Electrographic manifestations (the electrocorticogram — ECoG) of the stages of sleep and waking in the neuronally isolated cortex were studied in freely moving cats. The intensity of the electrographic manifestations of sleep—waking in the isolated cortex depends on the time elapsing after isolation: Whereas they are indistinct in the first weeks, after 4–6 months all stages of sleep and waking found in the normal animal can be recorded in the isolated cortex. The electrographic manifestations during various stages of sleep and waking in the isolated cortex are observed simultaneously with the appearance of the ECoG features of sleep in the opposite, control hemisphere. Of all the stages of sleep and waking, the most variable activity in the isolated cortex is observed in the theta and delta bands, the ways by which "sleep" activity arises in the isolated cortex are discussed.

INTRODUCTION

An important but by no means completely solved problem in the physiology and pathology of the brain is the role of the cortex and subcortical formations in the regulation of sleep. Investigations of some aspects of this problem, such as the role of each of these levels in the regulation of sleep, conducted on the intact brain meet with difficulties. One is that the presence of close synaptic connections between the cortex and subcortical formations makes it necessary to take constantly into account the possibility of electrical interaction between them and, consequently, this prevents the question from being answered unequivocally. Hence the use of an operation [8] to isolate the cortex neuronally by dividing all fiber connections between the cortex and subcortical formations surgically and then studying the electrical activity of the disconnected structures.

On the other hand, the isolated cortex is a preparation which offers new opportunities for solving another important problem, namely the humoral factors which participate in brain responses during sleep and waking.

The neuronally isolated cortex is characterized by a high level of spontaneous electrocorticographic activity, by responses to direct electrical stimulation, by definite spontaneous unit activity, and by various types of responses of its neurons to electrical stimulation of the cortex and ability to form temporary connections when time-coupled paired stimuli are applied to it [1, 9, 13]. Morphologically the isolated cortex preserves its clear stratification with all the cytoarchitectonic features and differences characteristic of normal cortical formations. At all times of isolation so far investigated (from 1 day to 2 years), no significant changes have been observed on staining by Nissl's method in any of the nerve cells except layer V in area 4, where the giant pyramidal cells die [5, 7].

The object of this investigation was to study the electrographic manifestations of the stages of sleep in the isolated cortex at various times after its isolation from the subcortex.

EXPERIMENTAL METHOD

Sixteen adult cats weighing 2.6–3.4 kg were used. The cortex was isolated by Khananashvili's method [8]. Bipolar nichrome electrodes with glass insulation, with a bare tip 100 μ in diameter and an interelectrode distance of 3 mm, were inserted simultaneously into the motor, parietal, and visual regions of the isolated and intact cortex. The reference electrode was fixed in the bones above the frontal sinus. To record the electromyogram of the cervical muscles and electrooculogram stainless steel electrodes were inserted. The sleep...
Fig. 1. Manifestation of wakefulness and drowsiness in isolated cortex during first weeks after operation: a) wakefulness; b) drowsiness manifested in isolated cortex in third week after operation: 1) motor; 2) parietal; 3) visual regions of isolated cortex; 4) intact motor cortex. Periods of isoelectric "silence" in isolated cortex in awakening (c) and drowsy (d) cat during first week after operation: 1) motor; 2) parietal; 3) visual regions of isolated cortex. Calibration: 50 μV, 1 sec.

electrocorticogram (ECoG) of the animals was recorded in the early afternoon, when the cats became drowsy and slept [20], and recording continued for 3–8 h without interruption on an eight-channel electroencephalograph. Each animal was used in the experiment from two to four times at intervals of 1–5 days. The results obtained with a frequency integrator were subjected to statistical analysis by Student’s t test. The completeness of isolation of the cortex was verified morphologically.

Some of the material (results from five animals) was subjected to factor analysis as described previously [2], for which purpose periods of each recording were digitized every second as the frequency during an epoch of analysis of 30 sec in each stage of sleep, after which the matrix of the coefficients of correlation was calculated between all pairs of leads. This matrix was then subjected to factor analysis by the method of chief components. To detect correlation between the leads in all the stages of sleep as a whole, and also to detect interdependence of the various states of sleep in all leads as a whole correlation powers were calculated for each lead in each stage of sleep by the formula $P = \frac{1}{n-1} \sum_{i=1}^{n} r_{ij}$, where $n$ is the number of leads, $r_{ij}$ are coefficients, and $i$ represents the lines of the correlation matrix. In this way, the $n$-dimensional vector of the correlation powers of the features can be obtained from each correlation matrix. The total number $m$ of such vectors for several stages of sleep forms an $n \times m$ matrix, which can be used as an initial matrix of observations, the corresponding matrix of the coefficients of correlation of the powers of the leads and the correlation matrix of the various stages of sleep can be calculated for it, and the method of chief components can be used with respect to each of them.

The matrix of correlation powers was also investigated by biplot analysis using the method of chief components.

All calculations were carried out by Promin'-2 computer.