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Full Length Research Paper

The relationship between speed and isokinetic knee strength in female volleyball players

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ABSTRACT

The present study aims to investigate the relationship between speed and isokinetic knee strength applied at different angular velocities in female volleyball players. 11 female volleyball players from the senior category volunteered in the study ($mean_{age}$: 20.2±3.9 years, $mean_{height}$: 176.8±7.1 cm, $mean_{weight}$: 66.6±5.7 kg). Isomed 2000 isokinetic dynamometer was used in order to measure the isokinetic strength of participants while 20 m sprint test was conducted in order to measure the speed. In measuring isokinetic strength, knee flexion and extension (H/Q) were measured separately on concentric/concentric dominant and non-dominant legs at 60°/sec angular velocity for 5 repetitions, at 180°/sec for 10 repetitions, and at 300°/sec for 15 repetitions. In data analysis, Spearman's correlation test was used for the relationship between isokinetic knee strength applied at different angular velocities and speed ($p < 0.05$). The highest peak torque value in participants was measured on both sides at 60°/sec angular velocity. This was followed by 180°/sec and 300°/sec angular velocities respectively. There was no significant relationship between isokinetic knee strength applied at different angular velocities and speed. In conclusion, there is not any significant relationship between speed and isokinetic knee strength in female volleyball players.

Keywords: Volleyball, speed, isokinetic strength.

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INTRODUCTION

Volleyball is a dynamic physical sport which is based on agility, strength, mobility, flexibility, endurance, and jumping with a high tempo and does not have a predetermined duration (Şimşek et al., 2007). Volleyball involves movements that require different muscle strengths at fast or slow tempo. The performance of a volleyball player is directly affected by the capacity of this power generation (Schons et al., 2018). In addition, muscle strength is an indispensable part of sportive performance (Lidor and Ziv, 2010).

Volleyball is a team sport involving technical elements with explosive power such as jumping, spike, and block. In addition to these technical elements, one of the most important factors affecting the success of elite athletes in competitions is muscle strength and power. Sports involving maximal power such as jumps require a high level of motor characteristics in hamstrings and quadriceps (Hadzic et al., 2010).

Due to its court, volleyball requires short-distance sprints. Volleyball players engage in movements involving speed and agility in their own zones while performing technical elements in a rally and/or moving towards the ball. They need to have a fast approach run and a fast spiking arm in order to spike harder. In addition, block, passing and defense require a quick movement between zones. In such a fast sport, speed is an indispensable motoric component (Cengizel, 2019a, b).

It was reported that elite volleyball players performed 250 to 300 high power activities involving hip and knee extension as well as ankle plantar flexion (Hadzic et al., 2010). Knee extensors are active at maximal level in eccentric mode in the landing phase during knee flexion. In addition, rapid deflections in volleyball requires a rapid transition from eccentric to concentric muscle movement in the lower extremities (Gollhofer and Bruhn, 2003). This demonstrates the role of hamstring and quadriceps muscle strength in motor skills such as sprint, which requires explosive power.

It is known that isokinetic dynamometer is a valid and reliable method in predicting muscle strength (Dekerle et al., 2014; Hadzic et al., 2014; Sattler et al., 2015) and it is frequently used in studies (Akarcesme et al., 2017; Markou and Vagenas, 2006; Teixeira et al., 2014). In the literature, there are studies in which isokinetic strength of athletes in different branches of sports and volleyball are measured (Cheung et al., 2012; Kabaciński et al., 2017), studies in which the role of different training programs on isokinetic strength is investigated in volleyball players (Mohammadi et al., 2012; Myer et al., 2006; Pau et al., 2012; Şahin et al., 2015; Yong-Youn and Si-Eun, 2016) and, 'in a remarkable way', many studies conducted on male volleyball players (Bamaç et al., 2008; Çelenk et al., 2019; Cheung et al., 2012; Hadzic et al., 2010; Kim and Jeoung, 2016; Markou and Vagenas, 2006; Özkan and Kin-İşler, 2011; Schons et al., 2018). However, the number of studies investigating the relationship between isokinetic knee strength and speed performance in volleyball is remarkably few (Yapıcı, 2016). Therefore, the present study aims to investigate the relationship between speed and isokinetic knee strength applied at different angular velocities in female volleyball players.

MATERIALS AND METHODS

Participants

Eleven female volleyball players from the senior category volunteered in the study (Table 1). Before conducting the study, all participants were informed of the research protocol and possible risks. Before starting the study, each participant completed the 'Informed Voluntary Consent Form'. Institute of Health Sciences Ethics Commission approved the research procedures. Prior to measurements, athletes had completed a one-month preparatory training session. However, measurements were performed just before the beginning of the competition period. Prior to speed and isokinetic tests, dominant legs of participants were identified (10 participants had a dominant left leg while 1 participant had a dominant right leg). Athletes, who had a lower extremity injury or surgery in the last six months, were not included in the study.

Study design

Isomed 2000 isokinetic dynamometer (D&R Ferstl GmbH, Hemau, Germany) was used in order to measure the isokinetic strength of participants while 20 m sprint test (Newtest Powertimer 2000 photocell) was conducted for the speed. All tests were performed at Gazi University Movement Analysis and Performance in Sports Application and Research Center. Measurements were conducted on four separate days with a full day interval resting period between each of them. Physical characteristics and speed performance were measured on the first day. All participants completed a 30-min standard warm-up protocol before the test.

Table 1. Characteristics of the subjects.

Parameter	Mean ± SD
Age (year)	20.2 ± 3.9
Years of experience (year)	11.0 ± 4.2
Body height (cm)	176.8 ± 7.1
Body weight (kg)	66.6 ± 5.7
Fat percentage (%)	20.5 ± 3.9

In measuring isokinetic strength, knee flexion and extension (H/Q) were measured separately on concentric/concentric dominant and non-dominant legs at 60°/sec angular velocity for 5 repetitions, at 180°/sec for 10 repetitions, and at 300°/sec for 15 repetitions. During these tests, athletes were encouraged verbally. Before the strength test, participants were asked to perform 3 submaximal repetitions and 1 maximal repetition on the isokinetic dynamometer. Participants were in a sitting position on the dynamometer, in accordance with the protocol, and they were stabilized to the dynamometer from the shoulder and the hip. At the end of this test, peak torque values were recorded for the dominant and non-dominant legs at different angular velocities. Full rest was given between repetitions.

Data analysis

Sigma Plot 11.0 (Systat Software, Inc.) software was used for descriptive statistics on data in the study. In data analysis, Spearman's correlation test was used for the relationship between isokinetic knee strength performed at different angular speeds and speed. P-values of <0.05 were considered statistically significant.

RESULTS

The highest peak torque value in participants was measured on both sides at 60°/sec angular speed. This was followed by 180°/sec and 300°/sec angular velocities respectively (Table 2).

There was no significant relationship between isokinetic knee strength applied at different angular velocities and speed (Table 3).

DISCUSSION AND CONCLUSION

In this study, the relationship between isokinetic knee strength and speed was investigated in female volleyball players. The highest peak torque was found at 60°/sec

Table 2. Isokinetic knee strength at different angular velocities in participants.

	Dominant	Non-dominant
60°/sec flexion (H)(Nm)	89.4 ± 13.5	89.0 ± 13.7
60°/sec extension(Q) (Nm)	142.6 ± 22.3	147.0 ± 23.3
180°/sec flexion (H) (Nm)	76.7 ± 9.6	76.0 ±9.5
180°/sec extension (Q) (Nm)	103.0 ± 13.0	103.1 ± 11.8
300°/sec flexion (H) (Nm)	65.9 ± 13.4	65.4 ± 11.8
300°/sec extension (Q) (Nm)	88.1 ± 14.4	85.3 ± 10.8

H: Hamstring, Q: Quadriceps femoris.

Table 3. The relationship between isokinetic knee strength and speed at different angular velocities.

		Speed				
		r	p		r	p
Dominant side	60˚/sec (H)	-0.018	0.946	Non-dominant side	-0.253	0.433
	60˚/sec (Q)	-0.337	0.296		-0.415	0.188
	180˚/sec (H)	-0.050	0.860		0.059	0.839
	180˚/sec (Q)	-0.233	0.467		-0.392	0.221
	300˚/sec (H)	-0.073	0.818		0.310	0.339
	300˚/sec (Q)	0.241	0.450		-0.121	0.714

H: Hamstring, Q: Quadriceps femoris.

angular speed. In addition, there was no significant relationship between isokinetic knee strength applied at different angular velocities and speed.

According to Cronin, the relationship between isokinetic strength and speed has generally not been found significant in the literature (low-to-moderate relationship level r=-0.52, -0.69). However, a relationship was identified between isokinetic knee strength data at 60 to 240°/sec angular velocities and 40-100 m speed and duration (Cronin, 2007).

The findings of studies investigating the relationship between isokinetic strength and sprint vary. Ozcakar et al. (2003) and Newman et al. (2004) have found that there is a strong relationship between peak torque of knee flexor and extensor and 10 to 20 m sprints. Cotte and Chatard (2011) have performed an isokinetic knee strength measurement at four different angular velocities (60, 180, 240 and 300°/sec) with 10 to 30 m sprints in national and international football players. In their studies, they have investigated the relationship between knee strength and sprint. They have found a significant and positive relationship between peak torque in quadriceps at 180, 240 and 300°/sec (r=0.77, r=0.74, and r=0.80, $p<0.01$, respectively) and 20-30 m sprint. Lockie et al. (2012) have measured knee extensor/flexor concentric strength at 60°/sec, 180°/sec, and 240°/sec angular velocities and knee extensor/flexor eccentric strength at 30°/sec angular velocity on 16 male team players. In addition, 40 m sprint was used for measuring linear velocity in these athletes while T drill test was used for agility performance. They have found a negative relationship between concentric 180°/sec and 240°/sec knee extensor torque and sprint while they have found a positive relationship between eccentric knee flexor strength and sprint. On the contrary, Cometti et al. (2001) have found no relationship. A significant relationship has not been found between knee flexion and extension isokinetic strength at 60°/sec and 180°/sec angular velocities and 10 to 30 m sprint performance in male basketball players (Alemdaroğlu, 2012).

Yapıcı (2016) in a similar study design conducted with twenty male volleyball players, has focused on the relationship between knee flexion and extension isokinetic strength at 60°/sec and 300°/sec angular velocities and some field tests. Although the researcher has found a significant relationship between jumping tests and isokinetic knee strength, the study has stated that there is not a significant relationship between isokinetic peak strength and T drill agility test and between 10 m and 30 m performances in volleyball players. Findings in our study are in parallel with these results. In addition, as a result of our study conducted with female volleyball players, the fact that we have obtained similar results to previous studies (Alemdaroğlu, 2012; Yapıcı, 2016) conducted with male subjects demonstrates that there is not a difference across genders in this regard.

In conclusion, there is not any significant relationship between speed and isokinetic knee strength in female volleyball players. It is suggested that similar studies be conducted in different age categories and in males. In line with the results of the present study, coaches and sports conditioners may focus on strength and speed programs.

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