle weakness that mimic peripheral or central nervous system disorders. Patients with FND are referred for electrophysiological evaluation, often at the onset of symptoms. The examiner's role is then to exclude any possible pathology that could explain the weakness and to demonstrate the overall integrity of the neural pathway, consistent with the overall clinical picture, in support of a diagnosis of FND. To illustrate the alterations in late responses in FND, we report a case with functional unilateral muscle weakness examined with electrophysiological studies.

2. Case report

A retrospective review of a case included collecting medical history and a clinical examination. The electrophysiological studies were performed using a Viking apparatus (Nicolet, Madison, Wisconsin, USA). Sensory and motor nerve conduction studies were performed using standard procedures. Bandpass filters were set to 2–10 kHz. Supramaximal stimulation was applied to obtain F-waves of peroneal and tibial nerves with a standard setup as with

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compound muscle action potentials (CMAP) recordings with cathode more proximal. At least ten stimulations were performed, the number was decreased if the patient did not tolerate further stimulation. F-wave latency was recorded as the minimal latency of responses obtained. The stimulation rate was 0.5 Hz. F-wave persistence was considered as the number of F-waves obtained per number of recordings. The CMAP and F-wave amplitudes were those of the negative peak.

We report the case of a 40-year-old female patient with a medical history of migraines and depression that was transferred to the Neurology department of Geneva University Hospitals nine days after laparoscopic surgery for endometriosis. After the intervention, the patient reported bilateral leg weakness associated with a decrease in sensation in the left thigh. Motor function of the right leg recovered within a few hours; however, the weakness and hypoesthesia, not respecting dermatomal distribution of the contralateral lower limb, persisted. Bowel and bladder function was normal. On neurological examination, severe weakness on the left with a muscle strength of 1–2/5 in proximal and distal muscle groups on the Medical Research Council (MRC) scale was observed, with normal and symmetric tendon reflexes without pyramidal signs, in addition, with non-efficient muscle contractions during the effort to initiate movement, Hoover's sign, and discordance between the muscle strength testing in the supine and upright positions. Moreover, sensory testing revealed a patchy sensory deficit, atypical for radicular or peripheral nerve distribution. MRI was negative for radicular compression, myelopathy, or lumbosacral plexopathy. Nine days after the onset of symptoms, sensory and motor NCS in the lower limbs were normal and symmetric. Surprisingly, F-waves of the peroneal (*m. tibialis anterior*) and tibial (*m. abductor hallucis*) nerves on the left were of reduced persistence and amplitude, compared to the asymptomatic right side. F-waves of the peroneal nerve recording from *m. extensor digitorum brevis* were absent on the symptomatic side (Table 1 and Fig. 1). Needle EMG did not reveal any denervation potentials in the L2-S2 myotomes. Based on clinical and paraclinical findings, FND (somatoform disorder) was diagnosed.

3. Discussion

We observed changes in late responses that can be influenced by alterations at the level of the central nervous system. The obser-

Table 1
Nerve conduction studies and F-wave parameters.

Nerve stimulated – response from the muscle recorded	Distal latency, ms		CMAP amplitude, mV		F wave-parameters							
					Latency, ms		Persistency Number of recordings/number of waves obtained		Amplitude minimal/maximal, μV		Amplitude, mean, μV	
	L	R	L	R	L	R	L	R	L	R	L	R
Tibial nerve – *m. abductor hallucis*	4.2	3.3	18.4	15.0	50.1	45.3	12/15, 80%	9/9, 100%	8.3/41.5	16.6/141.1	23.3	71.1
Peroneal nerve – *m. extensor digitorum brevis*	4.5	4.2	5.8	5.7	NR	43.1	NR	4/15, 27%	NR	17.4/26.1	NR	22.9
Peroneal nerve – *m. tibialis anterior*	2.4	3.1	6.0	5.3	29.5	28.2	2/16, 12.5%	9/16, 56%	9/18	16/64	13.5	37.3

Abbreviations: CMAP, compound muscle action potential; L, left; R, right; NR, no response.

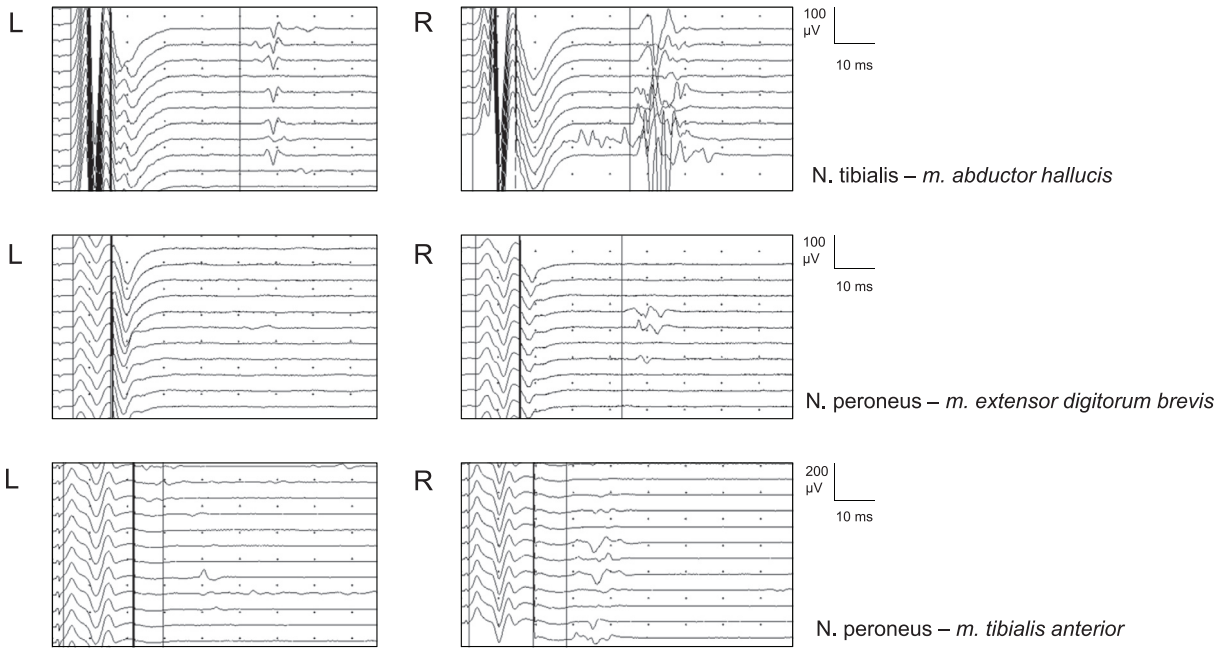

Fig. 1. F-wave recordings of the left (affected) and right (unaffected) lower limb nerves.

vation of a unilateral decrease of F-wave persistence and amplitude could be interpreted as an asymmetrical decrease of alpha motor neuron excitability on L4 – S2 segments, possibly mediated by the descending inhibitory pathway in the absence of peripheral nervous system dysfunction or structural lesion. Examples of how central nervous system activity influences the generation of F-waves can be seen through the suppression of F-waves by altered levels of consciousness or with general anaesthesia. Another external factor that can significantly alter F-waves is the prolonged immobilization of a limb in healthy individuals, where F-wave persistence and amplitude are immediately restored following muscle contraction. In the absence of volitional drive for a few hours, the anterior horn cells become hypoexcitable when tested by antidromic invasion, including F-waves by backfiring. Interestingly, peripheral input could also have an effect on alpha motor neuron excitability in the absence of proprioceptive signals from muscles and joints (Taniguchi et al., 2008). Although we cannot exclude the possibility that a lack of mobility itself could have triggered the observed changes in our case, in experimental studies, these findings were only evident in corresponding segments, associated with the immobilized muscle, and did not distribute to further territories (Taniguchi et al., 2008). As demonstrated by Zimnowodzki and colleagues (2020), F-waves in a weak limb could be recovered after a 1-second burst of repetitive 20 Hz stimulation, that further supports the hypothesis of decreased motor neuron excitability triggered by a prolonged period of reduced mobility.

In addition, a link between cortical activity and F-wave parameters is further illustrated in motor imagery studies. Motor imagery (MI) is a window into cognitive motor control, including primary somatosensory and motor areas (Munzert et al., 2009). Activation of synaptic networks controlling the preparation and execution of movements has a direct effect on F-wave parameters. Bunno (2018) showed that MI has an exhaustive effect with time on alpha motor neuron excitability: F/M amplitude ratios and persistence significantly increased over baseline at 1 and 3 min(s) after MI but decreased after 5 min. Thus, in cases of FND, dysfunction of MI networks could result in impaired movement initiation.

As a decrease of F-wave persistence can be observed in limb immobilisation, in healthy volunteers (Taniguchi et al., 2008), here we propose that in functional weakness alterations of the F-wave parameters could also exist. These electrophysiological findings are important to know especially in very early diagnosis of FND that mimics peripheral injury. Our patient did not have complete paresis, there were voluntary muscle contractions and attempts of initiating the movement against gravity. Nevertheless, we think that more comprehensive studies are needed in this population, incorporating other late responses, such as H (Hoffman) reflex, repetitive stimulation, as well as measures of cortical excitability in a standardized, formal setting.

In summary, F-waves are a robust marker for peripheral nervous system dysfunction, providing an important insight in mono- and polyneuropathies, radiculopathy, plexopathy or motor neuron disorders, but they also can be altered by activation or inhibition of central (cortical) function. Thus, F-wave alterations in patients with FND may indicate central control impairment or point to a more complex peripheral role for a central disorder.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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