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Nonlinear Dynamics of Cardiovascular Autonomic Control in Patients with Cardiovascular Diseases before and after Surgical Operations with Cardiopulmonary Bypass

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Objective

Slow oscillations (with main frequency about 0.1 Hz) in heart rate variability (HRV) and blood pressure variability (BPV) and its synchronization are characterized baroreflex features for control cardiovascular function. The aim of this study was to compare the nonlinear characteristics of cardiovascular autonomic control in patients with cardiovascular diseases before and after surgical operations with cardiopulmonary bypass.

Method(s)

We studied 101 patients with cardiovascular diseases (mean age 57.9±7.6 years) who underwent on-pump heart surgery. Synchronous registration of HRV, BPV (assessed by finger photoplethysmographic waveform variability) and respiration were made in rest in all patients before and after the surgery. We estimated the degree (in percentage) of phase synchronization of slow rhythms in HRV and BPV – index S. Spectral analysis of HRV was also performed.

Result(s)

According to the dynamics of index S after heart surgery, all patients were divided into three groups: I) patients with a significant decrease of index S ($\Delta S < -5\%$), II) patients with moderate (non significant) dynamics of index S (ΔS from -5% to $+5\%$, inclusive), III) patients with significant increase of index S ($\Delta S > +5\%$). Five main parameters, which associated with the dynamics of the index S ($R^2=0.82$, $p<0.001$), were identified by the regression analysis as the followings: index S before surgical procedure, dynamics of total power and low-frequency band power of HRV spectra after the surgical procedure, duration of the surgical procedure, left ventricular ejection fraction before surgical procedure.

Conclusion

Nonlinear characteristics of cardiovascular autonomic control depend of the initial autonomic and clinical status of patients, the duration of heart surgery and the dynamic changes in autonomic neurons system after the surgery.

Keyword

Circulatory hemodynamics, Bioengineering (incl physical modeling), Physiology (specify organ or system), Cardiac function, physiology, Cardiopulmonary bypass, CPB (incl set-ups, equipment, surface coatings, etc.)