Adaptations in Cardiac System of An Olympic Downhill Skiing Champion: A 6-year ECG Case-Study

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Introduction

Heart regulation monitoring of elite athletes during training and competition is frequently studied in various forms; however, longitudinal data on changes in cardiac function and regulation in elite skiers was previously not available.

The purpose of the study: over the course of 6 years, to observe and understand changes in ECG parameters which represent adaptations in the cardiac system of an Olympic champion in response to training and competition loads.

Methods

The 6 year longitudinal observational study involved a 2010 Olympic champion downhill skier. Bioelectrical heart activity was recorded by ECG using Omegawave 3 technology (USA). ECGs were recorded regularly for 6 years from 2004 up to the 2010 Olympic Games, where the athlete achieved the best results of his career.

Initial data contained over 800 ECG assessments. ECGs were recorded at rest using standard limb leads I, II, III (including aVR, aVL, aVF), and unipolar chest leads V2, V3R, and V6. Recording time was at least 128 seconds and took place before training or competition (5:00 to 10:00 am).

A comprehensive analysis of ECG intervals and amplitude characteristics was then conducted. Heart rate variability (HRV) analysis was also used to assess the state of the autonomic nervous system (ANS). Statistical analysis was performed using SPSS 23 (USA).

Results

With changes in sports-specific preparedness, changes were observed in the basic function of both the cardiac system and ANS regulatory mechanisms.

Over the course of the study, a general decrease in wave amplitude R, S, T in lead V2, and S & T wave amplitude in lead V6 was observed ($p<0.001$). In standard ECG leads the width of P & T waves was significantly increased, and the amplitude of the waves Q, R, S, T decreased ($p<0.001$).

However, during the year prior to the Olympic Games, as sports-specific preparedness increased, both ECG & HRV parameters showed opposite trends.

In ECG leads V2 & V6, wave amplitude R, S, T increased.

In HRV indices, the activity of the parasympathetic branch of the ANS and autonomous cardiac rhythm control loop increased (RMSSD, Total Power, HF), and the sympathetic branch decreased (amplitude of the mode and Tension Index).

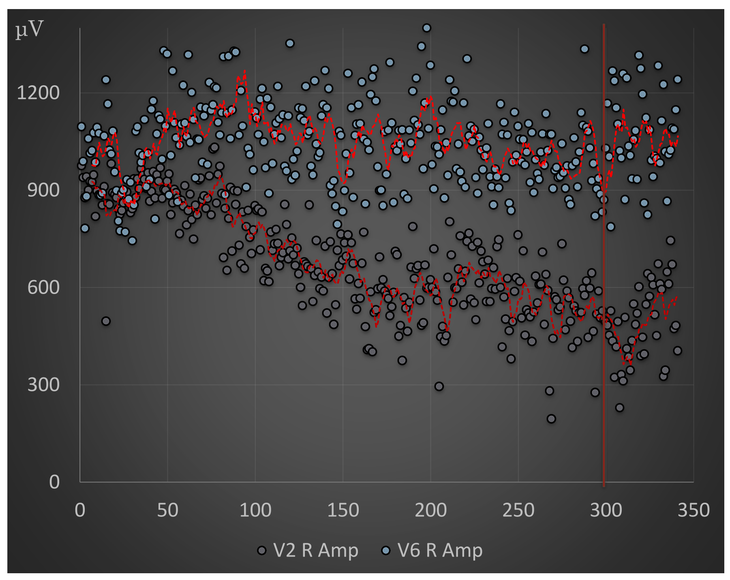

Figure 2. R amplitude changes in V2 & V6 leads.

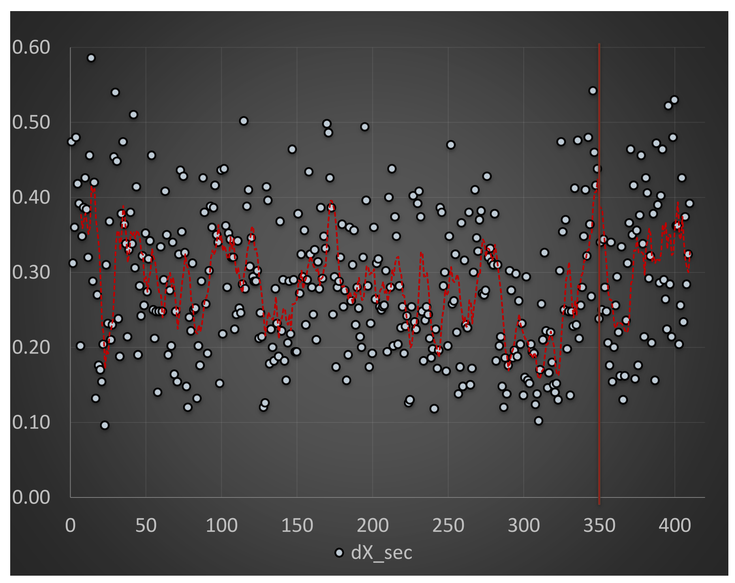

Figure 3. Activity of the parasympathetic branch of the ANS.

HRV parameters showed various wavelike trends depending on the period of preparation, all within normal range.

Discussion

ECG & HRV parameters are physiological markers that reflect the biological cost of forming adaptational changes in response to daily training and competition stressors. Frequent monitoring of these changes can be useful for optimizing the training process.

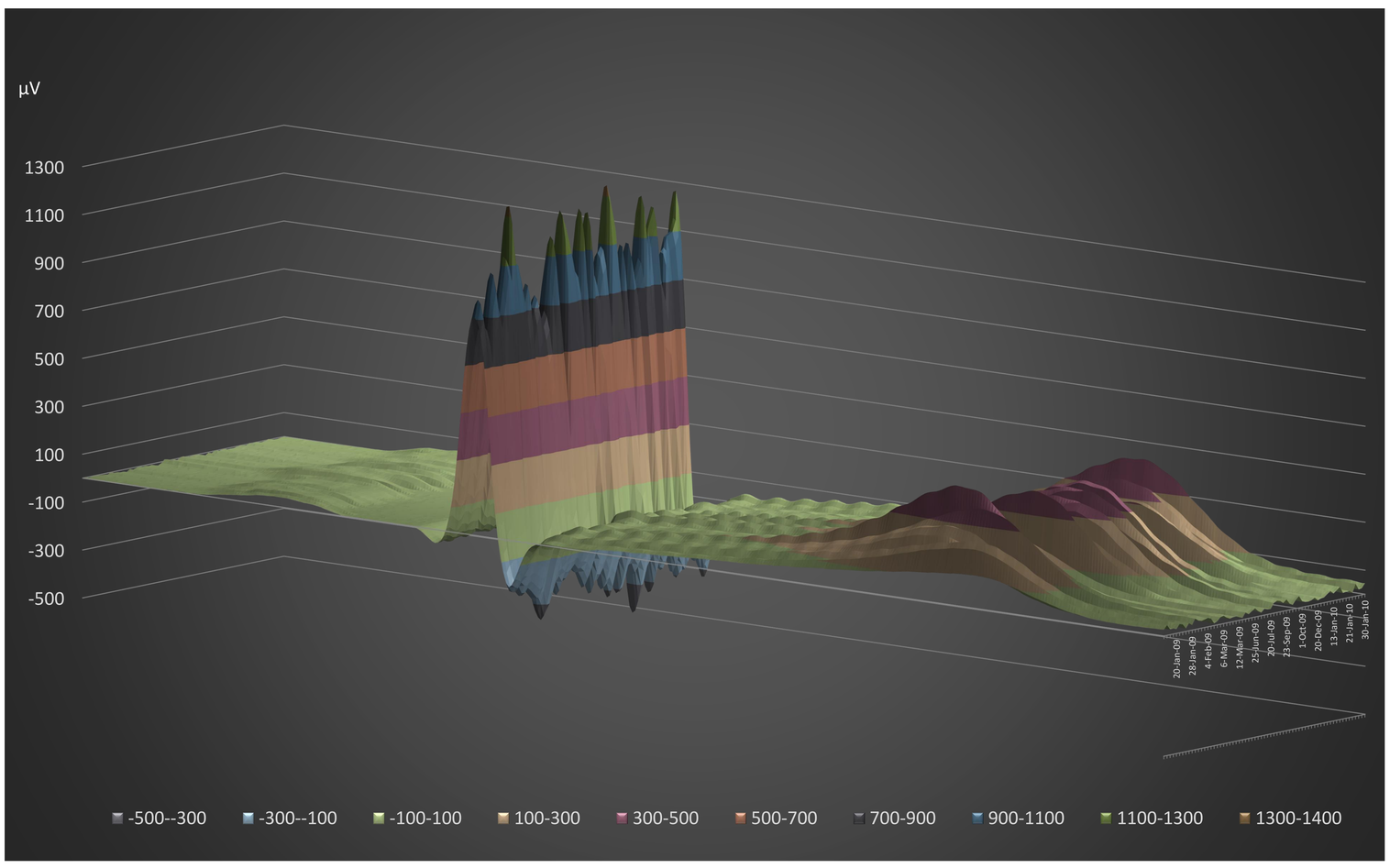

Figure 1. ECG changes in a year before the Olympic Games.

Conclusions

- Main characteristics of cardiac function - automatism, conductibility & excitability - showed a significant change from the previous 5 year pattern.
- Almost all trends in investigated parameters appeared to change in the opposite direction.
- Changes in ECG parameters collected from the right side of the heart were more expressed compared to the left side.
- Changes in HRV and ECG patterns appear to represent useful adaptations in response to the training process.

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