The autonomic control of blood pressure in severe hypovolemic critically ill patients

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Argomento: Funzione cardiovascolare in terapia intensiva

Background: Acute hypovolemia induces profound derangements of the circulation and, in response, the autonomic nervous system (ANS) changes its state aiming at compensating the blood pressure drop. Usually, the effects of hypovolemia on ANS have been studied in experimental controlled conditions on healthy subjects undergoing lower body negative pressure or in anesthetized animals, but the effects on autonomic control of arterial pressure in clinical settings are poorly understood. We studied the autonomic control of arterial pressure in critically ill patients with life-threatening acute hypovolemia due to massive plasma leakage in idiopathic systemic capillary leak syndrome.

Methods: ANS was studied non-invasively by spectral analysis of heart rate variability (HRV) and blood pressure variability and was factorized into high (0.5-0.15 Hz) and low (0.15-0.04 Hz) frequency bands as estimation of vagal and sympathetic modulation directed to the heart and vessels. Heart rate and systolic arterial pressure (SAP) variability were used to assess the baroreceptive control too. The measures were repeated daily during capillary leak crises. Three main timings were considered: the acute hypovolemia, the post-acute phase and the recovery phase. The same variables were assessed in a control group of euvolemic healthy volunteers.

Results: Six episodes were considered. Only one patient was mechanically ventilated, and five patients had no ventilatory support. During the acute hypovolemia SAP was free to oscillate in the high frequency band entrained to the respiratory activity in the absence of an appropriate baroceptive control. After the acute phase, a progressive restoration of autonomic baroreceptive control occurred and it restrained the arterial pressure oscillations.

Conclusion: acute hypovolemia in critically ill patients induced neurally mediated fluctuation of blood pressure synchronous with the respiratory activtiy. Baroceptive control undergoes progressive improvement paralleling the clinical picture, with complete resolution at the recovery.

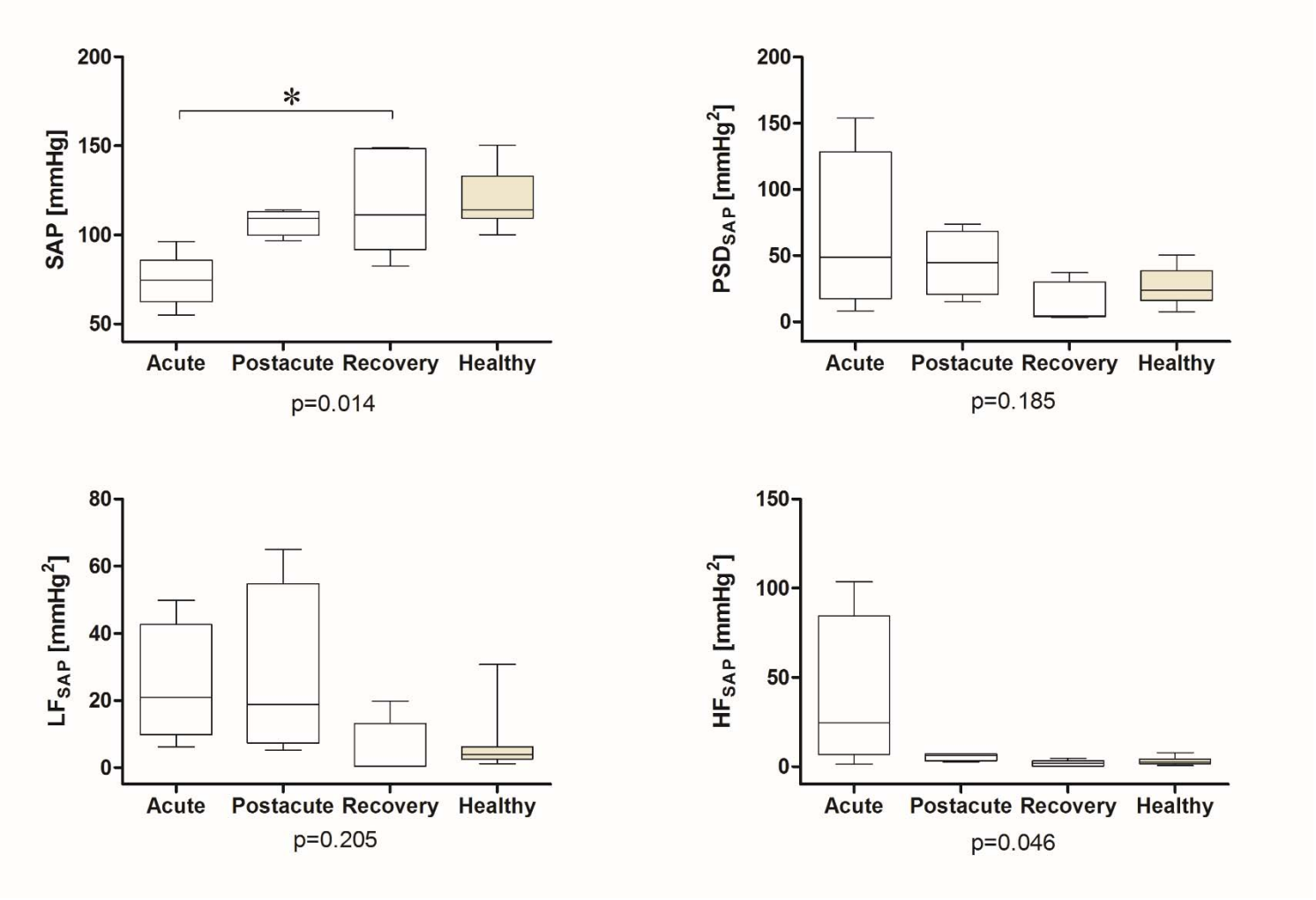

Figure 1

Representation of changes of systolic arterial pressure (SAP) in absolute values and the SAP variability in the time domain frequency. PSD_{SAP}, is the power spectral density of SAP variability. LF_{SAP} and HF_{SAP} were respectively the spectral density of SAP in the low frequency range and in the high frequency range. White box plots represent the measures in the critically ill patients, the ochre box plots those in healthy volunteers. The significance was assessed by one-way analysis of variance (ANOVA) for repeated measures on ranks among the patients group, and difference between time points was tested by post-hoc Dunn's test. *$p<0.05$ for comparison between time points.

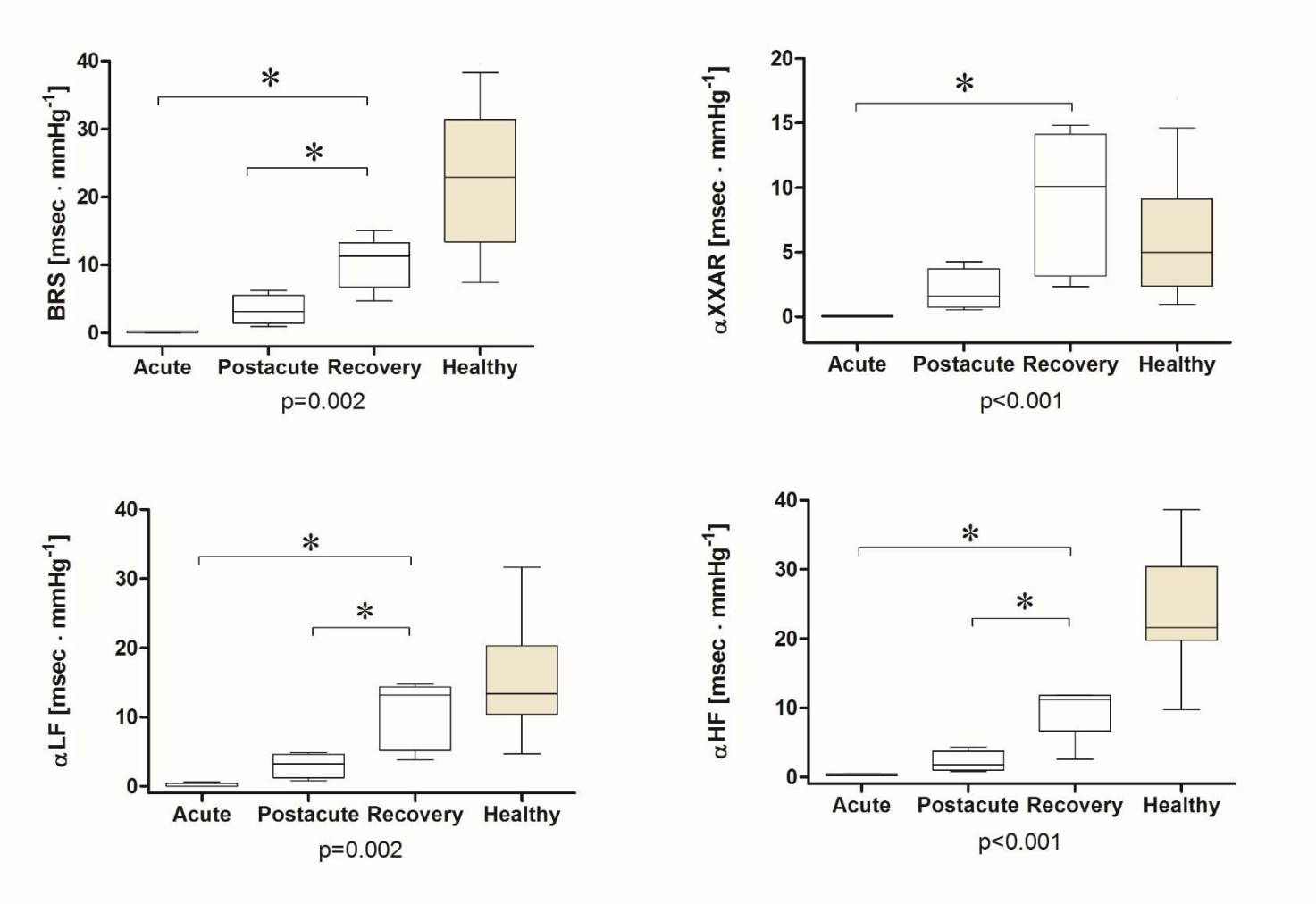

Figure 2

Baroceptive (BRS) assessment was based on spectral approach. BRS was computed as the square root of the ratio of LF of heart period to LF of SAP, indicated as αLF. Similarly, αHF was defined as the square root of the ratio of HF of heart period to HF of SAP. αXXAR assessment was based on double closed loop approach. White box plots represent the measures in the critically ill patients, the ochre box plots those in healthy volunteers. The significance was assessed by one-way analysis of variance (ANOVA) for repeated measures on ranks among the patients group, and difference between time points was tested by post-hoc Dunn's test. *p<0.05 for comparison between time points.