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The value of using heart rate variability for the long-term monitoring of training loads in tennis.

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ABSTRACT

This article discusses a new method designed for the monitoring of training, which is easily accessible to both coaches and physical trainers. Based on heart rate variability, it allows us to assess players' fitness level in a reliable and objective manner. Involving few constraints and requiring little equipment, this method is an innovative tool which may prove very useful in optimizing and customizing training loads based on future competitions, and in preventing the risk of overtraining.

Key words: Heart rate monitor, Fitness level, Periodisation, Planning, Overtraining.
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INTRODUCTION

Tennis is, in essence, an intermittent activity with many unpredictable factors that make it difficult to implement the periodisation process. Unlike a lot of other sports, there is no real off-season in tennis and the number of tournaments is such that players have the opportunity to compete every week. In addition, the way the ranking system works encourages players to play and win a lot of matches (Roetert & McEnroe, 2005). Because of this pressure to perform, players often neglect the recovery phase (Smith, 2012), thereby jeopardizing their health. On top of this are other factors that have an impact on the overall load and fatigue level, such as the number of matches played during a tournament, the duration of matches and rallies, the environmental conditions, the court surface, as well as the travel time and effects of jet lag (Roetert et al., 2005). Under these circumstances, it can prove very difficult for coaches and physical trainers to plan and periodise training. Indeed, it is virtually impossible to set up a clearly defined programme given that such a programme is constantly challenged by the player's results. Therefore, non-linear periodisation seems to be the most suitable periodisation model for tennis (Roetert et al., 2005). This means that a player's training programme must be adapted again and again according to the player's fitness level and future goals. More specifically, it seems that in modern tennis, recovery strategies are becoming increasingly important to achieve consistent performance levels. However, periodisation is often based on coaches' past experiences or guided by what other players do in that field (Reid et al., 2010). A good way to avoid the adverse effects of such practices is to rely on the study of heart rate variability (HRV), which allows to alternate periods of activity with periods of rest in an optimal manner on the basis of objective data. HRV, which is related to the medical field, refers to the study of the time between two heart beats (known as the R-R interval, Figure 1); the constant variations in the R-R interval provide information on the status of the autonomic nervous system. High heart rate variability is a sign of a good fitness level; on the other hand, a decrease in HRV is synonymous with a decline in the ability to adapt, thus reflecting a state of fatigue. Thanks to new, easy-to-use tools (heart rate monitors, processing software, etc.), the analysis of HRV has become accessible to athletes and can be used to monitor fitness and prevent overtraining on an individual basis. The monitoring of HRV data seems particularly suited for tennis when the goal is to build a flexible periodisation model that takes into account the unforeseen events of competition. In addition, HRV offers a comprehensive assessment of an athlete's fitness level based on physiological and psychological factors, both of which play a decisive role in tennis performance.

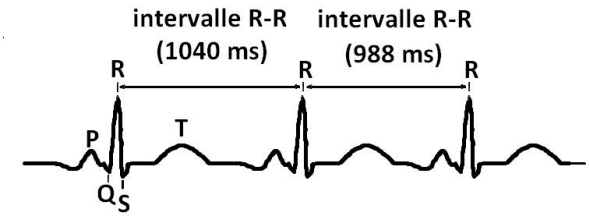

Figure 1: Illustration of R-R intervals.

METHOD

Due to the high sensitivity of HRV, the primary methodological requirement is to collect HRV measures appropriately, using a compatible heart rate monitor (Figure 2). The reason is that HRV is influenced by many parameters such as digestion, stress, physical activity, fatigue, body position and breathing (Saboul et al., in press; Aubert et al., 2003). For practical reasons, the preferred method is to measure HRV in the morning, soon after the player wakes up. To avoid unusual results, it is essential that the player strictly follows this protocol: he or she must be fasting, lying down on the bed the whole time, breathing as calmly as possible and avoiding any stress (no music, no discussion, no movement). As a precaution, it is advisable to have the player go to the toilet just before HRV is measured. The test should be performed at regular intervals, i.e. three or four times a week, during periods lasting between 5 and 8 minutes (Kiviniemi et al., 2011; Plews et al., 2012).

Figure 2. Sophisticated heart rate monitor capable of recording R-R intervals and the variations in such intervals over time.

As far as the HRV analysis is concerned, it is performed using a signal processing software, providing access to several types of data that are classified into two domains: the time domain and the frequency domain (Task Force, 1996). Although frequency-domain indices have been widely used in the past, their reliability has recently been called into question because of their interaction with the athlete's respiratory rate. In addition, controlled respiration disrupts the results (Saboul et al., in press). The solution is to be found in the use of time-domain measures and more precisely in the use of RMSSD (root mean square of successive differences). This index better reflects the state of fatigue than frequency-domain measures and is an accurate predictor of the athlete's ability to withstand additional stresses (Plews et al., 2012).

Example of longitudinal monitoring of HRV based on the competition and preparation periods during the tennis season.

INTERPRETATION OF DATA

In practical terms, HRV monitoring is very easy to implement and involves few constraints. This method is non-invasive, fast (approx. 5 minutes) and practical (upon awakening, in the bed) and can therefore be used directly by the players, independently and even when travelling.

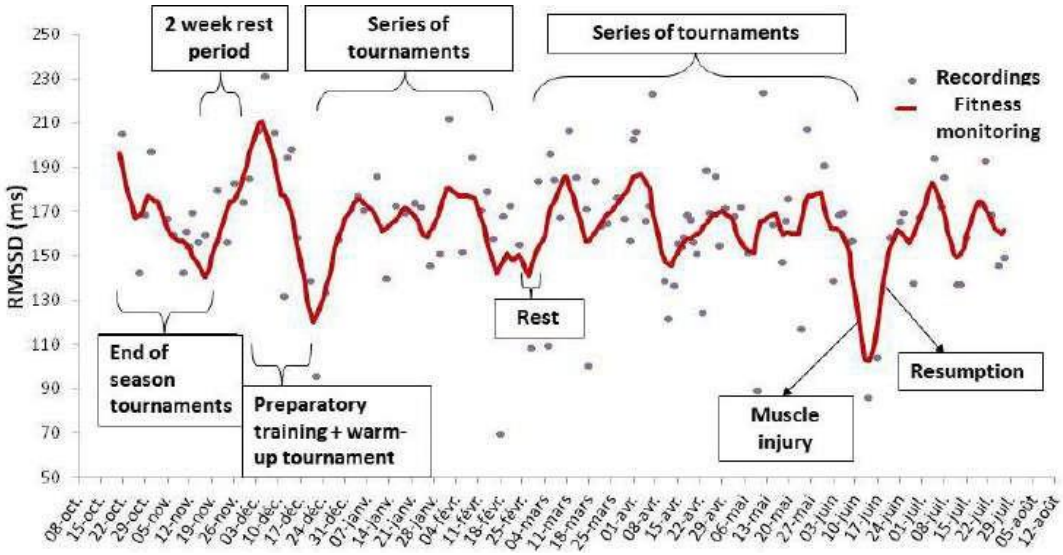

Figure 3. Each point represents the value of RMSSD on the day it was recorded. For greater readability, a trend line has been drawn to track the evolution of the player's fitness level.

In the context of longitudinal monitoring, variations in the RMSSD values are visible on a day-to-day basis depending on training sessions, tournaments or stress level (Figure 3). It is therefore important not to over-interpret each variation observed. Similarly, comparing gross values between players has no meaning from a physiological point of view. RMSSD must be interpreted as an individual measure; as such, it can only be compared with its previous values. Given that large variations can take place during the same week, it is recommended to simply observe the trends. In effect, RMSSD values will normally decrease during periods of high load, thus reflecting an accumulation of fatigue. Conversely, RMSSD should increase during preparation periods to above normal values, in the best of cases, just before the start of competition (Plews et al., 2012). The variations in RMSSD values, on a daily or weekly basis, are a sign of fitness and an indication of the ability to adapt physiologically to the different types of training performed. A long period of stagnation, even with high values, or a sustained decrease in RMSSD values generally indicate that the ratio between training load and recovery is inappropriate or that training is too monotonous. The interpretation of the results must always be done bearing in mind the content of training sessions and matches. Furthermore, it is appropriate to use RMSSD values in conjunction with other indices such as the workload or the subjective assessment of fatigue, sleep, appetite or mood.

CONCLUSION

The HRV method appears to be both effective and particularly well adapted to tennis since it allows coaches to perform long-term monitoring of their players' fitness level. Based on the variations in RMSSD values throughout the tennis season, they can adjust and optimize the training load by taking into account players' fitness level and goals at any given time. With data that is both objective and player-specific, this method allows for the planning of optimal recovery periods, thus helping players to peak at the right moment and avoid overtraining.

Given the current demands of modern tennis, it has become essential to provide coaches and players with efficient tools that can help them in their search for optimal fitness and preservation of health. Thanks to new technology, it seems that the HRV method can be used as such a tool.

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