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A study of the physiological characteristics of tennis.

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ABSTRACT

This article describes the most important physiological characteristics of tennis players, as heart rate, lactate concentration, oxygen consumption and subjective perception of effort, depending on the players´ age, level, and gender. This information will help coaches to plan training sessions according to these parameters.

Key words: Hart rate, Lactic acid concentration, Oxygen consumption.
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INTRODUCTION

Tennis is an intermittent sport, with effort intervals that vary from low to high intensity due to short and repeated but highly intensive actions (Kovacs, 2007). Even though its characteristics in terms of temporal structure with a number of continuous action intervals are similar, there are some characteristics such as court surface (carpet, natural lawn, artificial lawn, cement, clay, etc.), the age, gender, level of the player or the match situation that can have a direct impact on the characteristics of the effort or even the metabolic pathways used, and the physiological parameters of the players.

METABOLIC PATHWAYS USED IN RACKET SPORTS

Competitive tennis, analysed in its formal structure, can be said to be a sport in which different metabolic pathways are involved (Sanz & Ávila, 2004), due to the interval characteristics of the activity. Studies performed on tennis players indicate that tennis is predominantly an alactic anaerobic activity (70% of the playing time), with a minor lactic anaerobic activity (20%) and a supporting aerobic base (10%) (Bergeron, Maresh, Kraemer, Abraham, Conroy & Gabaree, 1991; Ferrauti, Maier & Weber, 2002; Weber, Ferrauti, Porten & Rochelt, 2002).

Thus, generally speaking, we can state that the metabolic demands in this sport vary between the supply of anaerobic energy during the high intensity phase (for example in direction and hitting changes) and a good aerobic base to recover the energy easily, closing the lactate accumulation pathway, delaying fatigue and indirectly, favouring concentration, technical skill and the level of work during the match (König et al, 2001; Roetert et al., 1992). The analysis of the metabolic pathways used in tennis have been analysed according to the evolution of those parameters such as heart rate, oxygen consumption, (VO2) lactic acid concentration (LA) or the subjective perception of effort (RPE) and observing the working and resting times during competition matches (König et al., 2001; Roetert et al., 1992).

Heart rate

One of the most deeply studied physiological parameters in tennis is the evolution of the heart rate during a match (Torres & Carrasco, 2004), since it is one of the few direct physiological indexes that we can get, and it is related to other cardio-respiratory effort indexes such as oxygen consumption in sub-maximal effort.

The study of the heart rate in high intensity exercises such as tennis, identifies the characteristics of effort and volume in terms of number and duration (Cabello, 2004). This way, when we study the evolution of the heart rate in competition, we must analyse the maximal and medium heart rate in order to determine the cardiovascular load that the sport demands (Bangsbo, 1996). The study of the medium heart rate on its own, does not reflect the intermittent nature of the game (Fernández, Sanz & Méndez, 2012).

Due to the intermittent nature of racket sports, including tennis, there are great variations in heart rate every few seconds. Research has shown how a tennis player's maximum heart rate can reach between 190-200 beats per minute when rushing to the net or to a drop-shot, while during resting periods between points it can decrease and reach 120-130 beats per minute (Bergeron et al. 1991; Gallach, 1992).

As a general reference, the medium heart rate in tennis players varies between 140-160 BPM, which is an intensity between 60- 80% of the maximum heart rate (Torres & Carrasco, 2004) however, these values may vary depending on the age, if players are playing singles or doubles, the weather and even if

the player is serving or receiving (Morgans, Jordan, Baeyens & Franciosa, 1987; Reilly & Palmer, 1995; Smekal et al., 2001). Several studies have shown higher heart rate values for players who are serving than for those players who are returning, both in male and female players (Méndez, Fernández, Fernández & Terrados, 2007; Fernández, Fernández & Terrados, 2007). In comparison, the maximum heart rate based on other studies show similar results to those in sports like badminton and paddle tennis. Baiget, Iglesias & Rodríguez (2008) showed maximum heart rate values that ranged between 189 & 191 BPM in male competition tennis players, higher than the results of Galiano, Escoda & Pruna (1996) with values that were relatively lower, 178- 180 BPM.

Authors	Sample	Max HR	Mid HR
TENNIS			
Christmass, Richmond, Cable, Arthur y Hartmann (1998)	8 tennis players	189 ± 3 BPM	----------
Sindal et al. (2001)	20 male players	193 ± 9 BPM	Between 145 ± 19 & 158 ± 16 BPM
Ferrauti, Bergeron, Pluim & Weber (2001)	6 men and 6 women	---------	Men 142.5 ± 12.7 & women 141.5 ± 18.9 BPM
Torres, Cabello & Carrasco (2004)	16 men and 16 women tennis players	---------	158.4 ± 8.51 BPM
Fernández, Sanz, Sánchez, Pluim, Timessen & Méndez (2009)	20 tennis players	Between 180.3 ± 6.5 & 185.3 ± 5.3 BPM	----------
Torres, Sánchez-Pay & Moya (2011)	8 male players	183 ± 14.85 BPM	134.12 ± 8.88 BPM

Table 1. Most important research related to HR in tennis. Adapted from Torres & Carrasco (2004).

Lactic acid concentration

The lactate concentrations have been used to estimate the intensity of the work during sport competition and training and to provide information about the energy production through glycolytic processes (König et al 2001; Roetert et al 1992). It is important to be careful when interpreting the lactic acid concentration during matches and training, since results may be affected by several factors such as fitness at the time of measuring (Fernández, Sanz & Méndez, 2012).

Studies made during a tennis match are usually low with averages between 1.00 y 4.00 mmol.L-1 (Bergeron et al., 1991; Christmass et al. 1998; Ferrauti et al., 2001; Reilly & Palmer, 1995; Smekal et al., 2001). However, during long and intense points, it is possible to find lactic acid close to 10 mmol.L-1 (Méndez et al, 2007). High lactic acid values have also been found in concrete actions like rushing to the net or during a sprint (Gallach, 1992), in highly trained players (Therminarias, Dansou, Chirpaz & Quirino, 1990), or during service where values were higher than in return (Méndez et al., 2007). The authors consider that the possible lactate concentrations do not remain high during a tennis match due to the ratio between working time and rest, in which the latter lasts more than the first (Bergeron et al. 1991; Christmass et al., 1998; Smekal et al., 2001).

Oxygen consumption

In general, tennis players consume more oxygen (VO2max), which varies between 47 & 53 mL/kg/min; higher than the sedentary population 38-42 mL/kg/min (González, 1992). Similarly, research shows that a male tennis players' VO2max is higher than in female tennis players and VO2max is significantly higher among junior players (16-17 years) as compared with children 8-12 years (Reilly & Palmer, 1995; König et al, 2001).

Subjective perception of effort

Effort subjective perception can be defined as `the subjective intensity of effort, stress, discomfort and / or fatigue during physical exercise´ (Robertson, 1997). The scale of effort perception in Borg (RPE) is a simple and reliable method to measure the intensity of exercise (Borg, 1998). There is little information to describe the response to RPE during a tennis match (Fernández & cols., 2012), although in competition players, values range from 12-13 in Borg´s scale (Méndez, Fernández, Bishop & Fernández., 2010), just as there have been increases in RPE values in response to longer points or more strokes per point (König et al., 2001; Roetert et al. 1992).

Practical application for coaches

The aim of knowing the physiological profile of a player is to determine the physiological and contextual demands that impact on performance, in turn to adapt training sessions and optimise the player´s profile (Torre-Luque, Sánchez-Pay, Bazaco & Moya, 2011). Thus, with elements like the pulse meter, it is possible to control training loads for players, allowing for better planning and periodisation for their training sessions. The coach or the trainer can control, not only the training volume with temporal parameters, but also its intensity through knowledge of the heart rate or oxygen volume.

Finally, the regular control of these physiological parameters and their evolution will help the coach to be aware of the effect of certain training loads and programmes for physical, tactical or technical work on court.

CONCLUSIONS

With the revised data, it is possible to state that tennis is an intermittent sport due to players reaching, between 130 and 160 beats per minute during a match and it can be classified as a sport of moderate / high intensity. Further research is still necessary since, as observed, depending on the gender, the playing surface or the level of the players, values vary enormously.

REFERENCES

Baiget, E., Iglesias, X., y Rodríguez, F. (2008). Prueba de campo específica de valoración de la resistencia en tenis: respuesta cardiaca y efectividad técnica en jugadores de competición. Apunts, 93(3), 19-28

Bangsbo, J. (1996). Physological factors associated with efficiency in high intensity exercise. Sports Medicine, 22 (5), 299-305. https://doi.org/10.2165/00007256-199622050-00003

Bergeron, M., Maresh, C., Kraemer, W., Abraham, A., Conroy, B., y Gabaree, C. (1991). Tennis: A physicological profile during match play. International Journal of Sport Medicine, 12 (5), 474-479. https://doi.org/10.1055/s-2007-1024716

Borg, G. (1998). Borg's Perceived exertion and pain scales. Human Kinetcis.

Christmass, M., Richmond, S., Cable, N., Arthur, P., y Hartmann, P. (1998). Exercise intensity and metabolic response in singles tennis. Journal of Sport Sciences, 16, 739-747, https://doi.org/10.1080/026404198366371

Fernández, J. A., Fernández, V. A., y Terrados, N. (2007). Match activity and Pgysiological Responses during a Junior Female Singles Tennis Tournament. British Journal of Sport Medicine, 41, 711-716. https://doi.org/10.1136/bjsm.2007.036210

Fernández, J. A., Sánz, D., Sánchez, C., Pluim, M. B., Tiemessen, I. y Méndez, A. (2009). A comparison if the activity profile and physiological demands between advanced and recreational veteran tennis players. Journal of Strength and Condicioning Research, 23(2): 604-610. https://doi.org/10.1519/JSC.0b013e318194208a

Fernández, J. A., Sanz, D., y Méndez, A. (2012). Fundamentos del Entrenamiento de la Condición Física para Jugadores de Tenis en Formación. Barcelona: Real Federación Española de Tenis.

Ferrauti, A., Bergeron, M., Pluim, B., y Weber., K. (2001). Physiological responses in tennis and running with similar oxygen uptake. European journal Applied Physiology, 85, 27- 33. https://doi.org/10.1007/s004210100425

Ferrauti, A., Maier, P., y Weber, K. (2002). Tennistraining. Aaechen: Meyer & Meyer.

Galiano, D., Escoda, J., y Pruna, R. (1996). Aspectos fisiológicos del tenis. Apunts, 44-45, 115-121.

Gallach, J. E. (1992). Control y dirección del entrenamiento del tenis por medios electrónicos. VII Simposium Real Federación Española de Tenis. Madrid.

González, J. (1992). Fisiología de la actividad física y del deporte. Madird: Interamericana McGraw-Hill.

König, D., y cols. (2001). Cardiovascular, metabolic and hormonal parameters in proffesional tennis players. Medicine and Science in Sport and Exercise, 33(4), 654. https://doi.org/10.1097/00005768-200104000-00022

Kovacs, M. (2007). Tennis physiology. Training the competitive athlete. Sport Medicine, 37, 189-198. https://doi.org/10.2165/00007256-200737030-00001

Méndez, A., Fernández, J.A., Fernández, B., y Terrados, N. (2007). Activity patterns, blood lactate concentrations and ratings of perceived exertion during a professional singles tennis tournament. British Journal of Sport Medicine, 41(5), 296-300. https://doi.org/10.1136/bjsm.2006.030536

Méndez, A., Fernández, J., Bishop, D., y Fernández, B. (2010). Ratings of perceived exertion-lactate association during actual singles tennis match play. Journal Strength Conditional Research, 24(1), 165-170. https://doi.org/10.1519/JSC.0b013e3181a5bc6d

Morgans, L., Jordan, D., Baeyens, D., y Franciosa, J. (1987). Heart rate responses during singles and doubles tennis competition. Physician and Sportsmedicine, 15(7), 67-74. https://doi.org/10.1080/00913847.1987.11702030

Reilly, T., y Palmer, J. (1995). Investigation of exercise intensity in male singles lawn tennis. Science and Raquets Sports, 10-13. London: E & FN Spon.

Robertson, R. J. (1997). Perception of physical exertion: methods, mediators and applications. Exercise an Sport Sciences Reviews, 25, 407-452. https://doi.org/10.1249/00003677-199700250-00017

Roetert, E., y cols. (1992). Performance profiles of nationally ranked junior tennis players. Journal Application of Sport and Science Research, 6(4), 225-231. https://doi.org/10.1519/1533-4287(1992)006<0225:PPONRJ>2.3.CO;2 https://doi.org/10.1519/00124278-199211000-00006

Sanz, D., y Ávila, F. (2004). La preparación física en el tenis: El desarrollo de las cualidades físicas básicas en tenistas de formación. En: Torres, G. y Carrasco, L. (Coords). Investigación en deportes de raqueta: tenis y bádminton. Murcia: Quaderna Editorial.

Smekal, G., Von Duvillard, S., Rihacek, C., Pokan, R., Hofmann, P., Baron, R., Tschan, H., y Bachl, N. (2001). A physiological profile of tennis match play. Medicine Science Sports Exercise, 33(6), 999-1005. https://doi.org/10.1097/00005768-200106000-00020

Therminarias, A., Dansou, P., Chirpaz, M., y Quirino, A. (1990). Effects of age on heart rate response during a strenuous match tennis. Journal Sports Medicine Physicial Fitness, 30, 389-396.

Torres, G., Cabello, D., y Carrasco, L. (2004). Functional differences between tennis and badminton in young sportmen. In: Science and Racket Sports III. Ed; Lees, A., Kahn, J.F. and Maynard, L.W. Routledge: Taylor & Francis Groupe, 185-189.

Torres, G., y Carrasco, L. (2004). Fundamentos fisiológicos y exigencias metabólicas del tenis. En G. Torres y L. Carrasco (eds.), Investigación en deportes de raqueta: tenis y bádminton. Murcia: Universidad Católica de San Antonio.

Torres-Luque, G., Sánchez-Pay, A., Bazaco, M. J. & Moya, M. (2011). Functional aspects of competitive tennis. Journal Of Human Sport & Exercise, 6 (3), 528-539. https://doi.org/10.4100/jhse.2011.63.07

Torres, G., Sánchez-Pay, A., y Moya, M. (2011). Análisis de la exigencia competitiva del tenis en jugadores adolescentes. Journal of Sport and Health Research, 3(1), 71-78.

Weber, K., Ferrauti, A., Porten, S., y Rochelt, S. (2002). Effect of work-load duration on stroke quality in on-court tennis training drills. International Journal of Sports Medicine, 23, Suppl., B-P 287.

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