ELECTROPHYSIOLOGICAL AND CHEMORECEPTIVE CHARACTERISTICS OF PONTOMEDULLARY AND THALAMIC NEURONS DURING ONTOGENETIC DEVELOPMENT

K. V. Shuleikina, V. V. Raevskii, and O. S. Raevskaya

Spontaneous and evoked activity of reticular neurons in the medulla, pons, and ventrobasal complex of the thalamus was studied in 54-65-day cat fetuses and kittens aged 1-60 days. Responses to microionophoretic application of noradrenalin, acetylcholine, and glutamate were studied. In the fetuses 63% of pontine cells and 92% of medullary cells were spontaneously active. The largest number of evoked responses (60% in the fetuses) was observed to stimulation of the tongue. Repetition of the stimulation facilitated discharges in the intertrial interval, and this effect was particularly marked in the early stages. Sensitivity to noradrenalin and glutamate in the fetuses was maximal (87 and 70%, respectively), and to acetylcholine minimal (43%). With increasing age, the number of neurons sensitive to noradrenalin decreased, the number sensitive to acetylcholine increased, and the number sensitive to glutamate remained unchanged. It is concluded that synaptic processes in the early stages are effected mainly through adrenergic and glutamate transmission.

INTRODUCTION

The reticular structures of the medulla and pons play an important role in the integrative processes of the developing brain. This is because the first movements of the embryo are controlled by reticulo-motoneuronal projections [13, 14, 28]. Reticular influences on the spinal motor system in the very early stages take place on account of adrenergic mechanisms [15].

The object of this investigation was a closer study of the electrophysiological characteristics of reticular neurons at stages of prenatal and early postnatal ontogeny, study of the chemoreceptive properties of these cells in relation to various mediators, and discovery of whether predominant sensitivity to noradrenalin is a distinguishing feature of reticular cells only, or whether in early stages of development it is characteristic of neurons of other structures also. For this purpose some experiments were carried out on thalamic neurons.

EXPERIMENTAL METHOD

Experiments were carried out on 54-60-day cat fetuses and on kittens aged 1-60 days. The age of the fetuses was determined from the tables of Scott et al. [24], on the basis of the weight of the fetus and its crown-rump length. For experiments on fetuses, a pregnant cat was immobilized with diplacin* and, under local anesthesia, a fetal head was exteriorized through an incision in the abdominal wall and uterus, while the body of the fetus remained inside the uterine cavity, with the placental circulation left intact [15]. In the experiments on kittens the operation was performed under local anesthesia with 0.5% procaine solution. The animals were also immobilized with diplacin.

Unit activity was recorded extracellularly. After the end of the experiment the brain, together with the microelectrode, was fixed in alcohol or formalin and sections were stained by Nissl's method. The orientation of the microelectrode was calculated stereotaxically on the basis of data obtained on brain preparations at comparable times of development. The results of recordings from neurons of the caudal reticular nucleus of

*1,3-di(β-platyneciniummethoxy)benzene hydrochloride.

Institute of Higher Nervous Activity and Neurophysiology, Academy of Sciences of the USSR, Moscow.

Fig. 1. Spontaneous (a, b) and evoked (c) activity of reticular units in cat fetuses and kittens. In a: 1) continuous; 2) grouped; 3) episodic types of spontaneous activity. In b) diagrams showing relative number of neurons with different types of activity (1, 2, 3). Age of kittens (in days) shown under diagrams; age of fetuses 56–59 days. In c) different types of responses (1, 2) to stimulation of tongue. Neurons from region of caudal reticular nucleus of pons (3) and gigantocellular nucleus of medulla (1, 2). Zones of recording indicated in Fig. 6d, e. Calibration: 1 mV, 1 sec.

The pons, the gigantocellular nucleus of the medulla (fetuses and kittens), and the parafascicular complex of the thalamus (kittens) are described. Derivation of unit activity and application of the substances were carried out by means of multibarreled glass micropipets filled with 2M noradrenalin solution, 3M acetylcholine solution, and 1M glutamate solution [16].

For microionophoretic application of the drugs, an apparatus of original construction, designed to compensate the electric current at the tip of the microelectrode, was used. The strength of the electrophoretic current was $8 \cdot 10^8$ to $50 \cdot 10^9$ A, and the recording time 10–60 sec.

Unit activity was recorded on magnetic tape and then reproduced on an ink-writing oscillograph with 1:3 reduction of the film winding speed.

Electrical stimulation of the tongue, forehead, and the region of the vibrissae through needle electrodes, with square pulses 0.5–1 msec in duration and a voltage of 5–10 V, was used as peripheral stimulation. The results of statistical analysis of the data are shown as histograms. Data obtained by the investigation of 37 neurons in fetuses and 180 neurons in kittens were used.