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EFFECTS OF LONG-TERM EXPOSURE TO HYPOBARIC HYPOXIA ON CARDIO-MECHANICAL ACTIVITY: PRELIMINARY RESULTS FROM THE CONCORDIA STATION

Abstract

The Concordia station, located in Antarctica at a corrected altitude of 3800 m, is a research station that is very much suited to the study of the effects of hypobaric hypoxia, prolonged isolation, reduced physical activity, and circadian cycles disruption. These factors can induce periodic breathing during sleep, causing attention disturbances, fatigue and increased arrhythmic risk. Our aim was to evaluate the cardiac electro-mechanical alterations during prolonged exposure to hypobaric hypoxia in ten crew members of the Concordia station winter-over expedition, and its relationship with apnea and respiration. A breathing protocol, including 10 breaths at 4 seconds per breathing cycle (4sBC), and a 20-second apnea (APN), was carried out in the morning 3 months before (baseline measurement) and at awakening once each month during the winter-over stay at Concordia. Electrocardiographic (ECG, fs = 500 Hz) and seismocardiographic (SCG, fs = 125 Hz) signals were recorded and processed to identify cardiac beats. The following beat-by-beat parameters were then computed: RR interval from the ECG; pre-ejection period (PEP), i.e. time interval between Q wave on the ECG and aortic valve opening (AO) on SCG; left ventricular ejection time (LVET), i.e. time interval between AO and aortic valve closure (AC) on SCG; peak-to-peak amplitude and slope of between isovolumetric contraction (IVC) and AO points on SCG. Statistical analysis was performed to compare values for each month of isolation with baseline (Wilcoxon Signed Rank test, $p<0.05$). Results are presented as median [25th percentile; 75th percentile]. Even though RR remained constant, PEP decreased during the winter-over stay, both during the 4sBC (-42[-47;6]% after two months) and APN (-13[-28;31]% on the seventh month). The LVET decreased already in the first month (-35[-49;-3]% 4sBC; -45[-63;-4]% APN), and remained decreased along the permanence at Concordia (up to -62[-71;-20]% after nine months for APN and -13[-34;-1]% on the last month for 4sBC). In addition, the IVC-AO amplitude and slope decreased, in the APN phase, during the second half of the stay (up to -46[-61;-32]%). Collectively, these changes highlight an adaptation over time of the cardio-mechanical activity and its coupling with respiration due to the prolonged exposure to the hypobaric hypoxic environment. In conclusion, alterations in the cardio-mechanical activity were observed in the crew members overwintering at Concordia station. Controlled respiration and apnea maneuvers highlighted changes in multiple parameters, underlining possible adaptation both in cardiac autonomic activity and left ventricular mechanical function.