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Respiratory and Cardiocirculatory Responses of Acclimatization of High Altitude Natives (La Paz, 3500 m) to Tropical Lowland (Santa Cruz, 420 m)

M. PAZ ZAMORA, J. COUDERT, J. ERGUETA COLLAO, E. VARGAS, AND N. GUTIERREZ

Socioeconomic development of the countries of the Andean region necessitates massive migration of population groups through colonization programs, which mobilize high altitude natives as well as lowlanders. Health problems of these natives need to be studied and solved since they must work and remain economically active. It is the objective of this study to contribute to the better understanding of the acclimatization pattern of highlanders when transferred to lowland.

Materials and Methods

Seventeen native Aymaras, sedentary males born and living at the Andean high plateau (3800 m), of an average age of 22 years, were first studied at La Paz (3500 m) and then in Santa Cruz (420 m) during the first 18 days of acclimatization to low altitude (group HL). A control group of 10 sedentary males, born and living at low altitude, with an average age of 19 years, were studied under the same conditions, i.e., 420 m (group LL). Several parameters were measured in each group by means of the same techniques.

Results and Discussion

The temperature conditions and relative humidity are different at low and high altitude (dryer and colder weather in La Paz, hotter and more humid conditions in Santa Cruz). The modifications observed during the acclimatization to low altitude and the existing differences between the HL and LL groups can be described as follows.

Lung Volumes

Contrary to the studies performed at high altitude during the first week of acclimatization, in which a transitory decrease in vital capacity (VC) (22) was noted, the static pulmonary volumes do not suffer any important change during acclimatization to low altitude. But the state of pulmonary expansion, together with an increase of residual functional capacity (CRF) and residual volume (VR) described at high altitude in the natives of the high plateau (9), is maintained during the first week at low altitude. Observations made on rats have given evidence of anatomic modifications of pulmonary tissue, such as an increase of the al-

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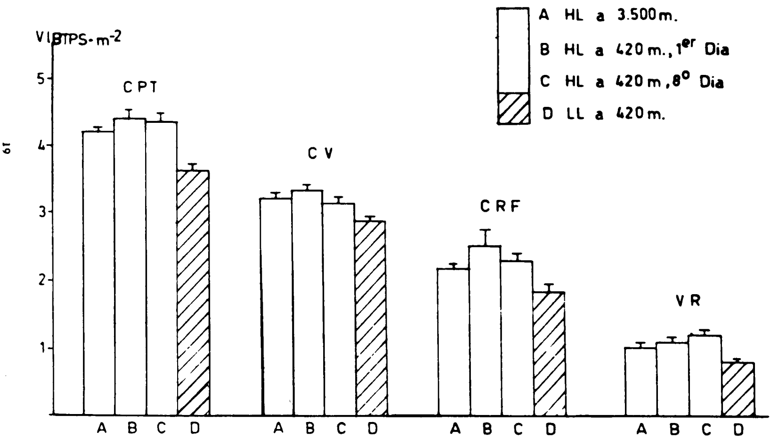

Fig. 4-1. Static pulmonary volumes obtained at high altitude (3500 m) and during the first week of acclimatization to low altitude (420 m) of a group of 17 males, natives of the Andes high plateau (3800 m) (group HL). CPT, total pulmonary capacity. CV, vital capacity. CRF, residual functional capacity. VR, residual volume.

veolar interchange areas and pulmonary capillaries when neonates are placed for a sufficient period in a hypoxic environment (2). In view of the above facts, the increase in pulmonary volumes of high altitude natives might be considered as a sign of adaptation to the chronic hypoxia of the environment. The decrease in the dynamic spirometric volumes—forced expiratory volume (VEMS) and maximum midexpiratory flow rate (VMM)—during acclimatization to lowland is due to the changes in the physical properties of air (increase of molecular density) (Fig. 4-1).

Ventilation and Gas in Arterial Blood

Ventilation during rest diminishes progressively in the first 2 weeks of acclimatization to low altitude. The initial drop in $\dot{V}E$ minute volume might be explained as a consequence of the suppression of hypoxic drive on the peripheral chemoreceptors. The latter have been studied in natives of high altitudes and are reputed to be hyposensitive to P_{O_2} variations (12,14,16,20). To explain the decrease in ventilation during acclimatization to low altitude, which is progressive in time and is parallel to a progressive increase in Pa_{CO_2} which stimulates ventilation, other mechanisms have to be invoked. This question is comparable to the one that arises during acclimatization to high altitude; i.e., the progressive increase in ventilation does not immediately reach maximum value (21). At high altitude changes in the hydrogen ion concentration of cerebrospinal fluid could also explain the progressive ventilatory response of what could be called the "hyperoxia of low altitudes." At first the increase in hydrogen ion concentration, together with respiratory acidosis (Fig. 4-2), will limit the effect of "hyperoxia" on ventilation. During subsequent days, active transport of hydrogen ions from the cerebrospinal fluid with an increased bicarbonate concentration would permit the decrease of induced ventilation due to the higher O_2 tension in the air (Fig. 4-3).

Alveolar-Arterial Oxygen Gradient

The decreased difference of alveolar-arterial O_2 tensions already described at high altitudes in the natives of such regions (10) is also maintained at low altitude. It was established that the pulmonary diffusion capacity is higher in natives of high altitude