Assessment of the sympatho-vagal interaction in central serous chorioretinopathy measured by power spectral analysis of heart rate variability

Abstract

Background: The purpose of this study was to measure the activity of the sympathetic nervous system in patients with central serous chorioretinopathy (CSC) by power spectral analysis (PSA) of heart-rate (RR-interval) variability, a noninvasive method that reflects the balance of the sympathetic-vagal interaction.

Methods: The following four different groups of patients were measured: group 1, acute CSC (n=11); group 2, acute recurrent CSC (n=7); group 3, chronic persistent CSC (n=4); group 4, complete remission of CSC (n=9). The data recorded for these 31 patients (29 men and 2 women), with an average age of 44 years were compared with those noted for a group of 15 age-matched healthy individuals. The sympathetic-vagal balance is expressed by the ratio of the low-frequency component (LF) to the high-frequency component (HF) of the power spectrum.

Results: Significant differences in mean LF/HF ratios were found as follows for all but one of the subgroups as compared with the normal controls (LF/HF=1.1): group 1, LF/HF=5.5 (P<0.01); group 2, LF/HF=5.4 (P<0.05); group 3, LF/HF=4.2 (P=0.1); and group 4, LF/HF=3.0 (P<0.01). There was also a significant difference between active CSC and inactive CSC (P<0.05).

Conclusions: These results support the view that the pathogenesis of CSC is related to an increase in the sympathetic activity of the autonomic nervous system. Furthermore, the LF/HF ratios seem to correlate with the activity of the disease.

Introduction

Although the pathogenesis of central serous chorioretinopathy (CSC) remains unknown, there is some evidence that behavioral factors contribute to the disease. Many patients with CSC are highly competitive and compulsive and often relate the onset of their symptoms to unusual stress [7]. This type A behavior pattern was investigated in detail by Yannuzzi in 1987 [21]. We would therefore conclude that dysregulations of the sympathetic activities play an important role in CSC. The purpose of this study was to measure the activity of the sympathetic-parasympathetic nervous system in patients with CSC by power spectral analysis of heart rate (RR interval) variability.

Power spectral analysis demonstrates that the beat-by-beat variability of RR intervals is not random but exhibits a periodicity in which two major peaks are found, one peak being mostly due to sympathetic activity (LF) and its changes and the other reflecting mostly vagal activity (HF). Another important parameter is the LF/HF ratio. Changes in this ratio are indicators of alterations in the sympathovagal balance [1, 14].

Patients and methods

A total of 31 patients (29 men and 2 woman) with a mean age of 44 years (range 32–52) were evaluated and divided into four different groups according to their ophthalmological history and the results of the fundus examination, including fluorescein angiography: group 1 (n=11), acute CSC; group 2 (n=7), acute recurrent CSC; group 3 (n=4), chronic persistent CSC; group 4 (n=9), complete remission after CSC (Table 1). Patients with acute CSC were suffering for
the first time from acute symptoms related to one or more leakage points. For patients with recurrent CSC there was a prior history of well-documented healed CSC (7–18 months earlier) and fresh leakage at the time of measurement. Chronic CSC was defined as cases in which widespread retinal pigment epithelium (RPE) alterations could be ascribed to persistent exudation of more than 1 year’s duration. Patients with a complete remission of CSC had experienced an acute episode of CSC 6–21 months earlier that had resolved spontaneously. There was no fresh leakage or retinal edema. At the second visit a complete medical history was taken, but no physical examination or laboratory test was performed.

The RR interval measurement data recorded for our 31 patients were obtained using a cardiometer BHL-6000 (Baumann-Haldi, Switzerland). They were compared with the data noted for 15 healthy age-matched volunteers (Table 1). The variability of the RR interval can be shown by plotting the RR as a function of the beat number, a representation that is usually termed the tachogram (Fig. 1, healthy volunteer). The distribution of such a signal can also be graphically observed using a deviation histogram (Fig. 2). The dotted lines in Fig. 2 indicate the standard deviation ($\pm \sigma$). For a normal gaussian distribution, 68% of all the data should be found between these two lines. In addition, for a normal gaussian distribution the obtained histogram should be symmetric (around 0). In the present case the percentage of data lying between the two dotted lines not only exceeds the expected value for a normal distribution, but the histogram is clearly asymmetric. Such differences are not very surprising, since it is known that many signals of cardiovascular origin are in general pseudo-periodical (i.e. the interval from beat to beat is not strictly constant but oscillates around a certain mean value even without arrhythmia).

For more information about the dynamics of heart-rate fluctuations the data can be analyzed in the frequency domain by means of spectral analysis techniques. In general, one applies the fastFourier transformation (FFT) algorithm to calculate the power spectral density (PSD). The obtained discrete PSD for the data corresponding to the tachogram shown in Fig. 1 is demonstrated in Fig. 3. It should be emphasized that this spectral analysis implicitly assumes that the data are cyclic, which is not strictly true for heart-rate fluctuations. This difficulty can be bypassed by the use of a modeling approach for the spectral estimation. A model that is particularly interesting because of its simplicity and efficiency of identification methods is the autoregressive (AR) model [11], which in the time mode is described by

$$x_n = \sum_{k=1}^{m} a_k \cdot x_{n-k} + \varepsilon_n$$