Conduction block in frog isolated sciatic nerve–gastrocnemius muscle preparation due to electromagnetic stimulation

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Electromagnetic stimulation of the nervous tissue has been studied by many workers (Kolin et al., 1959; Oberg, 1973; Polson et al., 1982). So far, the stimulatory effects of electromagnetic fields have been reported, but there is no reference to the inhibitory effect and to the orientation of the nerve trunk within the stimulating coil. In the present study, the effect of intermittent electromagnetic stimulation on nerve conduction was studied in the frog sciatic nerve–gastrocnemius muscle preparation.

The nerve trunk was placed longitudinally inside a 100-turn induction coil (copper wire, 0.5 mm diameter and 0.6 Ω resistance). The induction coil was wound on a PVC tube (internal diameter 2 mm). The nerve trunk was moistened with Ringer's solution and the gastrocnemius muscle lay outside the coil in an organ bath containing 80 ml of Ringer solution at room temperature. A pair of stimulating electrodes was placed on a portion of the nerve trunk, lying just outside the coil, nearest to the cut end of the nerve, and the nerve trunk was stimulated repetitively, at a constant rate of 0.5 Hz with 0.25–0.6 V (supramaximal) and 1 ms pulse duration. The induction coil was connected to a d.c. source (1.5–4.0 V), via a make-and-break switch, and current was induced at various frequencies (1–100 min⁻¹) and durations (20–120 s). The effect of this induced current on nerve conduction was assessed by analysing the amplitude of the twitch contractions, induced by repetitive electrical nerve stimulation, and these were recorded isometrically, using a force transducer and a pen recorder.

In the control experiments, with no induced current, repetitive electrical nerve stimulation produced twitch contractions (3.5 ± 0.15 g tension, mean ± s.e.m., n = 10) in the frog gastrocnemius muscle. When a current (from a d.c. source of 1.5 V, at a frequency of 100 min⁻¹) was passed through the coil, the twitch contractions were completely abolished in 40 ± 3 min. The inhibition was frequency and voltage dependent; complete inhibition occurred at a frequency of 100 min⁻¹ and voltage of 1.5 V. Increasing voltage to 4.0 V caused an immediate initial contraction (5.5 ± 0.22 g, n = 6), followed by a complete inhibition of the twitch contraction. Recovery of the twitch contractions was achieved in 1 min after cessation of the induced current. In four experiments, the temperature of the fluid bathing the nerve trunk was measured. It was found that the temperature was increased by 10–12°C above the room temperature in 6–7 min intermittent stimulation. However, this effect was reversible upon cessation of stimulation. There was no significant change in the pH of the solution after magnetic stimulation. In conclusion, electromagnetic induction can inhibit impulse conduction in frog sciatic nerve–muscle preparations. This effect could be due to interference by the induced (magnetic) currents with the ionic fluxes across the nerve membrane, thereby inhibiting propagation of the nerve action potential. Experiments are in progress to analyse the mechanisms involved in the inhibition of conduction by electromagnetic stimulation in the frog sciatic nerve–muscle preparation.


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