EFFECT OF PRELIMINARY VIBRATION ON THE COURSE OF ETHER ANESTHESIA AND THE POSTANESTHETIC PERIOD

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Experiments on albino rats showed that vibration (46.6 Hz, amplitude 1 mm, duration 3 h) reduces the functional competence of the CNS and also of the respiratory and circulatory systems. Ether anesthesia after vibration aggravates the state of the animals, 60% of which die in the postanesthetic period. Survival of the animals after exposure to extremal factors (vibration, anesthesia) is determined by the level of resistance of the cerebral cortex.

KEY WORDS: vibration; anesthesia; rat cerebral cortex; respiration; circulation.

An important aspect of anesthesiology is the way in which the course of anesthesia depends on the initial functional state of the patient. As a result of the scientific and technical revolution, vibration, together with other extremal factors acting on the body, plays an important role in various spheres of human activity [1, 6, 8, 9, 12, 13]. The study of the special features of anesthesia preceded by vibration stress is thus of particular importance at the present time.

The object of the experiments described below was to study the course of ether anesthesia and of the postanesthetic period after a single preliminary exposure to vibration.

EXPERIMENTAL METHOD

Acute experiments were carried out on 120 albino rats. Vibration (46.6 Hz, amplitude 1 mm) was created by means of a bench of original design (Efficiency Suggestion No. 230/74). The rats were anesthetized in a poisoning chamber with a capacity of 58 liters for 1 h. The experimental results were subjected to statistical analysis [5] by the Minsk-32 computer.

EXPERIMENTAL RESULTS

In the biological experiments vibration was applied as a single exposure for 3 h. The rats in this case were unrestrained.

Counting the respiration rate showed that the response of the respiratory center to vibration was biphasic. An initial brief period of more rapid respiration was followed by slowing of the respiratory excursions. At the end of vibration, the behavior of the experimental and control animals differed. Whereas the control animals moved actively and responded briskly to external stimuli, the rats exposed to vibration were inhibited and responded sluggishly.

The course of ether anesthesia differed in the experimental and control animals. For instance, during administration of ether 23 of the 50 experimental animals fell asleep 6 ± 2.4 min before the controls. As anesthesia deepened, their respiration was depressed more rapidly.

It was natural to suggest that the changes arising through vibration would be manifested not only during anesthesia but also in the postanesthetic phase. Testing this hypothesis showed that of 50 animals exposed to vibration, 23 died after the end of anesthesia, 12 of them (24%) during the first 14 min, the remaining 11 (22%) on the fifth to seventh days of the postanesthetic period. All the control animals survived.

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TABLE 1. Dynamics of Brain Potentials of Albino Rats under Ether Anesthesia (B) and in Postanesthetic Period (C) after Preliminary Exposure to Vibration (A)

Experimental conditions	Statistical index	Control						Experiment					
		β-waves		α-waves		Δ-waves		β-waves		α-waves		Δ-waves	
		No.	A	No.	A	No.	A	No.	A	No.	A	No.	A
A	*M*	14,83	10,05	6,02	26,33	1,37	53,61	10,72	10,37	5,44	27,97	2,21	74,05
	m	0,8	0,7	0,3	3,0	0,1	5,1	0,6	0,4	0,3	1,7	0,1	6,6
	P	—	—	—	—	—	—	<0,01	<0,5	<0,25	<0,5	<0,002	<0,05
	%	100	100	100	100	100	100	72,2	103,0	90,0	102,2	169,2	138,1
B	*M*	5,4	11,1	4,2	38,2	2,0	91,6	4,4	12,6	2,9	35,6	1,3	84,8
	m	0,7	1,4	0,5	3,3	0,2	4,4	0,6	1,1	0,4	3,1	0,2	11,3
	P	—	—	—	—	—	—	<0,5	<0,5	<0,25	<0,5	<0,25	<0,5
	%	100	100	100	100	100	100	81,4	113,5	69,0	92,9	65,0	92,5
C	*M*	15,1	9,3	4,6	26,3	0,8	42,2	5,0	3,6	1,9	10,6	0,5	21,5
	m	0,4	1,0	0,1	2,8	0,06	5,4	2,0	1,5	0,8	4,5	0,2	8,8
	P	—	—	—	—	—	—	<0,001	<0,02	<0,01	<0,02	<0,5	<0,1
	%	100	100	100	100	100	100	33,1	38,7	41,3	40,3	62,5	50,9

Legend. No) Number of waves per second; A) amplitude of waves, μV

The biological tests thus left no doubt that under these experimental conditions vibration reduced the tolerance of the animals to ether. These experiments showed for the first time that the harmful effect of general vibration on vitally important functions of the body is manifested not only during but also after anesthesia. They also showed that, other conditions being the same, animals respond to vibration differently depending on their individual differences. This was shown by the data given above for the survival period of the experimental animals in the postanesthetic period.

Considering that the cerebral cortex plays the leading role in adaptive reactions [2-4, 10, 11], it was decided to study the effect of vibration on the functional state of the cerebral hemispheres. A special series of observations was made on 20 male albino rats by means of electroencephalography, electrocardiography, and determination of the respiration rate (Tables 1 and 2).

In the initial state the EEG showed predominance of fast β-waves, and after the end of vibration, well-marked slow Δ-waves are present ($P < 0.002$). Meanwhile the respiratory center of the experimental animals was inhibited: The respiration rate was reduced by 30.6% compared with the control ($P < 0.002$). The cardiac frequency showed a tendency to decrease on average by 4% ($P < 0.25$) compared with the control rats. Ether anesthesia caused regular depression of cortical electrical activity of both the experimental and the control animals. Under these conditions differences in the indices of cortical electrical activity between the control and experimental animals were not significant ($P < 0.5$). Differences in the functional state of the respiratory ($P < 0.5$) and circulatory system ($P < 0.5$) likewise were not significant.

Differences in the functional state of the control system and the vitally important functions of respiration and circulation in the control and experimental animals were clearly manifested in the postanesthetic phase. For instance, the EEG of the experimental animals showed marked depression of cortical potentials ($P < 0.001$) and a simultaneous decrease in the amplitude of the β-waves ($P < 0.002$).

Such changes in the control apparatus led to depression of respiration to 33.6 ± 13.8 excursions/min from the control level ($P < 0.001$) and to a decrease in the pulse rate by 58.8% ($P < 0.001$). In six of the ten animals this state of the vitally important functions was incompatible with life: Three rats died during the first 15 min after the end of anesthesia and another three on the fifth to seventh days of the postanesthetic period.

Meanwhile all the control rats, exposed in the same way to ether as the experimental animals, survived. As was postulated, the resistance of the animals exposed to vibration during anesthesia and in the postanesthetic period was directly dependent on the resistance of their cortical electrical activity. In other words, animals in which cortical electrical activity was preserved despite exposure to extremal factors survived, but those whose cortical electrical activity was depressed under the same conditions died.

TABLE 2. Comparison of Functional State of Cardiovascular System and of Respiration of Albino Rats during Ether Anesthesia (B) and in Postanesthetic Period (C) after Preliminary Vibration (A)

Experimental	Statistical index	Control				Experiment			
		respiration rate, excursions/min	ECG			respiration rate, excursions/min	ECG		
			pulse rate beats/min	interval, sec	R wave, μV		pulse rate, beats/min	interval, sec	R wave, μV
A	*M*	111,6	500,0	0,121	204,0	87,6	480,0	0,125	202,0
	m	4,7	11,9	0,004	10,5	4,3	15,2	0,005	15,7
	P	—	—	—	—	<0,002	<0,25	<0,5	<0,5
	%	100	100	100	100	69,4	96,0	103,3	99,0
B	*M*	104,8	406,0	0,156	217,0	101,2	388,0	0,156	195,5
	m	5,8	17,1	0,007	9,2	7,2	22,7	0,009	13,9
	P	—	—	—	—	<0,5	<0,5	<0,5	<0,25
	%	100	100	100	100	96,5	96,0	100,0	91,0
C	*M*	104,0	490,0	0,126	223,5	33,6	198,0	0,048	74,5
	m	3,5	11,2	0,003	7,7	13,8	81,1	0,02	31,9
	P	—	—	—	—	<0,001	<0,01	<0,01	<0,002
	%	100	100	100	100	33,4	41,2	41,7	33,3

Legend. ECG) Electrocardiogram

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