Indices of segmented symbolic dynamics as risk markers in ischemic heart failure patients

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Introduction

Heart failure is a major and growing public health problem especially in the industrialized countries with a five-year mortality rate of 62%-75% in men and 38%-42% in women after the initial diagnosis of heart failure. In spite of several studies which investigate the usefulness of linear and nonlinear heart rate variability (HRV) analysis for risk stratification in heart failure, there are no generally accepted non-invasive indices of increased mortality risk in such patients. The aim of this study was to investigate the suitability of a new developed nonlinear segmented symbolic dynamics (SSD) analysis for risk stratification in ischemic heart failure patients (IHF).

Methods

For the investigation of long-term beat-to-beat interval (BBI) time series a novel short-term segmented symbolic dynamics analysis method was introduced. In contrast to other established short-term symbolic dynamics methods, SSD which is based on short-term windowing is in its shifted version also applicable for long-term analysis, and therefore, considers also activity-related and circadian influences on HRV. In comparison, standard linear indices and standard symbolic dynamics (SD) were applied to 24-h BBI time series of 221 low risk (LR) and 35 high risk (HR) patients with IHF.

Results

Seven indices from SSD could significantly discriminate between LR and HR (p<0.01). Multivariate Cox regression analysis resulted in an optimal mixed parameter set of two clinical and three non-clinical indices (two from SSD and one from SD, no linear index). Compared to both the best clinical and best non-clinical parameter set, this mixed parameter set could lead to an improved risk stratification in IHF patients at high risk of cardiac death (sensitivity=75%, specificity=76%, area under curve=81%).

Conclusion

In this study the suitability of the new developed nonlinear SSD analysis for enhanced risk stratification in IHF could be demonstrated.