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ROLE OF MUSCLE RECEPTORS CONNECTED TO NONMEDULLATED FIBRES IN REFLEX HYPERVENTILATION

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Experiments using electrical stimulation of different groups of muscle afferent nerve fibres have shown that most of the known medullated fibres in muscle nerves are involved in reflexly stimulating ventilation (Bessou et al. 1959, Koizumi et al. 1961, Senapati 1966). Investigations using natural stimulation of muscle receptors and passive limb movements (Kao et al. 1963, Senapati 1966, Kalia et al. 1972) have confirmed these results. From available histological evidence it is known that one-third of the total number of fibres in muscle afferent nerves are non-medullated fibres (Ranson and Davenport 1931). The role of this component of muscle nerves in the reflex hyperventilation of muscular exercise remains to be established.

Accordingly, an attempt was made to study the reflex ventilatory effects of stimulating the receptors connected to non-medullated fibres when the activity in the endings of all medullated fibres had been blocked by repetitive antidromic stimulation (Paintal 1959, 1961).

These experiments were carried out on dogs anaesthetized with sodium pentobarbitone (30-35 mg/kg, intraperitoneally). The experimental arrangements for recording ventilation ($\dot{V}_E$), stimulating the lateral gastrocnemius nerve, preparing the muscle for natural stimulation and fixing the limbs were similar to those described earlier (Senapati 1966, Kalia et al. 1972).

The sensory muscle receptors were blocked by stimulating electrically the fibres of the lateral gastrocnemius nerve repetitively as described by

Paintal (1960), so that the endings were depressed owing to antidromic stimulation (Paintal 1959). Since the frequency of stimulation used was 200/sec, the endings not only remained unresponsive during the period of stimulation but if any impulses were produced peripherally at the ending these were not conducted centrally owing to collision with the antidromic impulses. By raising the strength of stimuli by different multiples of the threshold, it was therefore possible to block endings connected to different groups of medullated fibres. Figure 1 is a diagrammatic representation of the blocking technique.

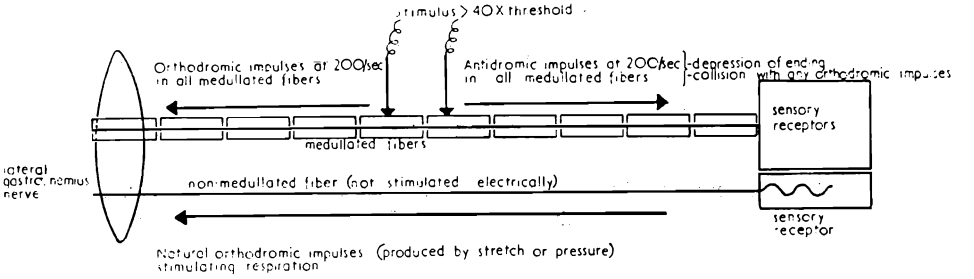

Fig. 1. Schematic diagram showing the basic principle underlying the method of antidromic block used for studying the reflex ventilatory effect of impulses generated by certain muscle receptors (in this case receptors with non-medullated fibres) and not in others (in this case, all receptors with medullated fibres in the lateral gastrocnemius nerve). This was made possible by depressing the sensory receptors of medullated fibres by antidromic impulses at 200 shocks/sec. These impulses also served to collide with (and thereby extinguish) any occasional impulses that might be generated at the sensory ending during strong natural stimulation.

Ventilatory responses to repetitive stretch and repetitive squeezing were then studied with the different muscle receptors thus blocked. The repetitive stimulation used to produce the differential antidromic block always increased $\dot{V}_E$. When, in addition to stimulating the nerve electrically natural stimulation of the muscle was done, $\dot{V}_E$ increased still further. This further increase in $\dot{V}_E$ was still seen when the antidromic block was done with a stimulus 40 times the threshold strength, which is known to excite all Group III fibres (Paintal 1960). Figure 2 illustrates a typical experiment. The V_E during natural and electrical stimulation is expressed as a percentage of the steady base line level it reached during electrical stimulation alone. The results obtained in 10 other dogs were qualitatively similar. This increase in $\dot{V}_E$ was not due to an increase in oxygen consumption since there was no further increase in oxygen consumption during application of natural stimuli.

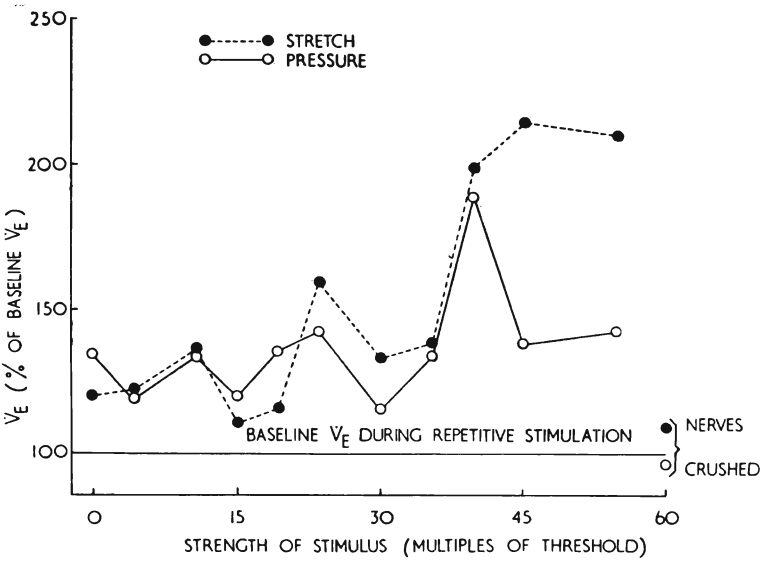

Fig. 2. Effect on ventilation of stretching the gastrocnemius muscle or squeezing it locally 60 times/min while the lateral gastrocnemius nerve was stimulated repetitively at 200/sec at various strengths so as to block endings of certain fibres. The ventilation ($\dot{V}_E$, ordinate) is expressed as a percentage of the baseline ventilation recorded during repetitive stimulation but before application of pressure or stretch. The strength of the electrical stimulus (abscissa) is expressed as multiples of threshold for motor fibres.

The results obtained using the repetitive antidromic blocking method establish that there are endings in muscle connected to non-medullated fibres which are stimulated by pressure and stretch and that stimulation of these endings produces a reflex increase in ventilation.

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