Physical performance characteristics of university male tennis players in division I and II

Özkatar Kaya E.^{1ABCDE}, Karahan M.^{2BCDE}

¹ Faculty of Sport Sciences, Erciyes University, Turkey

² Faculty of Sport Sciences, Aksaray University, Turkey

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Abstract

Purpose: The purposes of this study were to examine the physical performance characteristics of Division-I (D-I) and Division-II (D-II) university male tennis players and to evaluate whether these characteristics could be determinative on the divisional differentiation.

Material: Twenty athletes who compete in D-I (n=10) and D-II (n=10) of Turkey university tennis league (n=10) and also ranked in top-ten in their division voluntarily participated in this study.

Results: Measurement of agility, upper and lower body explosive powers, fatigue index, aerobic and anaerobic powers was conducted on two non-consecutive days. Significant differences were observed in physical performance characteristics powers between the groups ($p<0.05$). D-I players had significantly greater anaerobic power, agility, vertical jump height, upper and lower body explosive powers, and lower fatigue index level than D-II players. However, aerobic power did not differ between groups.

Conclusions: It may be possible that these results allow us to suggest that physical performance characteristics should be regarded as one of the important discriminative factors in determining the competitive level of university male tennis players.

Keywords: tennis, aerobic power, anaerobic power, agility.

Introduction

Tennis is characterized as a racket sport with an intermittent movement profiles involving short rallies in which each rally that lasts 4-12 seconds with 20- 90 seconds rest intervals sprinkled with brief breaks. These movements are repeated dozens of times by the athletes at a short high intensity to almost every direction [1], and sustainability of those movements in 1-5 hours' tennis matches require well-developed physical performance characteristics [2]. Physical performance characteristics such as change of direction speeds, upper and lower body explosive powers, muscular strength, endurance, aerobic and anaerobic powers are considered as important variables contributing to the performance of the tennis competition. Although success in modern sports depends on various factors such as psychological readiness, technical and tactical ability, physical performance characteristics should be taken into consideration as the cornerstone of technical and tactical performance in tennis. [3]. For example, the upper and lower body explosive powers are important components for an effective execution for ball acceleration during service or technical strokes [4]. However, aerobic and anaerobic powers are regarded significant indicators that players are able to resist to fatigue during 1-5 hour game actions [5].

A few studies comparing divisional or age-related differences in tennis have highlighted to demonstrate the importance of the relationship between physical performance characteristics and player levels. Gelen et al. [6] reported that physical fitness profile such as strength, speed, jump and anaerobic power of adult male tennis athletes depicted divisional differences. Kuroda et al.

[7] concluded in their study that agility for juniors and endurance for seniors were the discriminative physical performance variables to determine the competitive levels among tennis players. Similarly, Roetert et al. [8] indicated that agility is the only predictor to differentiate competitive levels in younger tennis players. In a recent study, Ulbricht et al. [4] found that national selected tennis players had better physical performance characteristics than their regional counterparts.

The researchers studying on the identification of the physical fitness profiles of athletes reported that it was generally necessary to determine both the basic and specific physical performance characteristics of athletes for the sake of selection of players for a particular sport or discipline and organization of training process [9]. As far as we know, up to this date, no study has been conducted on the university male tennis players' fitness profiles. Therefore, in this study, it was aimed to make a comparison of physical performance characteristics of the male tennis players who were competing in Division I and II of Turkey university league. In addition, it was to evaluate whether physical performance characteristics were determinative on the divisional differentiation.

Material and Methods

Participants.

Twenty single male players who were depicted descriptive demographic characteristics in table 1 and ranked on the first top ten (the ranking of players was based on the points in tournaments of their divisions) in Division I (D-I, n=10) and division II (D-II, n=10) of Turkey university tennis league, participated voluntarily in this study. In prior to the tests, experimental procedures

Table 1. Demographic Characteristic of University Tennis Players

Divisions	Age (Years) Mean $\pm$ sd	Sports Experiences (Years) Mean $\pm$ sd	Body Height (cm) Mean $\pm$ sd	Body Mass (kg) Mean $\pm$ sd
D-I	22.1 $\pm$ 2.1	8.3 $\pm$ 0.9	176.6 $\pm$ 3.6	74.2 $\pm$ 2.6
D-II	22.3 $\pm$ 1.4	7.9 $\pm$ 1.1	175.1 $\pm$ 3.2	74.5 $\pm$ 1.5

Sprint numbers 1 and 5 represent a distance of 4.11 m whilst numbers 2, 3 and 4 each measure 5.49 m.

Fig. 1. Spider Agility Test

and risks and possible discomforts related to this study were explained to the players. Informed written consent was obtained from each player to participate in this study which was approved by the university ethical committee for human research.

Participants were requested whether they had prior experience with the tests used. Therefore, the testing protocol was explained in detail to the athletes who hadn't been tested previously on several occasions. The tests were carried out over three separate consecutive days that following the end of the competition season for both groups and the athletes were allowed their standard warm up prior to tests. Athletes were asked to participate in the tests by wearing match clothes and to avoid alcohol consumption and excessive physical practices that could affect test performance for 24 hours, and eating and drinking two-hour prior to tests.

Research Design.

Aerobic Power (VO_{2max}) Test: The athletes ran in a straight line to axis upon completing, and proceeded according to the given sound signals. The test was finished when the players stop or fail to reach the end lines concurrent with the audio signals on two consecutive occasions. Estimated VO_{2max} values were calculated using the method of Leger et al. [10].

Anaerobic Power Test: Anaerobic power was determined with the RAST (*Running Anaerobic Sprint Test*) protocol. Players performed six 35-m maximal sprints with a 10 sec interval between each sprint. Each sprint time was measured by two photocell equipment. The power in each sprint was then calculated by the formula that was determined by Zagatto et al. [11].

Vertical Jump and Explosive Power Test: The vertical jump heights of the athletes were tested by using the Vertec tool. Three repetitions with 60-second rest interval were carried out, and the best data were formulated to determine explosive power values as watts [12].

Overhead Medicine Ball Throw: The players stood in a standing position with feet parallel to each other slightly apart, and the players hold a 3-kg medical ball with both hands and bring it to the back of the head, and then they threw it as forward as possible in facing direction. The farthest distance that the player threw the ball was measured and the best performance of two efforts was recorded.

Spider Agility Test: A rectangle (30 by 46 cm) was marked off behind the centre baseline. Five tennis balls were positioned on the court one on each numbered corner. The player started with one foot in the rectangle after starting from the timing gate. The player was requested

to complete all sprints as outlined figure 1, retrieving each ball and to place each one in the rectangle one at a time, moving in a counter clockwise direction [13]. The best performance of the two non-consecutive trials (3 min rest) was recorded.

Statistical Analysis.

After calculation of the means and standard deviations (SD) of all variables, data analyses were performed using an independent t-test to determine whether there were significant differences between tested values of division I and II's players. The level of significance was set at $p < 0.05$.

Results

Basic statistical characteristics of division I [D-I] and division II [D-II] groups are shown in table 2. No significant differences were found in maximal aerobic and anaerobic power between D-I and D-II. However, D-I player had more developed agility, vertical jump height, upper and lower body explosive power, fatigue index, mean and minimal anaerobic power than D-II ($p < 0.05$).

Figure 2 shows the percentage of differences between division I and II. The highest significant difference (17%) as observed in the fatigue index. The percentage of differences in the agility (5.62%), vertical jump height (5.38%), lower body explosive power (5.74%), the distance of medicine ball throws (6.74%), mean (9%) and minimal anaerobic (12.7%) power was also significant. However, although the percentages of differences in

maximal aerobic and anaerobic power were 3.5 and 4.2% respectively, these values were not statistically significant.

Discussion

To our knowledge, this is the first study that has examined the physical performance characteristics of Turkish university male tennis players in the different divisions. The main findings of this study were that division I male tennis players achieved statistically better scores than the division II in agility, upper and lower explosive power, fatigue index and mean and minimum anaerobic power ($p < 0.05$). However, no significant differences were observed in maximal anaerobic and aerobic power.

Tennis is a sport that characterizes with brief rest periods following high or maximal intensity efforts. The intense efforts that requires to use a-lactic anaerobic energy sources (ATP-PCr) are related to the anaerobic power [1]. In this study, the RAST test that is formed as six repeated 35-meter sprint with 15 seconds recovery between sprints was used to determine the anaerobic power. Maximal anaerobic power was calculated by formulating the best 35-meter sprint and body weight of the athletes [11]. There was no significant difference between the best sprint times and body mass of the athletes in division I and II. So, the difference in maximal anaerobic power (4.2%) was not statistically significant. In contrast, the greatest significant difference between divisions I and II were observed in mean (9%) and minimal (12%) anaerobic power, and fatigue (17%) index

Table 2. Physical Performance Characteristics of Players in Division I and II

Variables	Divisions	Mean	SD.	Difference	T	P
Agility [sec]	D-I	15.83	.84	-.55	3205	<0.05
	D-II	16.72	.91			
Vertical Jump Height [cm]	D-I	46.6	2.4	2.38	2494	<0.05
	D-II	44.2	1.8			
Lower Body Explosive Power [watt]	D-I	1971.54	156	107	2557	<0.05
	D-II	1864.03	97			
Medicine Ball Throw [m]	D-I	12.36	.65	.78	2306	<0.05
	D-II	11.57	.86			
Mean Anaerobic Power [watt]	D-I	527.35	38	43.5	2573	<0.05
	D-II	483.76	37			
Maximal Anaerobic Power [watt]	D-I	619.89	43	25	1222	>0.05
	D-II	594.83	48			
Minimal Anaerobic Power [watt]	D-I	527.35	38	62	4007	<0.05
	D-II	483.76	37			
Fatigue Index [watt/t]	D-I	5.51	.81	-.94	2430	<0.05
	D-II	6.45	.92			
VO _{2max} [ml/kg/min]	D-I	51.39	2.4	1.74	1750	>0.05
	D-II	49.64	1.9

Fig. 2. Percentage of differences between D-I and D-II: 1 – agility; 2 - vertical jump height; 3 - lower body explosive power; 4 - medicine ball throws; 5 – mean anaerobic power; 6 – maximal anaerobic power; 7 - minimal anaerobic power; 8 – fatigue index; 9 – anaerobic power; * - statistically significant ($p < 0.05$).

($p < 0.05$). The reduction in high intense sprint activities towards the end of the game could be a result of fatigue [14]. It has been speculated that this type of fatigue may be in relation to a decrease in muscles' glycogen levels or phosphagen stores, or decreases of muscle buffer capacity [15]. Bishop et al. [16] reported that the RAST induces a greater depletion of phosphagen stores during the first three sprint intervals. Thus, minimal anaerobic power indicates using lactic anaerobic energy metabolism which has the substantial influence on that physiological variable of fatigue. This could be explained by the inadequacy of fatigue resistance in repeated sprint of D-II players when compared with D-I's. During a tennis match that lasts at least 1.5 hours, the players have to perform sprint activities in different parts of the court within each 4-10 seconds rally [1]. Higher anaerobic power and lower fatigue index could be regarded as an indication that players could perform the ability of repeated sprints that reduced towards the end of a high-intensity period of the game [17]. This result suggests that anaerobic power may be a determining physical component of differentiation between divisions in the university tennis league.

This study showed that agility scores of D-I athletes were higher on average 5.62% than D-II's, and this result also indicated a significant statistical difference between the groups ($p < 0.05$). This result was supported by the finding of Kuroda et al. [7] who pointed out significant differences between superior and average junior tennis players' spider agility test scores. A tennis player needs to perform to different regions of the court by moving in different multi-directions so that he or she can able to hit the ball during the match. Thus, agility is regarded as one of the physical characteristics and a determinant

factor of these game actions that most influence the level of competition of tennis players [8]. Therefore, this result suggests that agility may be an important indicator of the divergence between divisions of university male tennis players.

The medicine ball throws and vertical jump height formulated with body mass results showed that the D-I group was able to express greater upper (6.74%) and lower body (5.74%) explosive power of shoulder and leg extensor than the D-II group, respectively. The results for the lower body explosive power could be associated with vertical jump heights. Given that vertical jump-height was significantly different between two groups of the tennis players. During the game, a tennis player executes average 2.5-3 strokes per rally, and most strokes are implemented within a distance of 2.5 m or 4.5 m where the player's movement pattern with sprinting speed that depending on player's ability of the lower explosive power as well as the ability of the change of direction speed [4]. So higher body explosive power in D-I tennis players may contribute to greater leg drive in tackles during the ball stroke in order to increase the ball more speed. The upper explosive power is needed when hitting the ball, and there is a strong relationship with the upper explosive power and the serve or the stroke velocity in tennis [18] as well as many factors such as technical, mechanical that affect service or stroke velocity [19]. However, the stroke velocity can not only be related to the ball speed, because it often depends on the combination of several factors such as stroke technique, elasticity or coordination [20]. Nevertheless, it should be taken into account that the higher upper body explosive power will able to contribute to a tennis player gaining more points or won the game.

Related with, Ulbricht et al. [4] reported that there was a positively strong correlation between player's level and upper explosive power.

Although tennis game is based on the movements such as short sprint, striking the ball, change of direction running that requiring anaerobic energy sources, aerobic conditioning is needed to avoid fatigue and aid in recovery between rallies or sets, and it may also help to promote continuous success in tennis game. For this reason, it has been reported that an elite male tennis player for upper-level competition performance should have maximum oxygen use capacity within the range of 44-69 ml/kg/min [5]. In this study, it was found that the estimated $\text{VO}_{2\text{max}}$ values of the male tennis players were 51.39 and 49.64 ml/kg/min for D-I and D-II, respectively, and this result was seen to be consistent with the literature criteria. This study also showed that there was a difference of 3.5%, which is not significant between the $\text{VO}_{2\text{max}}$ of the groups. Kovacs [1] argues that there may not be a significant difference between elite and sub-elite tennis players in terms of aerobic capacity because of the specific nature of tennis game which requires more anaerobic energy use. Aerobic capacity differences may not be often seen between divisions of those sports athletes where anaerobic energy use is more intense, but it should be taken into consideration that $\text{VO}_{2\text{max}}$ values of such racket sports athletes may have significant differences related to the intensity of the training or competition [21]. These results could be explained by the fact that players competing with the sport of anaerobic content would not be able to make any specific training to improve their aerobic variable.

As a result, in this study was observed a significant difference in physical performance characteristics between D-I and D-II university male tennis players, with mean and minimal anaerobic power, fatigue index, agility, vertical jump height, upper and lower body explosive

power increasing as the division level increased. However, maximal aerobic and anaerobic power values did not differ between divisions. Thus, it can be concluded that higher mean and minimal anaerobic power, agility, vertical jump height, upper and lower body explosive power, and lower fatigue index were as common discriminator variables to determine the difference between divisions of university male tennis players. Furthermore, the significant differences in physical fitness profiles between D-I and D-II players suggest that well-developed anaerobic power, fatigue resistance, change of direction speed, lower and upper body explosive power, as well as the technical skills, tactical knowledge and psychological readiness may contribute to be higher standard of elite level tennis league players. In contrast, this study did not indicate that aerobic power data was a determining factor of the divisional differences in the levels of D-I and D-II male tennis players. Therefore, further research is needed to identify whether aerobic power is a determining variable for male tennis players' levels according to the divisions.

Conclusions

It is important to have knowledge on the divisional differences of the fitness profile required by a particular sport to form the norm for that sport and to classify and evaluate the players according to the performance level. The physical performance characteristics play an important role in determining players' potential for success in tennis and can be a decisive factor that may make a difference between divisions in a tennis game. Therefore, the determination of the success-related physical performance variables in tennis may be valuable both scientifically and practically.

Conflict of interest

The authors have declared no conflict of interest.

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Information about the authors:

Özkatar Kaya E.; (Corresponding Author); <http://orcid.org/0000-0002-6349-8761>; eozkatar@gmail.com; Faculty of Sport Sciences, Erciyes University; Kayseri, Turkey.

Karahan M.; <http://orcid.org/0000-0002-1907-6908>; mkarahan@aksaray.edu.tr; Faculty of Sport Sciences, Aksaray University; Aksaray, Turkey.

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