form. This mode of alteration of the oxygen capacity of the blood has not been studied sufficiently.

Together with the main mechanism underlying the gas homeostasis of the organism, a mediated (through the blood) influence of a magnetic field due to changes in the rheological properties of the blood and neurohumoral factors [9,10] is not excluded.

It may be assumed that such a complex influence of several factors accompanying the extracorporeal "magnitizing" of the blood lies at the basis of the effect of a prolonged period of mortal hypoxia endurance.

LITERATURE CITED

1. V. M. Bogomolov, *Vopr. Kurortol.*, No. 4, 2-8 (1981).
2. L. S. Juckson and I. L. Brandt, *Trudy Kazan. Nauchno-Issled. Inst. Klin. Eksp. Khirurgii*, No. 37, 76-80 (1986).
3. B. N. Zhukov, L. A. Trufanov, and S. M. Musienko, *Vopr. Kurortol.*, No. 1, 27-30 (1984).
4. L. D. Klimovskaya, Z. N. Nakhil'nitskaya, and N. P. Smirnova, *Probl. of Kosm. Biol*, **37**, 223- 225 (1980).
5. G. V. Lud, G.V., *Zdravookhr. i Belorussii*, No. 8, 47-49 (1986).
6. Z. N. Nakhil`nitskaya, *Probl. Kosm. Biol.*, **37**, 116-124 (1978).
7. Yu. A. Novikov, *Anesteziol. Reanimatol.*, No. 3, 21-23 (1982).
8. V. L. Semenov, *Patol. Fiziol.*, No.1, 56-61 (1987).
9. L. I. Tyvin and V. A. Gusel, *Byull. Eksp. Biol.*, No. 9, 29-31 (1985).
10. Yu. A. Kholodov, Magnetism in Biology [in Russian], Moscow (1970).
11. M. M. Yakovleva, Physiological Mechanisms of the Effect of the Electromagnetic Fields [in Russian], Leningrad (1973).
12. B. Grinet, and Makowski, *Acta Physiol. Polonica*, **30**, No. 1, 10-11 (1972).

0007-4888/93/0001-0019$12.50

Significance of the Pleura in the Breathing Mechanism

T.N.Bodrova, A.I.Korzilov, and F.F.Tetenev

UDC 616.24-008.4-092:616.25

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, No. 1, pp. 20-21, January, 1993
Original article submitted July 10, 1992.

Key Words: *pleura; breathing mechanism; transpulmonary pressure; respiratory activity; lung elasticity*

Obstructive therapy of breathing mechanism disturbances constitutes the essence of the modern notion of obstructive syndrome pathogenesis. At the basis of this theory lies the Donders paradigm of the view on the breathing mechanism, in which the lungs are considered as a passive elastic body, whose mechanical movements are conditioned by the influence of forces exerted by the thorax and diaphragm [4]. Clinical and experimental investigations of the breathing mechanism have revealed a number of paradoxical observations which do not fit into the paradigm and thus invite a critical attitude toward it [3]. One of these consists in the fact that under the conditions of the Donders experiment an increase in hysteresis occurs and lung elasticity is reduced [1]. The paradoxical phenomena in the breathing mechanism have been studied from the standpoint of the lung mechanical activity theory [2]. The insufficiently studied role of the pleural cavity in the transmission of mechanical force to the lung surface remains a problem.

TABLE 1. Breathing Mechanism Indicators in Life, 60 min after Cessation of Respiration and in the Donders Bell (M+m)

Indicator	in life (n=14)	in the box (n=8)	in the bell (n=7)
MVR, liters/min	0,94±0,17	0,90±0,16	1,0±0,2
TRA, kg·cm/min	3,8±0,6	5,4±1,3	12,0±2,8
SRA, kg·cm/min	4,04±0,29	5,61±0,52*	11,23±0,99*
Ael, kg·cm/min	1,92±0,26	3,40±0,96	4,84±1,02*
Wel/TRA, %	50,5±13,9	62,6±18,3	39,9±20,0
NRA, kg·cm/min	2,92±0,47	4,12±0,82	10,8±2,7*
NRAin, kg·cm/min	1,76±0,42	1,63±0,38	4,59±1,55*
NRAex, kg·cm/min	1,05±0,12	2,15±0,73	3,49±0,87*
NRAact	0,12±0,05	0,82±0,33*	2,72±0,60*
Sdyn, m/cm water	6,0±0,6	3,8±0,7	3,7±1,1

Note. Asterisk - the values are given with $p<0.05$ in comparison to the first indication during the vital period.

Department of Propedeutics of Internal Diseases, Central Research Laboratory, Siberian Medical University, Tomsk (Presented by Academician R.S.Karpov of the Russian Academy of Medical Sciences)

The purpose of the present study was to compare the main indications of the breathing mechanism in an acute vital experiment, after death under the conditions of preservation of thoracic-pulmonary system integrity, and also under the conditions of lung ventilation in a Donders bell, when the integrity of the thoracic-pulmonary system is destroyed.

MATERIAL AND METHODS

The breathing mechanism was studied under intravenous thiopental anesthesia in 14 rabbits (3 - 3.5 kg). The trachea was connected to a miniature spirograph with the aid of a cannula. The transpulmonary pressure (pressure difference between esophagus and trachea) was measured by a standard PDP-1000 MD electromanometer. The simultaneous registration of respiratory fluctuations of lung volume (spirograms) and of the transpulmonary pressure was conducted on a multichannel recorder. At the same time in 6 animals the transpulmonary pressure was registered by the difference between pressure in the pleural cavity and trachea. The results of measurements using the methods of intraesophageal probing and intrapleural pressure determination were on the average the same. Preference was given to the method of intraesophageal probing as being more stable and not disturbing the integrity of the thoracic-pulmonary system.

The arrest of spontaneous breathing and heart activity was caused by a toxic dose of anesthetic injected intravenously. The animal's body was then placed in a special hermetic box. The system of measurement of the transpulmonary pressure and respiratory volume remained the previous one, but was performed via rigid tubes passed through sleeves in the walls of the box.

To the box bellows were connected, whose movements rarefied pressure in the cabin, imitating inhalation. By the reverse movement of the bellows pressure in the cabin rose, promoting exhalation. The frequency and intensity of respiration were held in the range close to the values in life. The investigations were carried out immediately after the moment of death and 30 and 60 min later. The lungs were removed from the thorax and placed in the Donders bell. Now the transpulmonary pressure was registered as the difference between the pressure in the bell and in the trachea. The spirogram was recorded in the previous way. "Breathing" fluctuations of lung volume were produced by the same mechanisms connected to the Donders bell. Respiratory loops were plotted and minute volume of respiration (MVR), total respiratory activity (TRA), specific respiratory activity (SRA), elastic fraction of respiratory activity (A_{el}), percentage of A_{el} to TRA, total nonelastic fraction of respiratory activity in the inhalation (NRA_{in}), in the exhalation (NRA_{ex}), the part of respiratory loop corresponding to the activity of active inhalation (NRA_{act}) and the dynamic elasticity of the lungs (S_{dyn}). Statistical treatment of the experimental results was performed by the differential method.

RESULTS

In the animal study under three compared conditions MVR was on the average the same, so the comparison of breathing mechanism indicators was justified (see Table 1). Breathing mechanism indicators obtained immediately after the cessation of respiration and 30 and 60 min later, were on the average the same. So the indications obtained 60 min later were taken for comparison. One feature of the results consisted in significant variations of the breathing mechanism indicators, and therefore the trends of changes in a number of indications were not confirmed statistically. Nevertheless, SRA 60 min after the cessation of respiration and heart beat increased significantly and even more significantly during lung ventilation in the Donders bell. NRA_{act} changed in the same way.

The majority of breathing mechanism indicators in the Donders experiment increased highly significantly. This confirmed earlier-obtained data [1], although the S_{dyn} decrease was not reliable on the average. Nevertheless S_{dyn} did not increase, as was to be expected given the accepted views on the breathing mechanisms. The results of the research confirmed that the Donders model of the lungs is incorrect for the consideration of the mechanical aspects of lung ventilation. Breathing mechanism indicators obtained immediately after death and measured under conditions of thoracic-pulmonary system preservation were closer to the values during life. Thus, the thoracic-pulmonary system preservation of the integrity of the pleura promoted a decrease in work expenditures for overcoming the mechanical resistance of the lungs.

LITERATURE CITED

1. F. F. Tetenev, *Byull. Eksp. Biol. Med.*, No. 6, 21-23 (1974).
2. F. F. Tetenev, The Specificities of the Breathing Mechanism in Different Forms of Bronchopulmonary System Pathology. Substantiatim of the Lung Mechanical Activity Hypothesis: Synopsis of Thesis submitted for the degree of Doctor of Med. Sci., Kazan (1977).
3. F. F. Tetenev, The Biomechanics of Respiration [in Russian], Tomsk (1981).
4. F. Donders, *Ztcsch. f. Rat. Med.*, No. 3, 287 (1953).
5. P. Mucklem, B. Murphy, and B. Eng, *Amer. J. Med.*, **57**, No. 10, 371-377 (1974).