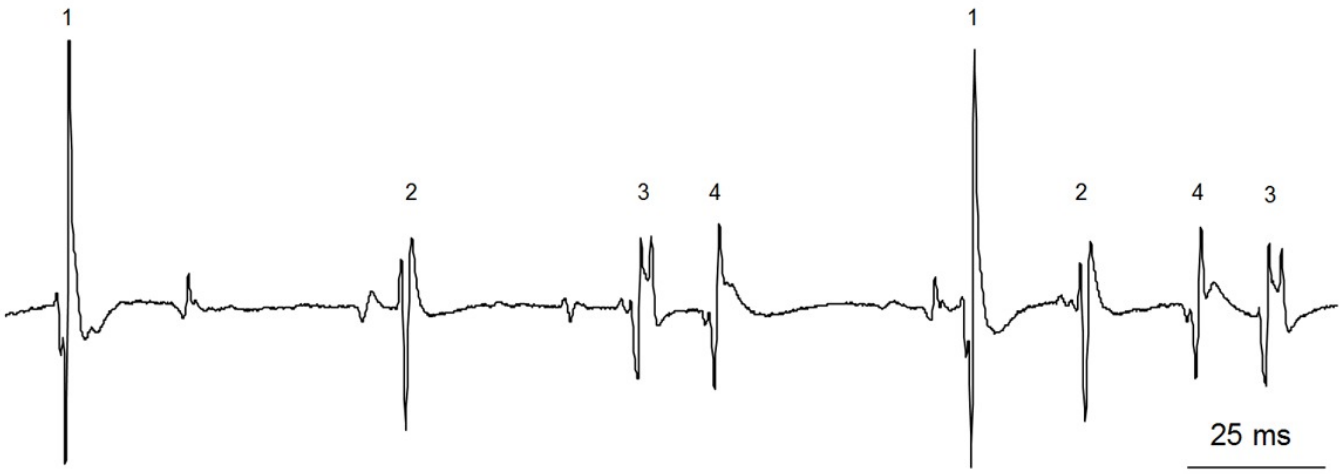
What is injured: motor neuron or motor nerve?

All movements, whether simple or very complex (ballet dancing, playing the piano, speaking) are the results of the complex interaction between nerve cells (neurons) from different departments of the brain. But the final arbiters of movement patterns are motor neurons (motoneurons) of the spinal cord that have one main function: possessing of input information obtained from great number other neurons and producing output trains of nerve impulses that control contractions and relaxations of muscles.

Motoneurons are unique since they are the only neurones whose firing patterns can be recorded in humans. It is possible because motoneuronal firing is normally transmitted by motor nerves (axons) to muscles in the “one to one” fashion, without any pattern distortion. Therefore, firing of each motoneurone can be recorded from those muscle fibers that it controls (from so called the “motor unit”). In the Figure, example of firing of four motor units presenting firing of four motoneurons during a gentle voluntary contraction of a hand muscle is shown. This unique method allows to investigate and to understand, little by little, how the brain controls natural movements.



However, in neuromuscular diseases, axons themselves can generate spontaneous discharges (“fasciculations”) without motoneuron controlling that can result in movement disturbances. Moreover, at some diseases, motoneurons, in one’s turn, can become uncontrolled by other brain departments and produce fasciculations as well. And then a question arises of whether or not the axonal and motoneuronal fasciculations could be distinguished and what are criteria for their differentiation. This important but rather difficult question remains still without the exact answer.

A promising criterion based on the analysis of fasciculation firing pattern was recently suggested in the clinical literature. Here, it is necessary to say about one particular characteristic of motoneurone firing, about its surprising short intervals between impulses measured in milliseconds (ms). So, it was reported that two types of fasciculations have been observed, for example, in

amyotrophic lateral sclerosis that leads to severe disability and often premature death. One fasciculation type displayed preferred intervals between impulses around 80 ms, suggesting motoneuronal origin of fasciculations, whereas the second type included fasciculations with intervals of approximately 5 ms, providing an evidence for their axonal origin, as was concluded by the authors. However, this point is in sharp contradiction with direct findings from animal experiments in which firing with intervals as short as 3-5 ms (so called “doublets”) were recorded in motoneurones. To clarify this contradiction, special investigations analysing characteristics of firing evoked in motoneurons and their axons in healthy humans were necessary. The question was explored in our study.

First of all, we analysed of motor unit firing elicited by voluntary muscle contractions (i.e., firing originated in normal motoneurones), searching doublets, so scarce in healthy humans. Then, using the special methods of the stimulation of motor units and special methods of the estimations of their firing behavior, we evoked doublets originated either in a motoneurone or in its axon and compare their intervals. Many muscles were investigated, but it is appears that the significant difference between motoneuronal and axonal doublet intervals was absent. Thus, the only possible conclusion is that the doublet interval *alone,* unfortunately, cannot be the reliable criterion for the axonal firing origin, including fasciculations; additional evidences are needed for this conclusion. One of such evidences was suggested in our report.

To sum up, the knowledge obtained by scientists exploring problems of the movement control in normal gives a chance to hope that the genesis of neuromuscular disorders can be recognized.

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