III.6. Distribution of Cardiac Output at Rest in High Altitude Natives and Adapted Sea Level Natives

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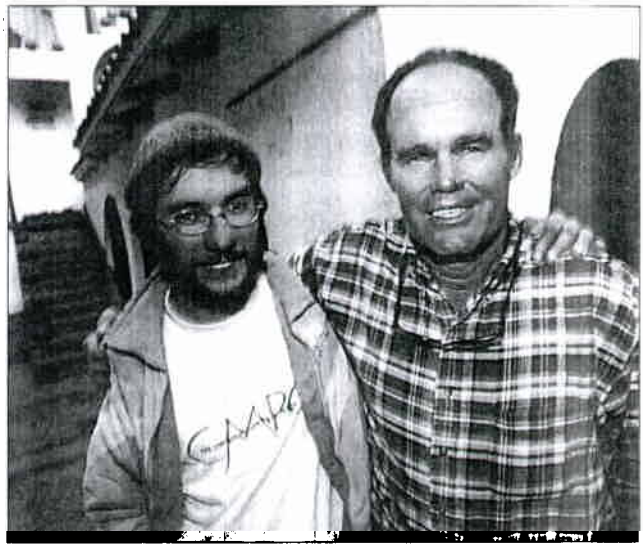
Chronic hypoxia (CH) alters, developmentally or genetically, the human cardiovascular system and the mechanisms of oxygen transport. Although the effects of acute hypoxia on central hemodynamics and various regional blood flows are well understood, the influence of CH on the global distribution of cardiac output (DCO) and its convective transport of oxygen has not been reported. Clearly, the competition between organ systems for blood flow from a transport system which is limited by oxygen content is an important aspect of human homeostasis and adaptation during hypobaric hypoxia (high altitude). Using noninvasive image-guided Doppler flowmetry (95% CI, accuracy ±11%, linearity ±7%), we studied 8 healthy, lean, echogenic Andean high altitude natives (HAN: 27 ± 6 yrs) and 8 adapted (9 weeks) sea level natives (SLN; 24 ± 6 yrs) during acute hypobaric normoxia (HN: P_IO_2 = 150 Torr) and during chronic hypobaric hypoxia (HH: P_IO_2 = 80-85 Torr, Chacaltaya). The SLN were also studied at sea level (normobaric normoxia). Due to logistical limitations, the HAN could not be studied at sea level. We measured supine, resting, phasic, steady-state blood flows (avg 6 cardiac cycles) in the: ascending aorta (CO, cardiac output); common carotid (CQ, brain); subclavian (SQ, arm); renal (RQ, kidney); superior mesenteric (MQ, gut) and common femoral (FQ, leg) arteries (Figure 8). Mean blood pressure (BP), pulse oximetry (SpO_2), heart rate (HR), and total peripheral resistance (PR) were also determined. Results in the HAN and SLN are given as means + SD. In the HAN during HN, CO, and HR dropped 12 ± 6% ($p<0.05$), and S_pO_2 rose 16 ± 3% ($p<0.05$). BP and PR were unchanged. DCO during HH and HN, respectively, given as % of CO, were as follows: CQ 21 ± 4, 19 ± 3; SQ 8 ± 3, 10 ± 4; MQ 13 ± 5, 16 ± 6; RQ 20 ± 6, 23 ± 5; FQ 12 ± 4, 13 ± 6; Other (mostly skin) 26 ± 6, 19 ± 5. These observations suggest that: 1) the resting, supine DCO is similar between HAN and SLN during HH; and 2) no major redistribution of the DCO occurs with acute hypobaric normoxia in HAN or adapted SLN, and 3) the DCO in the two groups were also similar to those obtained from the same SLN during normobaric normoxia (at their normal sea level residence). Thus, we conclude that the distribution



Marco Majero, our Italian cook, standing with Dick Greene in the courtyard of our hotel in La Paz.

of an elevated cardiac output at high altitude and its reactivity to sea level conditions is well maintained and is similar in HAN and SLN. It appears that no organ system in either population group is given preferential, convective oxygen delivery in resting, hypoxic conditions.

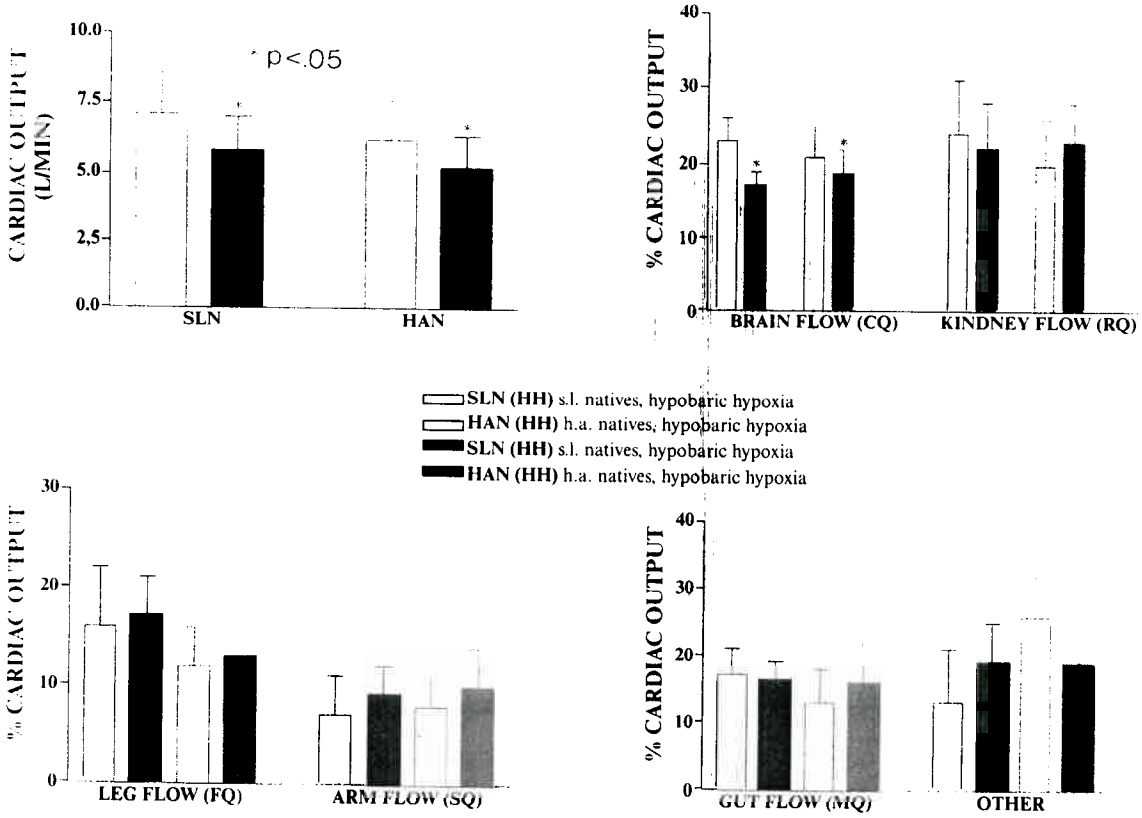


Figure 8. *Summary of mean values for cardiac output and the percentage distributed to various organs and regions of the body in sea level and high altitude natives in various conditions of inspired pO_2*