The Examination of the Heart Rate Recovery after Anaerobic Running in Soccer Players

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A B S T R A C T

The purpose of this study was to examine the heart rate recovery depending on anaerobic running. A total of 23 professional soccer players who were player of Turkish Super Leagues, were examined. Anaerobic Run test was applied to the soccer players and their heart rates were recorded before running, just after running, in 3rd and 6th minutes of recovery period. Any statistical differences were not found between the heart rates before run and in 6th minute after run ($p>0.05$). On the other hand, there was a statistical difference between the heart rates before run, after run and in 3rd minute after run; the heart rates after run and before run; the heart rates in 3rd and 6th minutes of recovery ($p<0.05$). A relationship was determined between the heart rates after run, before run ($r=0.457$) and in 3rd minute of recovery ($r=0.537$) and the heart rates in 3rd and 6th minutes of recovery ($r=0.629$). On the other hand, no relation was found between the heart rates before run, in 3rd minute recovery ($r=0.247$) and in 6th minute of recovery ($r=–0.004$) and the heart rates just after run and in 6th minute of recovery ($r=0.280$) ($p>0.05$). In conclusion, even if the increase of heart rate occurring after anaerobic run doesn't completely return to normal in 3rd minute of recovery, it will supply the athlete with a suitable condition for the second loading with regard to efficient rest. It is thought that a rest over 3 minutes should be given for athletes to make the heart rate after anaerobic run return to normal.

Key words: *football, heart beat, recovery, anaerobic run test*

Introduction

Elite football is a complicated sports and performance depends on many factors such as training level, psychological situation, and player technique and team strategy[1]. Soccer players may repeat high-intensity short-distance runs for a few times in series during the match[2]. Considering this skill's being developed, trainers use high-intensity exercises in their programs. Recovery mode is very important in determining the high-intensity training periods. So, recovery is vital for all players. Much more recovery may start during detraining. Here, there is a sensible balance between rest, recovery and detraining. The skill of individual recovery depends on rest break necessary between trainings. Older players need more recovery time than younger ones because physiological potential of young players is higher[3].

Recovery way is important in determining the breaks of high-intensity runs. There are two basic metabolic processes in recovery time after a maximal exercise. These are renewal of phosphocreatine (PC) stores and acid-base equilibrium in muscles exposed to exercise[4,5]. Quite long-term recoveries are used to reach lower lactate level or lactate's going away from organism[6]. On the other hand, much more recovery doesn't contribute to support suitable levels in organism, so the training frequency doesn't seem to have been introduced as necessary in this situation and enough overloads doesn't take place to support performance.

Heart rate and myocardial spasms increase during run to supply active muscles with energy[7]. With finishing exercise, as a function of parasympathetic nervous system' stepping in; Heart rate decreases immediately after the exercise[8]. Then, decrease in heart rate rises more and this may go down to the level before run, also this situation depends on the effect degree of sympathetic nervous system[9].

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In last years, in some studies carried out, it has been reported that decrease in heart rate after exercise takes much longer time[10,11,12]. Therefore, in this study, it has been aimed to examine the heart rate recovery increasing in parallel with the anaerobic run.

Materials and Methods

Experimental approach to the problem

This investigation involved sectional design to evaluate the heart rate recovery depending on anaerobic running. A total of 23 professional soccer players were examined. These soccer players were playing in super leagues of Turkey. The F-MARC test battery, which was designed by FIFA, was used for soccer players.

Subjects

A total of 23 soccer players were examined. These soccer players were playing as professional in super leagues of Turkey. The mean (SD) age was 25.91±4.252 years, height was 180.09±5.178 cm, and weight was 75.957± 7.721 kg for all of the soccer players. Soccer players' height is measured with an instrument sensitive to 1 mm. Their body weight is measured with a weigh bridge sensitive up to 20 g while they are dressed in only shorts (and no shoes). Height variable is in terms of meters, and body weight variable is in terms of kilograms. Before conducting the experiment, all soccer players were informed of the risks of the study and given informed consent, and it was a part of their Professional contract. The study was approved by an ethics board and met the conditions of the Helsinki Declaration.

Procedures

In this study, the F-MARC test battery designed by FIFA, was used[21]. All of the soccer players included in the study had the same physical fitness because they attended the preparatory period, which had lasted 6 weeks. The Anaerobic run test was applied the first week of September during competition season. The Anaerobic run test was started with a 10-minute warm-up session.

The heart rate (HR)

The heart rate all of the soccer players are measured before the run, directly after the finish, and again in 3rd and 6th minutes after the run. Heart rate was recorded and monitored continuously for the anaerobic run test via a heart rate monitor (Polar Electro Oy, Kempele, Finland). Each soccer player was familiarized with the anaerobic test procedures prior to data collection. Test-retest intraclass reliabilities the anaerobic run test were 0.89 [22].

Anaerobic running test (Figure 1)

The anaerobic Run test facilitates assessment of anaerobic endurance. Before the run, the player's heart rate is measured at rest. On the signal »Ready – Go«, he runs in a triangle from the flag post at the start, 80 m to the flag post (1), around it, 20 m to the flag post (2), around it, 82.4 m back to the start, around this flag post, and then 20 m to the finishing line (4). Directly after the run and then 3rd and 6th minutes of recovery period heart rate is measured again. The examiner measures the time between the »Go« signal and crossing the finish line with a handheld stopwatch. The heart rate is measured before the run, immediately after the running, and again in 3rd and 6th minutes of recovery period. Measurement is in units of 0.1 seconds for the time and heart beats per minute for the heart rate (Figure 1)[1,13].

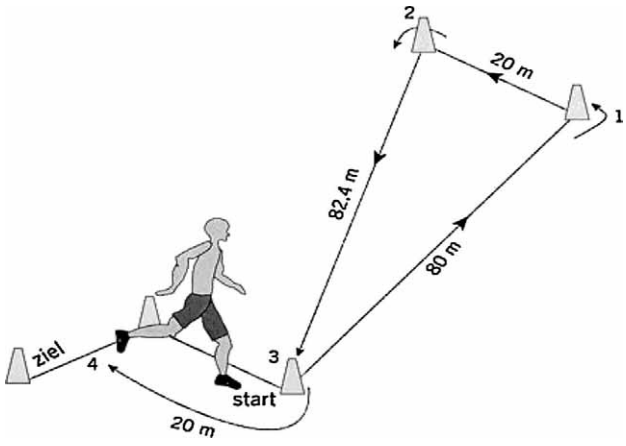

Fig. 1. Anaerobic running test[1,13].

Statistical analysis

The SPSS statistical program (version 16.0) was used for data analysis. Standard statistical methods were used for the calculation of means and SD. The Kolmogorov-Smirnov test was used to determine if dependent variables were normally distributed. In comparative of the heart rate, Multivariate and Test of Within-Subject effect tests were used according to the variance-covariance structure. However, Bonferroni test was used for the repeated measurements. Pearson correlation coefficient was used for the relation between the heart rates of the soccer players. For all analyses, the criterion for significance was set at an alpha level of p=0.05.

TABLE 1
THE SUMMARY OF THE DATA RELATED TO THE SOCCER PLAYERS PARTICIPATED IN THE RESEARCH AS AVERAGE AND STANDARD DEVIATION

	N	$\bar{X}$	SD
Age (year)	23	25.91	4.252
Height (cm)	23	180.09	5.178
Weight (kg)	23	75.957	7.721
Anaerobic Running (second)	23	29.943	1.053
Before Running HR	23	96.696	3.037
After Running HR	23	172.70	5.269
3rd minute of recovery HR	23	115.00	9.224
6th minute of recovery HR	23	99.217	5.877

Results

In the shown in Table 1, the mean (SD) age was 25.91±4.252 (years), Height was 180.09±5.178 (cm), weight was 75.957±7.721 (kg), Anaerobic run was 29.943± 1.053 (seconds), before run HR was 96.696±3.037 (beats/minute), after run HR was 172.70±5.269 (beats/minute), 3rd minute of recovery HR was 115.00±9.224 (beats/minute), and 6th minute of recovery HR was 99.217±5.877 (beats/minute) for the soccer players.

Significant differences were found between the heart rates before run, after run and in 3rd and 6th minutes after run ($p<0.05$, Table 2).

When Table 3 was examined, a significant difference has been found between heart rates before run and heart rates after run and heart rates in 3rd minute of recovery ($p<0.05$, Table 3). In these comparisons, heart rates before run have been found to be lower than the ones after run and in 3rd minute of recovery. A significant difference was also found between the heart rates before run and after run, and between the heart rates in 3rd and 6th minute of recovery ($p<0.05$, Table 3) and it has been determined that the heart rates after run were higher. Beside, it has been found that there is a significant difference between the heart rates in 3rd minute of recovery and the heart rates before run, after run and in 6th minute of recovery ($p<0.05$) and in these comparisons, it has been seen that the heart rates in 3rd minute of recovery are higher than the ones before run and in 6th minute of recovery. No significant difference has been determined between the heart rates before run and in 6th minute of recovery ($p>0.05$, Table 3).

When Table 4 was examined, a relationship was determined between the heart rates before run and after run ($r=0.457$, $p<0.05$, Table 4) and the heart rates in 3rd minute of recovery ($r=0.537$, $p<0.05$, Table 4). Beside, it was reported that there is a relation between the heart rates in 3rd minute of recovery and the ones in 6th minute of recovery ($r=0.629$, $p<0.05$, Table 4). After all, no relation was found between the heart rates before run and the ones in 3rd minute of recovery ($r=0.247$, $p>0.05$, Table 4) and in 6th minute of recovery ($r=0.004$, $p>0.986$, Table 4). Also, any relationship was not indicated between the heart rates after run and the ones in 6th minute of recovery ($r=0.280$, $p>0.05$, Table 4).

Discussion and Conclusion

In this study carried out with the aim of examining the heart rate recovery increasing in parallel with the anaerobic run, it was found that the heart rate before run was 96.696±3.037 beats/min.; the heart rate after run was 172.70±5.269 beats/min.; the heart rate in 3rd minute of recovery was 115±9.224 beats/min., and the heart rate in 6th minute of recovery was 99.217±5.877 beats/min.

The heart rate recovery after exercise depends on some factors. These are the density of exercise, cardiorespiratory suitability, cardiac autonomic nervous system modulation, hormonal changes and baroreflex sensibility[14]. Therefore, much faster heart rate recovery after exercise may result from much bigger cardiac parasympathetic activity in rest. In current studies over heart

TABLE 2
THE COMPARISON OF THE HEART RATES OF THE PLAYERS PARTICIPATED IN THE RESEARCH

		Value	F	Degree of freedom of Hypothesis	Degree of freedom of Mistake	p
HR	Pillai's Trace	0.997	2155	3.000	20.000	0.000

TABLE 3
MULTIPLE COMPARISONS OF THE HEART RATES OF THE PLAYERS PARTICIPATED IN THE RESEARCH

(I) HR	(J) HR	Difference means (I-J)	Std. Eror	p
Before Running HR	After Running KAH	–76.000	0.986	0.000*
	3rd minute of recovery HR	–18.304	1.871	0.000*
	6th minute of recovery HR	–2.522	1.382	0.489
After Running HR	Before Running KAH	76.000	0.986	0.000*
	3rd minute of recovery HR	57.696	1.624	0.000*
	6th minute of recovery HR	73.478	1.399	0.000*
3rd minute of recovery HR	Before Running KAH	18.304	1.871	0.000*
	After Running KAH	–57.696	1.624	0.000*
	6th minute of recovery HR	15.783	1.496	0.000*
6th minute of recovery HR	Before Running KAH	2.522	1.382	0.489
	After Running KAH	–73.478	1.399	0.000*
	3rd minute of recovery HR	–15.783	1.496	0.000*

TABLE 4
THE RELATION BETWEEN THE HEART RATES OF THE PLAYERS PARTICIPATED IN THE RESEARCH

		After Running HR	3rd minute of recovery HR	6th minute of recovery HR
Before Running HR	R	0.457	0.247	–0.004
	P	0.028*	0.257	0.986
	N	23	23	23
After Running HR	R		0.537	0.280
	P		0.008*	0.196
	N		23	23
3rd minute of recovery HR	R			0.629
	P			0.001*
	N			23

rate recovery according to the kinds of exercises, the recovery after cycling was faster than the one after treadmill in exercises in which one-minute recovery in heart rate or the heart rate recovery in one minute after exercise, determined as the percentage of one-minute recovery in heart rate were examined[15].

It was reported that the time when the decrease in heart rate became fixed as a reactional function of parasympathetic nervous system after exercise was only in first 30 seconds after exercise[16]. The past studies have shown that the heart rate recovery in one minute after exercise has 8 bpm changes at average day by day when submaximal run tests are used and passive recovery is provided at sitting position[17]. The studies about heart rate decreases may be useful in determining the changes in trainings, in regular controls of submaximal heart rates, and in submaximal run density with the rise of aerobic suitability[17]. Also, heart rate increases in submaximal exercise density may be indicators of hard training, water loss and training situations' decreasing[18]. In a study carried out, it was found that the heart rate recovery was faster in players having the higher aerobic capacity[19].

An increase happens in heart rate at the moment when exercise starts and this increase comes to balance situation in a few seconds then the increase in heart rate shows itself depending on exercise, this increase goes on regularly according to the intensity of exercise and heart rate reaches maximum level[20]. The recovery time after exercise depends on the condition level of athlete. The heart rate in athletes having good condition turns to normal in shorter time. If the number of heart rates in 6 minutes after loading is below 115 beats/min., the performance value is well, if it is below 105 rate/min., the performance value is very well, if it is below 100 beats/min., the athlete has high performance and ready for the competition conditions[21].

When the heart rates of Denmark high-level players were examined, it was reported that the maximum heart rate changed between 150 beats/min. and 190 beats/min. and the heart rate decreased below 150 beats/min. in short terms during the match[22].

In conclusion, the increase in heart rate happening in anaerobic run supplies the athlete with the suitable environment for the second loading depending on productive rest even if it doesn't turn to normal completely in 3rd minute after run. It is thought that a rest over 3 minutes should be given to provide the heart rate's turning to normal after anaerobic run in athletes.

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PREGLED OPORAVKA SRČANOG RITMA NAKON ANAEROBNOG TRČANJA KOD NOGOMETAŠA

S A Ž E T A K

Cilj ovog istraživanja bio je ispitati oporavak srčanog ritma ovisno o anaerobnom trčanju. Isiptano je ukupno 23 profesionalnih nogometaša, igrača turske Super lige. »Anaerobic Run« test je primijenjen na nogometaše i njihov otkucaj srca je zabilježen prije trčanja, nakon trčanja kao i u 3. i 6. minuti razdoblja oporavka. Statističke razlike nisu pronađene između otkucaja srca prije trčanja i u 6. minuti nakon trčanja ($p>0,05$). S druge strane, postoji statistički značajna razlika između otkucaja srca prije trke, nakon trke, i u 3. minuti; otkucaja srca nakon i prije trke; prije trke i u3. i 6. minuti oporavka ($p<0,05$). Utvrđen je odnos između otkucaja srca nakon trke, prije trke ($r=0,457$) i u 3. minuti nadoknade ($r=0,537$) i otkucaja srca u 3. i 6. minuta oporavka ($r=0,629$). S druge strane, nije pronađen odnos između otkucaja srca prije trke, u 3. minuti ($r=0,247$) i u 6. minuti oporavka ($r=–0,004$) i otkucaja srca neposredno nakon vožnje i u 6. minuti oporavka ($r=0,280$) ($p>0,05$). Zaključno, čak i kada se otkucaj srca nakon anaerobne trke ne vrati potpunosti u normalnu vrijednost u 3. minuti oporavka, sportaš će imati zadovoljavajuće uvjete za daljnje napore. Smatra se kako je sportašima potrebno pružiti oporovak duži od 3 minute kako bi se broj otkucaja srca nakon anaerobnog trčanja vratio u normalu.