NATURE OF RHYTHMIC DISCHARGES IN VENTRAL SPINAL ROOTS

V. V. Lisin, L. N. Sergeeva,
and S. I. Frankshtein

UDC 612.819.94"5"

After recording rhythmic discharges in the ventral spinal roots Perret and co-workers postulated the existence of a special "locomotor pacemaker." The present writers showed that the "locomotor discharges" discovered by Perret and co-workers increase during asphyxia and disappear during apnea. Rhythmic discharges in the ventral roots thus depend on the irradiation of excitation from the respiratory center and they cannot be evidence of the existence of a special locomotor pacemaker.

KEY WORDS: ventral roots of the spinal cord; respiratory center; asphyxia; hyperventilation apnea.

Comparatively recently Perret and co-workers [2] made the following interesting observation. In animals immobilized completely by flaxedil they recorded discharges in rhythm with striding movements in the ventral roots of the lumbosacral division of the spinal cord. On this basis they postulated the existence of a special suprasegmental pacemaker for the spinal mechanism of striding movements.

It was natural to suggest that, in accordance with the Orbeli–Kunstmann phenomenon [1], the discharges recorded by these workers in the ventral roots are the result of irradiation of excitation from the respiratory center to the spinal mechanism of striding movements. To test this hypothesis, parallel recordings had to be made of activity in the ventral roots and discharges in the phrenic nerve. If the hypothesis is correct these discharges ought to correspond to each other. If the discharge of the respiratory center were increased (in asphyxia), discharges in the ventral roots ought also to be increased. If discharges from the respiratory center are prevented (by hyperventilation), the discharges in the ventral roots ought also to stop.

The hypothesis mentioned above was verified in the investigation described below.

EXPERIMENTAL METHOD

Cats were decorticated by Khananashvili's method. The phrenic nerve of the animal was mobilized, divided, and its central end was placed on bipolar recording electrodes. Laminectomy was performed, the dorsal roots from S_1/L_6 were divided, and the ventral roots from S_1/L_6 also were divided, separated into filaments, and placed in bipolar recording electrodes. Two hours after the administration of ether ceased the animal was immobilized with flaxedil (4-5 mg/kg) and artificially ventilated through a tracheostomy. The respiratory volume of the pump was 25-30 ml and its frequency 30 strokes per minute. Asphyxia was produced by stopping the artificial ventilation for 2-3 min. Hyperventilation was produced by increasing the respiratory volume to 50-60 ml. Electrical activity of the phrenic nerve and of the filaments of the ventral roots was recorded on a two-channel electromyograph. Altogether eight experiments were carried out.

Laboratory for Compensation of Disturbed Functions, Institute of Normal and Pathological Physiology, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR A. M. Chernukh.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 80, No. 12, pp. 9-10, December, 1975. Original article submitted October 9, 1974.

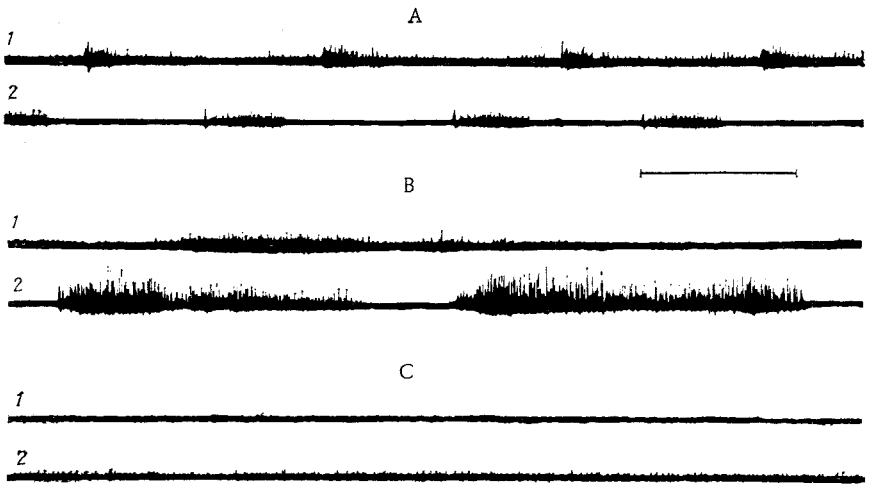

Fig. 1. Relationship between discharges in phrenic nerve and in ventral spinal roots: A) normocapnia; B) hypercapnia; C) hypocapnic apnea. 1) Record from filament of ventral spinal root; 2) from phrenic nerve. Calibration 2 sec for all records.

EXPERIMENTAL RESULTS AND DISCUSSION

Discharges in the filaments of a ventral root of the lumbar spinal cord (1) and phrenic nerve (2) are shown in Fig. 1A, B, and C. Record A was obtained during normal ventilation of the lungs or with a slight ventilation deficit. As Fig. 1A shows, the discharges in the ventral roots corresponded strictly in time to discharges in the phrenic nerve and they appeared in the interval between the phrenic discharges. In other records discharges appeared in the ventral roots synchronously with the phrenic discharges or at their end. These time relationships as a rule were constant for each filament.

Record B was obtained during asphyxia caused by stopping the artificial ventilation of the lungs for 2-3 min. Corresponding with the asphyxia the discharges in the phrenic nerves became stronger and more prolonged and the intervals between the volleys were reduced. Discharges in the filaments of the ventral roots changed in the same way. They became longer and stronger, but the temporal relations between them and discharges in the phrenic nerve remained the same. In deep asphyxia the discharges in the ventral root disappeared whereas those in the phrenic nerve were still quite well defined.

Record C was obtained during hyperventilation. To correspond to the increasing hypocapnia the discharges in the phrenic nerve were depressed (hyperventilation apnea). Meanwhile, activity in the ventral root also was depressed.

These observations suggest that the rhythmic discharges recorded in the ventral roots are in fact the result of irradiation of excitation from the respiratory center to the spinal mechanism of striding movements. They are strengthened when discharges from the respiratory center are strengthened and they disappear when discharges from the respiratory center are prevented. The observations of Perret and co-workers [2] evidently cannot be regarded as proof of the existence of a special supraspinal locomotor pacemaker.

LITERATURE CITED

1. L. A. Orbeli, Lectures on Physiology of the Nervous System [in Russian], Leningrad (1935).
2. C. Perret, M. Mullenvage, et al., J. Physiol. (Paris), 65, No. 1, 153A (1972).