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CASUISTIC PAPER

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Cardiopulmonary exercise test performed on a football player: a case report

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ABSTRACT

Introduction. Cardiopulmonary Exercise Test (CPET) can precisely determine aerobic capacity, conjugate and independent functions of the pulmonary cardiovascular, and skeletal muscle systems.

Aim. To describe CPET feedback from a high stamina professional football player.

Description of the case. The test took place in course of one CPET session. The method of an individual case study was used in this research. The participant was a local team football player. According to the coaches' opinion, this player had the best ability to perform long distance work. The test was performed using a cycle ergometer. Cardiopulmonary Exercise Test was performed with a cycle ergometer RAMP test.

Conclusion. The player's capacity is at a level that allows us to outline his results as a unique case.

Keywords. capacity, circulatory system, CPET, effort, endurance, football, RAMP, respiratory system

Introduction

The Cardiopulmonary Exercise Test (CPET) is a non-invasive and very safe process engaging an estimation of the respiratory and cardiovascular system during exercise to set personal exercise performance and functional capacity.[1] In the last years, CPET has changed from the area of the surveys in laboratories and sports medicine to the direction of clinical practice.[2] By measuring a wide range of different variables, CPET can precisely determine aerobic capacity, conjugate and independent functions of the pulmonary cardiovascular and skeletal muscle systems.[3] The test provides the researcher an indirect survey of cardiopulmonary physiology and fundamental metabolic base in healthy and unhealthy populations.[4] Respirometry is allowed continuously in physical effort and in rest to register oxygen uptake, carbon dioxide production and quantity of minute ventilation.[5] The measurement of gas exchange is carried out breath by breath and the measurement results are almost simultaneously displayed on the computer screen, by fast processing and correction of data, taking into account the delay, which is the transfer of data from the exhalation to the measurement.[6] The respiratory system has a particular value among body's functioning system. A significant and prominent role of this system is to provide the requested energy for organs and different tissues that are affected seriously in short and long term exercises.[7] CPET is a ramped survey during which

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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the blood pressure, electrocardiography and saturations of oxygen are measured. Respiratory variables, including oxygen uptake and carbon dioxide excretion are also quantified. An amount of variables can be derived taking into consideration the oxygen uptake peak, which depends on effort, and oxygen uptake at the anaerobic threshold, which is not related to motivation or stress.[8] Maximum oxygen peak consumption and oxygen consumption at anaerobic threshold have been reported to be good predictors of physical fitness, physical effort and death rate.[9] Oxygen uptake in CPET test is measured in effort with growing load. Increasing of physical effort intensity, through crossing the lactate threshold, provides to reaching maximal oxygen uptake. Maximal oxygen uptake (VO_2max) parameter is the most popular indicator of physical fitness in the healthy population. In this concept we understand maximal oxygen amount used by an organism in one minute.[10] Effort is usually put forth on a treadmill or upright-bicycle. To emphasize the importance of this test, it should be assumptive that direct measurement uptake is the most efficient and appoint measurement method of physical effort assessment.[11]

This review presents the data of a CPET test of a professional football player. Among a group of participants, this particular player is characterized by a huge maximal oxygen uptake compared both to the other players and to the rest of the population.

Description of the cases

The survey was conducted at the University of Rzeszów. The tests were performed in the Laboratory of Cardiopulmonary Research. The method used in this research was an individual case study. The participant was a local team football player. The player, in opinion of coaches, had the best ability to perform long distance work. The subject took part in the study voluntarily and was informed in detail about the aim of the test.

The test took place in the course of one CPET session. Cardiopulmonary Exercise Test was performed using a cycle ergometer RAMP test Wasserman protocol 1. The test was performed using a cycle ergometer in cooperation with a "Metamax 3B" spiroergometry device and "Metasoft Studio" software. For the functioning of the spiroergometry device, other devices like gas sample line, transmitter belt and elastic strap, or face mask were used. First of all, the CPET device was calibrated in order to exhibit authoritative results. Cardiopulmonary Exercise Test equipment was supported under manufacturer conservancy agreements in keeping with manufacturer references.

The player cycled for 6 minutes with no resistance at a rate of 60 rpm. After this time, resistance was increased linearly at 25 W min^{-1}. The participant was also obligated to keep a minimum rate of 60 rpm during the total time of the test. After maximum effort, the patient performed a regeneration phase with no resistance, pedalling in a 60 rpm load. The regeneration phase and CPET was ended when approximate initial indicators reached their values. Standards used to set the maximal effort that was reached were: VO_2 (ml/kg/min) >46, VO_2 (l/min)/% > 3.51, HR max/% > 182, VO_2/HR > 19, VAT (l/min)/% > 80%, BF > 41, VE max (l/min) > 141.7, VE/VCO_2 slope < 30, VE/VCO_2 in AT < 34.[12] The continuous data was assembled using Metamax Toolbox software. The characteristics of the participant are featured in Table 1.

Table 1. Basic biological and medical data of the participant

Height	184 cm
Body weight	76.0 kg
Mask	blue ,small
Race	White / Caucasoid
Fat tissue	7%
BMI	22
Estimation physical fitness	high
BSA	1.98 m^2

Results

Maximally, the participant performed the exercise test to the level of 413W and reached VO_2max equal to 4.96l/min. Data of measured basic variables are presented in tables number 2 and 3. This result is above the expected value of 3.51 l/min (141%). The relative maximal oxygen uptake VO_2/kg amount is 65ml/min/kg. According to AHA Classification, physical fitness is defined as perfect.[13] At maximum effort, the RER ratio of respiratory exchange tallied 33g/h, and the heart rate HR reached 169/min, which corresponds to 94% of the predicted value. The AT anaerobic threshold is at 3.46 l/ min, corresponding to 45ml /min/kg. This represents 99% of the anticipated, and 70% of actually achieved maximum oxygen consumption. Figures 1, 2 and 3 depicted the VT1 and the VT2 threshold and the method of their appointment.

Discussion

Maximum adaptation to endurance training, which is characterized by the world record holders in endurance competitions, requires many years of regular and optimal training. In addition, it is only possible for people with appropriate genetic conditions[10]. Typical maximal values of oxygen uptake for young students ranges from 44 to 55 ml/min^{-1}/kg^{-1}. Values of VO_2max exceeding 60 ml/min/kg were noticed only in master athletes. VO_2 max exceeding 70 ml/min/kg, were investigated in endurance disciplines like (athletics, short and long distance runs, cycling, ski, cross-country skiing).[15] The master athletes' maximal heart rate was stationary (171

Table 2. Data of basic measured variables 1

Variable	Unit	Rest	Futile load	VT1	VT1 % Norm	VT1 % Max
$V'O_2$	l/min	0.61	0.68	3.46	99	70
$V'O_2$/kg	ml/min/kg	8	9	45	99	70
$V'O_2$/HR	ml	9	10	25	127	84
WR	W	0	0	277	87	67
HR	/min	68	67	141	78	83
$V'E/V'O_2$		21.2	21.1	24.5	-	61
$V'E/V'CO_2$		28.6	28.1	26.1	-	71
V'E	l/min	15.2	16.7	89.9	-	43
BF	/min	16	16	36	87	49

Table 3. Data of basic measured variables 2

Variable	VT2	VT2 % Norm	VT2 % Max	$V'O_2$max	$V'O_2$max % Pred	Norm	Maximal absolute values
$V'O_2$	4.52	129	91	4.96	141	3.51	5.17
$V'O_2$/kg	60	129	91	65	141	46	68
$V'O_2$/HR	28	144	96	29	151	19	30
WR	378	118	91	413	129	321	414
HR	162	89	95	169	94	181	171
$V'E/V'O_2$	32.8	-	82	39.9	-	-	50.1
$V'E/V'CO_2$	31.5	-	85	37.0	-	-	37.8
V'E	156.0	-	75	208.2	-	-	212.2
BF	53	127	72	73	176	41	79

+/- 3 beats/min) and their maximal O_2 pulse reduced from 0.32 to 0.30 ml.kg^{-1} beat[16]. When high intensities of exercise describe the training program, taking advantage of heart rate to quantify training loads appears invalid.[16]

Based on surveys in football, systematic recreational football training increases maximum oxygen uptake VO_2max in players, who were previously untrained. Many surveys have depicted 7–15% increases in VO_2max after training of duration 12–24 weeks, which is similar to or higher than observed in surveys with cycling and running.[17] Commonly, peak O_2 and AT fall equally.[18] It has been noted that the variables of the power–time connection are related to different markers of cardio-respiratory fitness.[19]

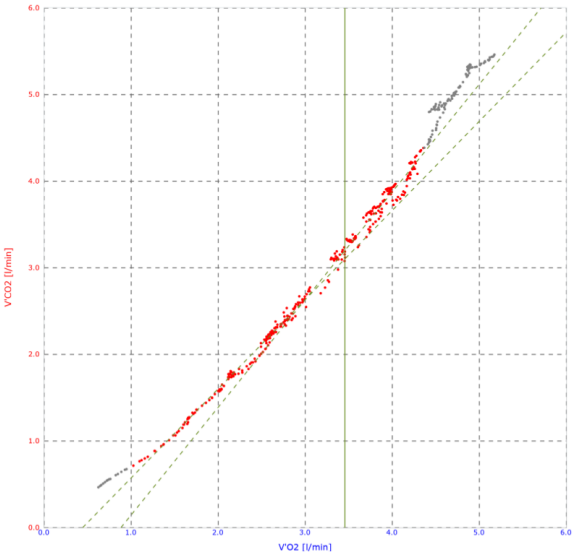

Fig. 1. VT1 appointed on data refined method average apiece sample, with 13 parameters. Range of calculations from 0:07:00 to 0:18:50

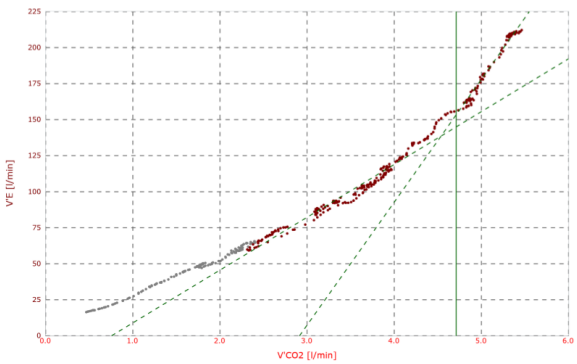

Fig. 2. VT2 appointed on data refined method average apiece sample, with 13 parameters. Range of calculations from 0:13:18 to 0:20:36

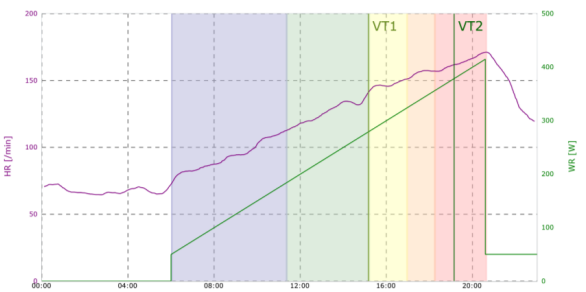

Fig. 3. Zones of exercise intensity. Violet: compensating, green: sustainable, yellow: formative, orange: mix aerobic/anaerobic red: anaerobic (LA). Zones based on manufacturer proposal[14]

The Cardiopulmonary Exercise Test can be used to estimate the rawness of pulmonary hypertension in participants with established illness and provide feedback to therapy. Studies showed that persons with VO_2 peak lower than 10.4 ml kg^{-1} min^{-1} had a worse prognosis.[20]

Conclusion

The tested player achieved $V0_2max$ which ascertained perfect assumptive values. Values of VT1, oxygen pulse, breathing frequency and maximum work performed by the participant can also be acknowledge as perfect. VO_2max, which is the most important indicator of physical fitness, assessing efficiency on level of 65 ml min^{-1}/kg^{-1} is a result, which is reached by top athletes in endurance competitions. Taking into account the testing in laboratory conditions, the perspective of achievement of an even higher VO_2max in natural conditions for the player is presumable.

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