J. Physiol. (1938) 93, 86–89 612.893:612.816.3

THE TRANSMISSION OF IMPULSES BY GANGLIONIC DIRECT FIBRES

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(*Received* 24 *January* 1938)

Obrador & Odoriz [1936] have described a blocking of impulses, or "inhibition" occurring in the direct fibres of the fifth lumbar ganglion, i.e. the fibres which traverse the ganglion without synaptic relay, as indicated by a decrease in the amplitude of the spike potential of a second volley following a similar volley at intervals from 100 to 600 msec. Since the fifth lumbar ganglion possesses a number of collaterals from these direct fibres, synapsing with cells which send their postganglionic processes into the grey ramus, it was suggested that the "inhibition" might be susceptible of a similar explanation as that advanced by Barron & Matthews [1935] in the interpretation of intermittent conduction in the spinal cord, i.e. that it could be brought about by an electrotonic block at the collateral junction, the source of the electrotonic potential being, presumably, the ganglion cells in anatomical or synaptic relationship with the collateral.

In the inferior mesenteric ganglion, which resembles the fifth lumbar ganglion in possessing direct fibres with collaterals [Lloyd, 1937], no alteration of the spike potential recorded from the direct fibres has been observed, providing the stimulus interval is greater than the relatively refractory period of the fibres. Because of this discrepancy, it was decided to reinvestigate the conditions of transmission by the direct fibres of the fifth lumbar ganglion. In addition the sixth lumbar ganglion has been similarly investigated.

Method

Cats have been used, sixteen in all. Twelve were examined after decerebration and four under the influence of nembutal (40 mg./kg.). After preliminary exposure of the sympathetic chain in the lumbar

region, interganglionic stretches of the chain were isolated for the placing of stimulating and recording electrodes. The ganglion itself was left undisturbed to avoid damage to the blood supply. Break shocks from coreless coils timed by a Lucas pendulum were applied to the chain, the potentials being recorded beyond the ganglion by means of R.C.

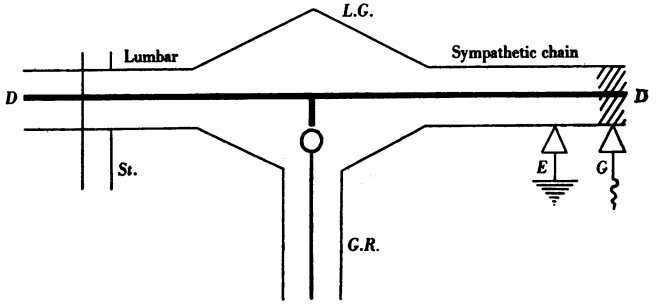

Fig. 1. A diagram of a lumbar ganglion to show the position of stimulating and recording electrodes in relation to the ganglion and direct fibre system traversing the ganglion. Other conduction pathways have been omitted for simplicity. *L.G.* lumbar ganglion; *G.R.* grey ramus; *D*, direct fibre with collateral; *St.* stimulating electrodes; *E* and *G*, earth and grid amplifier leads.

coupled amplifiers and cathode-ray oscillograph. Fig. 1 shows the position of stimulating and recording leads in relation to the ganglion and the direct (*D*) fibre system traversing the ganglion.

Results

As Obrador & Odoriz have shown, a maximal volley applied to the lumbar sympathetic chain gives rise to two distinct spike potentials (*A* and *B* in their terminology) in the chain beyond a ganglion. This is true, not only with the fifth lumbar ganglion, but also with the sixth lumbar ganglion. These spikes have been renamed in the present paper in accordance with the unified system of nomenclature suggested in a previous paper [Lloyd, 1937]. Thus the *A* and *B* spikes as recorded from the chain itself may be called the *D* (direct fibre) spike and the *S* (synaptically relayed) spike respectively (cf. Fig. 2). However, it must be noted that some of the second (*S*) spike is due to direct fibres of slower conduction. It is thus a combined *D* and *S* spike.

In the present experiments submaximal, maximal and supramaximal volleys were applied to the lumbar sympathetic chain in various combinations and with various stimulus intervals. Fig. 2 shows part of the series of observations in each of two experiments, employing volleys

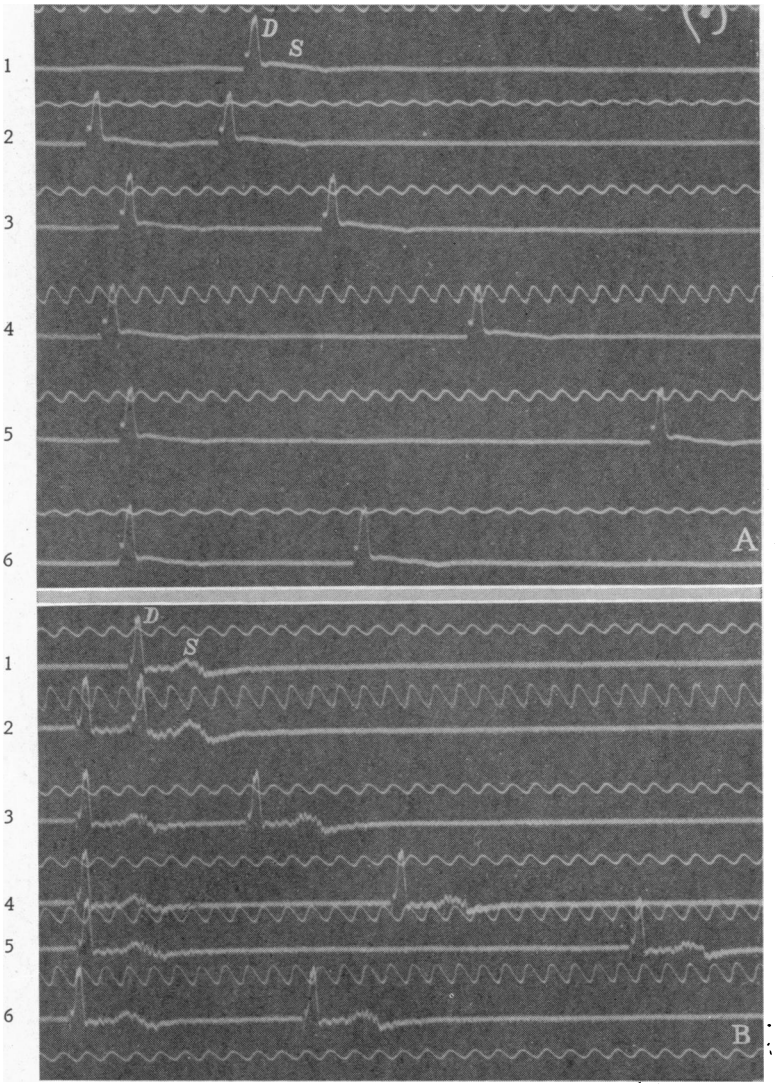

Fig. 2. (A) Action potentials of *D* fibres in the fifth lumbar ganglion evoked by two volleys just maximal for the *D* fibres. Stimulating electrodes on the lumbar sympathetic chain above the ganglion. Recording leads on the chain below the ganglion. (B) A similar experiment, but for the sixth lumbar ganglion. Further explanation in text. Time: 1 d.v. = 10 msec.

just maximal for the *D* spike, the potentials being recorded from the chain beyond the ganglion as indicated in Fig. 1. In Fig. 2A the fifth lumbar ganglion has been used, obs. 1 being the potential from the testing volley alone, obs. 2–6 being the potentials from the two volleys in succession, the intervals varying from 58 to 228 msec. In Fig. 2B a similar experiment on the sixth lumbar ganglion is illustrated, obs. 1 being the control potential from the testing volley alone, while obs. 2–6 are the potentials from the two volleys in succession at intervals from 22 to 233 msec. In both experiments the amplitude of the *D* spike from the testing volley is unaltered throughout the range of stimulus intervals. This has been a constant finding with all combinations of volleys and intervals, provided the interval was sufficiently long to avoid relative refractoriness. It may be concluded that, under the conditions of the present experiments, it is impossible to demonstrate the "inhibition" of direct fibres described by Obrador & Odoriz. Thus the presence of a collateral does not affect the transmission of impulses along the main preganglionic axone traversing a ganglion in any way that can be demonstrated by the present technique. The observations shown in Fig. 2 do not extend over the whole range of intervals at which the blocking effect might occur *ex hypothesi*, but they do include the theoretical optimal region, 50–200 msec., assuming that the rapid appearance and disappearance of electrotonus at a point some distance from the potential source, as described by Bogue & Rosenberg [1934], would obtain in this special case.

SUMMARY

Under the usual conditions of ganglion experiments, it has been impossible to demonstrate "inhibition", or blocking of impulses in direct fibres of the inferior mesenteric ganglia, the fifth or the sixth lumbar ganglia of the cat.

The author wishes to thank Dr J. C. Eccles for suggesting this work, and Dr Donald G. Marquis for his valuable co-operation in the experiments performed in Oxford, and to express his gratitude to the Christopher Welch Trustees for defraying the cost of photographic plates used in Oxford.

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