CHANGES IN CORTICAL UNIT ACTIVITY DURING INHALATION OF VARIOUS CONCENTRATIONS OF ETHER

E. K. Aganyants

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Inhalation of a gas mixture containing 2-3% ether causes initial activation of cortical unit activity followed by depression (but not complete inhibition). Higher concentrations of ether (6 and 12%) slow the frequency of unit activity, lower spike amplitude in a stepwise manner, and cause complete disappearance of action potentials.

* * *

Few pharmacodynamic studies of ether have been made at the level of single units of the central nervous system [3, 4]. To determine the sensitivity of cortical neurons to ether and to examine the physiological mechanism of depression of cortical function during ether anesthesia of changes in neuronal activity must be studied during inhalation of this anesthetic in different concentrations. Because of the current importance of this problem the present investigation was undertaken.

EXPERIMENTAL METHOD

Acute experiments were carried out on 16 adult cats weighing 2.1-3.8 kg. The skull was trephined and tracheotomy performed under nembutal or hexobarbital anesthesia (45-60 mg/kg). Unit activity was recorded from neurons of the sensorimotor cortex by means of glass microelectrodes (external diameter 0.8-1.5 μ) filled with 3M KCl. Microelectrodes were introduced by means of an oil-operated micromanipulator [1]. Potentials were recorded through the cathode follower and amplifier of an "Alver" electroencephalograph on a type ÉMOF-2 CRO.

The ether-oxygen mixture (2, 3, 6, and 12%) was prepared in a Douglas bag immediately before use and administered through the tracheotomy tube. The experiment began 2.5-3 h after the end of the preparatory operation. The initial background activity was observed for 10-30 min while the cats inhaled air or oxygen.

The effect of ether on the activity of 44 neurons was investigated.

Statistical analysis of the experimental data was carried out by the method of direct differences [2].

EXPERIMENTAL RESULTS

The frequency characteristics of action potentials of the cortical neurons were comparatively stable during inhalation of air or oxygen.

Inhalation of an ether-oxygen mixture containing 2 or 3% ether caused changes in background cortical unit activity. The action of ether became apparent in the first 5 min as an increase in frequency of unit discharges (Table 1).

The phase of activation of spontaneous discharges during the action of low concentration of ether (2 and 3%) lasted from 5 to 30 min in individual neurons.

Under the influence of a 6% ether-oxygen mixture depression of the spontaneous activity of most neurons (8 of 13) also took place after transient activation (Table 1). In every case the activity mainly consisted of groups of large numbers of spikes. The unit discharges quickly became exhausted, and a stepwise decrease in amplitude of the spikes was observed. Complete inhibition of unit activity was not ob-

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TABLE 1. Changes in Frequency of Spontaneous Cortical Unit Discharges during Inhalation of Ether ($M \pm m_D$)

Experimental conditions	Initial data	Inhalation				Recovery
		5 min	10 min	30 min	60 min	
Inhalation of 2% and 3% ether	7,6	12,1±1,3 $P<0,01$	11,5±1,5 $P<0,02$	4,6±2,6 $P>0,05$	3,5±2,3	7,0
Inhalation of 6% ether	6,7	13,2±2,9 $P<0,05$	10,0±3,6 $P>0,05$	20± 5 $P<0,05$	3±3,1 $P<0,05$	6,8±2,8 $P>0,05$
Inhalation of 12% ether; neurons with initial increase in frequency of discharges	5,8	25,8±7,8 $P<0,05$	8,1±5,0 $P<0,05$	0	0	4,8±2,8 $P>0,05$
neurons without initial increase in frequency of discharges	12,4	4,6±2,5 $P<0,01$	1,9±3,5 $P<0,05$	0	0	3,7±4,0 $P<0,05$

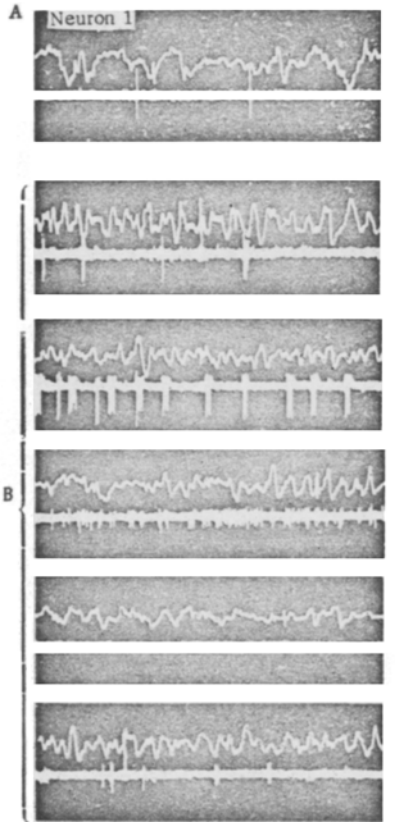

Fig. 1

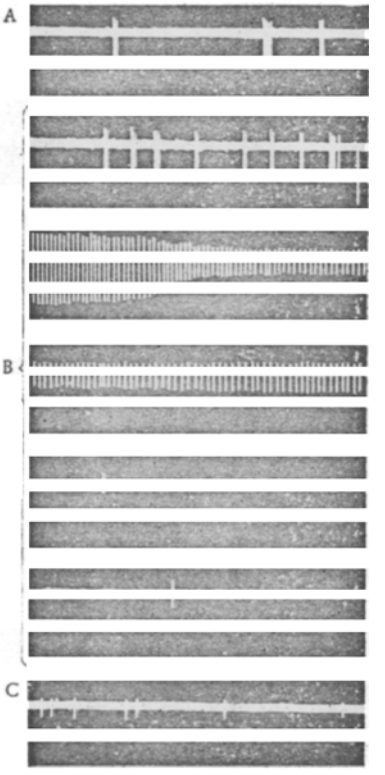

Fig. 2

Fig. 1. Unit activity of motor cortex before (A) and 10, 13, 15, 20, and 30 min (B) after beginning of inhalation of 6% ether-oxygen mixture. From top to bottom: ECoG, unit activity.

Fig. 2. Disappearance of unit activity in motor cortex during inhalation of 12% ether-oxygen mixture. A) Before, B) 3, 5, 6, 7, and 8 min after beginning, and C) 6 min after end of inhalation of ether. ECoG not recorded.

served under these conditions (Fig. 1). Parallel with depression of activity of some neurons, other cortical units began to discharge.

During inhalation of 12% ether the action potentials of 15 neurons (from a total of 19) disappeared in the first 10 min and the potentials of the other four neurons disappeared within 20-25 min after the beginning of inhalation. In 6 cases complete inhibition of unit activity was preceded by a sharp increase in frequency of spikes (Fig. 2). In the other 9 cases the frequency of the spontaneous activity was reduced from the very beginning. The number of active units in the cortex decreased during inhalation of 12% ether; 30 min after inhalation began no active units could be detected in the cortex.

When inhalation of ether was discontinued the cortical unit activity returned to its initial level. After the action of 6% ether, action potentials of individual neurons appeared after 2-18 min, while after inhalation of 12% ether they appeared after 6-45 min.

The results described above show that ether produces regular changes in unit activity in the cerebral cortex. Under the influence of low concentrations (2 and 3%) of the anesthetic action potentials of the neurons are not depressed. In the initial period of ether action a phase of activation of unit activity takes place. Marked depression of potentials is found when high concentrations (6 and 12%) of ether are inhaled. The activation phenomenon is not a specific response of cortical cells. A. I. Shapovalov [3] observed it in 17% of spinal neurons during ether anesthesia. Spontaneous activity is known to reflect the state of synaptic mechanisms of the neurons and not of the neurons themselves [3]. It is clear that changes in cortical unit activity under the influence of ether may be due to disturbance of the activity of either of these elements or of both together.

LITERATURE CITED

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