PATHOLOGICAL PHYSIOLOGY AND GENERAL PATHOLOGY

THE EFFECT OF HYPOXIA AND LOW BAROMETRIC PRESSURE ON THE MOTOR AND SENSORY CHRONAXY IN MAN

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In spite of the quantity of literature on chronaximetry, the effect of hypoxia and, especially, of low barometric pressure on the motor and sensory chronaxy has not been studied sufficiently.

Most authors [3,5,6] studied changes in motor chronaxy under conditions of circulatory hypoxia. They noted more or less marked increases in the chronaxy rate. A.M. Vorobyev [2] showed by experiments on frogs that during hypoxia the chronaxy of the sciatic nerve increases after a brief period of decrease. N.A. Vishnevsky and B.A. Tsyrlin [1] established the fact that the electric response of the eye decreases at an elevation of over 1500 m. Later A.A. Volokhov and L.T. Zagorulko found a noticeable increase in the chronaxy rate of the optic nerve at 4000-5000 m.

Yu.M. Ufliand [4] demonstrated, in experiments on rabbits, that increased pressure in the large intestine produces an increase in the motor chronaxy. K. Kh. Kekcheeva's data indicate that the optic chronaxy in man may be lengthened when the hollow internal organs are distended.

We studied the changes in the motor and sensory chronaxy in man under conditions of hypoxia and low barometric pressure.

EXPERIMENTAL METHOD

The changes in the chronaxy of the surface flexor of the fingers of the left hand (m. flexor digitorum sublimis) and the optic chronaxy of the left eye were studied. Measurements were made by means of a condenser-type chronaximeter in a low-pressure chamber, with constant light and air temperature. The standard posture of the subject was sitting.

Two series of observations were made: 1) while the air was rarefied to 405 mm, without oxygen – determination of the effect of hypoxia; 2) while the air was rarefied to 198 mm, with sufficient oxygen supply – determination of the effect of low barometric pressure without hypoxia.

The same methods of measuring were used in both series. The motor and sensory chronaxies were determined before the "ascent", 10-15 minutes after arrival at "altitude" and during the first 10 minutes after the "descent". In a number of cases measurements were made during the first hour after the "descent" in order to elucidate the processes involved in the after effects. Control measurements were made in both series.

In all, 70 healthy men, ranging in age from 20-30 years, were studied: 23 men under hypoxic conditions, and 47 at low barometric pressure.

RESULTS OF THE EXPERIMENTS

First series. 18 of the 23 men reacted satisfactorily to hypoxia, while 5 reacted poorly.

In those cases where there was a satisfactory reaction to hypoxia, the rheobases changed little.

The motor chronaxy at "altitude" increased in 70% of the subjects. One of the records of this series is shown below.

Subject R. Record No. 4, dated July 12, 1951

Time of measurement	Motor				Sensory			
	Rheobase		Chronaxy		Rheobase		Chronaxy	
	In V	In %	In σ	In %	In V	In %	In σ	In %
Before "ascent"	35	100	0.36	100	6	100	1.2	100
At "altitude"	40	114.3	0.52	144.4	4	66.6	2.8	233.3
After "descent"	35	100	0.52	144.4	5	83.3	2.0	166.6

In the majority of cases the motor chronaxy remained above normal some time after "descent". Usually it would return to normal after 30-40 minutes of wave-like fluctuation.

The sensory chronaxy, in general, changed in a manner analogous to the motor at "altitude" – it increased in 70% of the cases, decreased in 18.8%. In most cases it remained somewhat high after the "descent".

The rheobase of the flexor digitorum decreased (by 10-15 V) at "altitude" in comparison with its original level in all cases where the reaction to hypoxia was poor. The rheobase of the optic nerve varied insignificantly.

The variations in the motor chronaxy at "altitude" were complex in cases where the reaction to hypoxia was poor.

The reason was that the analysis of the data was considerably complicated by the fact that the majority of subjects were receiving oxygen at the time the chronaxy was measured.

In some cases, a short period of general excitation preceeded the feeling of illness at "altitude". At this moment the motor chronaxy became noticeably less. For example, Subject G., whose original rheobase was 55 V and original chronaxy was 0.12σ, at the 17th minute of hypoxia had a rheobase of 40 V (72.7%) and chronaxy up to 0.04 σ (33.3%), while he was in a condition of general excitation. 10 minutes later, he lost consciousness.

An increase in the motor chronaxy was established in the other subjects, examined at "altitude", which disappeared on administration of oxygen.

Subject Ya. Record No. 67, dated May 20, 1952

Time of measurement	Motor				Sensory			
	Rheobase		Chronaxy		Rheobase		Chronaxy	
	In V	In %	In σ	In %	In V	In %	In σ	In %
Before "ascent"	62	100	0.2	100	2	100	2.0	100
At "altitude"	43	69.3	1.16	580	2	100	1.6	80
"	43	69.3	0.2	100	2	100	1.6	80
After "descent"	50	80.7	0.28	140	2	100	1.6	80

Note: The first measurement at "altitude" was carried out 5 minutes after fainting, while the subject breathed oxygen; the 2nd, during the 15th minute of oxygen administration.

The time required for the return of the chronaxy to the original levels while breathing oxygen varied with the individual.

The sensory chronaxy at "altitude" while breathing oxygen was usually less than the original value.

Second series. The subjects in this series can be divided into three groups, according to their response to low barometric pressure. Good responses were found in 19 men; satisfactory (slight abdominal pain, meteorism), in 22; poor, in 6.

When the response to low barometric pressure was good, changes in the rheobase at "altitude", as well as after "descent", were imperceptible.

The motor chronaxy at "altitude" varied insignificantly in most of these cases. However, when the condition of the subject deteriorated, it increased markedly.

The changes in the optic chronaxy, when the response to low barometric pressure was good, both at "altitude" and after "descent", paralleled the changes in the motor chronaxy in many cases.

When the response to low barometric pressure was satisfactory, both the motor and sensory rheobases and chronaxies developed a number of general peculiarities. For example, the motor and sensory rheobases at "altitude" varied almost identically as regards their increase (in 47.6% of the subjects) and decrease (38.1% of the subjects), while the amplitude of the variations was considerably greater than that when the response to lowered pressure was good. After "descent", they decreased in comparison with the original levels in 70% of the subjects.

Fluctuations in the motor and optic chronaxy at "altitude" differed, while their amplitude was comparatively large. When the response to low barometric pressure was relatively worse, the lengths of the chronaxies studied increased considerably and remained large after the "descent". Analysis of the data obtained when response to low barometric pressure was poor was similar to analogous cases during hypoxia, complicated by first aid measures.

Subject U. Record No. 40, dated February 12, 1952

Time of Measurement	Motor				Sensory			
	Rheobase		Chronaxy		Rheobase		Chronaxy	
	In V	In %	In σ	In %	In V	In %	In σ	In %
Before "ascent"	95	100	0.24	100	3	100	2.4	100
At "altitude"	70	74.7	0.36	150	2	66.6	4.0	166.6
After "descent"	75	78.9	0.48	200	3	100	2.8	116.6

The rheobases of the flexor digitorum and of the optic nerve at "altitude" increased somewhat when response to low barometric pressure was poor.

The motor and sensory chronaxies at "altitude" changed insignificantly. This can be explained by the fact that the measurements were taken while first aid measures were under way. In those cases where the condition of the subject was poor (sharp abdominal pains), the motor chronaxy increased markedly although the "altitude" at which the measurements were taken was less.

Subject Ya. Record No. 70, dated May 29, 1952

Time of Measurement	Motor				Sensory			
	Rheobase		Chronaxy		Rheobase		Chronaxy	
	In V	In %	In σ	In %	In V	In %	In σ	In %
Before "ascent"	70	100	0.2	100	2	100	2.0	100
At "altitude"	70	100	0.72	360	4	200	2.4	120
After "descent"	33	47.1	0.56	280	2	100	2.8	140

Note: 308 mm pressure – emergency "descent".

Thus, when the response to hypoxia is satisfactory the changes in the rheobases of the flexor sublimis digitorum and of the optic nerve are insignificant, both at "altitude" and after "descent". Under the influence of hypoxia, the motor and sensory chronaxy increase in most cases. After "descent", the motor chronaxy and, to a lesser extent, the sensory chronaxy usually remain above the original figures, oscillating back to the original level in the course of 30-40 minutes. In all cases, the motor chronaxy oscillates more than the sensory.

When the response to hypoxia is poor, the rheobase of the flexor digitorum decreases. In acute cases, the motor chronaxy increases sharply. This increase disappears on oxygen administration. In some cases, the increase in the chronaxy is preceeded by a brief stage when it is decreased.

When response to low barometric pressure is good, the rheobases at "altitude" and after "descent" vary around the original figures. The motor and sensory chronaxies, also, do not change substantially in the majority of cases, although they increase when the response is relatively worse.

Characteristic of a satisfactory response to low barometric pressure is a wide diversity of the changes in the rheobase and chronaxy, coupled with oscillations of large amplitude.

When the relative condition of the subject deteriorates, a considerable increase is observed in the chronaxy, especially in the motor chronaxy, at "altitude" and after "descent".

Chronaximetry can be recommended as a supplementary method for the objective determination of response to various barometric pressures.

LITERATURE CITED

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