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Is There a Difference in Isokinetic Knee Muscle between Player Positions in Volleyball?

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Abstract

Background and Purpose: This study was conducted to compare the isokinetic knee muscle strength and hamstring / quadriceps (H / Q) ratios of female volleyball players according to their player positions. Methods: 59 elite female volleyball players playing in different positions (hitter n=26, setter n=14, middle blocker n=19) participated in the study voluntarily. The dominant and nondominant isokinetic leg strengths of the participants were determined by isokinetic dynamometer at the angular velocities of $60°s^{-1}$ and $180°s^{-1}$. Kruskal Wallis H test was used in determining the isokinetic strength difference between the players' positions. Results: According to the statistical analysis, there is no significant difference between the positions of the female players and isokinetic knee muscle strength and H/Q ratios ($p<0,05$). Conclusion: This situation can be explained by the fact that although players have different roles depending on their positions, they perform similar training programs.

Keywords: Volleyball, İsokinetic Strength, Player's position

Introduction

Volleyball is an Olympic team game that is characterized with short and explosive action patterns, agility and rapid take offs (Lidor & Ziv, 2010) and required explosive actions such as spiking and blocking (Marques, González-Badillo & Kluka, 2006; Marques, Van den Tillaar, Gabbett, Reis & Gonzalez-Badillo, 2009). Therefore, in volleyball, while a minimum level of aerobic capacity is needed to meet the requirements of the game, anaerobic capacity is the determinant of the performance in maximum efforts that determine the result of the game such as blocking and hitting the ball (Grgantov, Milic & Katic, 2013). Although upper extremity performance is important in the actions performed with maximum effort, lower extremity performance is more important to perform these actions and their efficiency (Almeida & Soares, 2003; Dal Pupo, Detanico & dos Santos, 2012; İbiş, İri & Aktuğ, 2015; Yenigün et al., 2008). Especially the strength of hamstring and quadriceps among the lower extremity muscles is an important factor in achieving optimal performance in sports.

Quadriceps and hamstring muscle groups both provide joint stability and play a significant role in performing athletic activity in all actions in which knee joint is used (Malliou, Ispirlidis, Beneka, Taxildaris & Godolis, 2003). One of the actions in volleyball performed by the contraction of quadriceps muscle actively is take off (Şimşek, Ertan, Göktepe & Yazıcıoğlu, 2007). Considering that elite volleyball players take off multiple times during spiking, blocks, serves and passes throughout a game, and they also practice take off exercises in training, an increase in quadriceps muscle strength and a decrease in H/Q muscle strength ratio is an expected condition (Akarçeşme, Aktuğ, Aka & İbiş, 2017).

It is stated that volleyball players' poor lower extremity knee flexor-extensor muscle strength and lower strength balance between these muscles may cause performance loss in basic actions in volleyball (spike, block and bump pass) (Akarçeşme, Aktuğ, Aka & İbiş, 2017; İbiş, İri & Aktuğ, 2015). In addition, it is known that strength instabilities in lower extremity affect volleyball players' take off skills negatively and cause injuries (Dal Pupo, Detanico & dos Santos, 2012; Schons et al., 2019). Thus, the isokinetic strength of volleyball players' knee muscles is at vital importance in both improving their performances and preventing possible injuries.

Considering that a volleyball team includes players having different physical, physiological and motoric characteristics and playing in different positions such as hitter, middle blocker and setter and that these players perform different actions in accordance with their positions (e.g. the severity and the repetition numbers of the actions) (Marques, Van den Tillaar, Gabbett, Reis & Gonzalez-Badillo, 2009; Gabbett et al., 2006; Sheppard, Gabbett & Stanganelli, 2009) being strength differences between player positions is an expected situation. Thus, the object of this study is to compare volleyball players' isokinetic knee muscle strength and H/Q ratios in terms of their game positions.

The fact that there is no study in the literature analyzing volleyball players' isokinetic knee muscle strength in terms of their positions makes this study unique.

Material and Method

59 elite female volleyball players (age=23,00±4,14) playing in different positions (hitter n=26, setter n=14, middle blocker n=19) participated in the study voluntarily. Setter diagonals and hitters were included in the same group since they had similar action patterns. It was taken care of that the participants did not have any muscle or ligament injuries in the knee and

thigh area in the last 6 months and did not do any physical activity until 24 hours before the measurements. The heights of the players were measured by a device of Seca brand (Seca, Germany), and their weights by a body analysis system device of Tanita brand (Tanita BC-418 Segmental, Tokyo, Japan).

Isokinetic Strength Test

The players' lower extremity (knee) isokinetic muscle strengths were measured by an isokinetic dynamometer of Isomed 2000 (Ferstl, Germany) by specialists. Before the test, volleyball players performed cycling ergometer exercise or a 5 minute mild warm-up on a treadmill and a 3-4 minute stretching exercise depending on their preference. After the warm-up program, the players were taken one by one on the isokinetic dynamometer on which the measurements would be performed. The bodies of the volleyball players and the thighs of the legs which they would exercise were fixed to the seat with the help of bands from the middle parts. In addition, during the test, the freedom of the arms was prevented by holding on both sides of the seat. The test of concentric hamstring – concentric quadriceps isokinetic knee strength in angular velocities of $60°s^{-1}$ and $180°s^{-1}$ and with 10 repetitions was performed.

Statistical Analysis

The data were analyzed with SPSS 24 software. Kruskal Wallis H test, which was one of the nonparametric tests, was used in comparing the isokinetic strength values in terms of the players' positions. The significance level was accepted as $p<0,05$ in the study.

Results

Table 1. Demographic characteristics of the players

	Hitter (N=26)	**Setter (N=14)**	**Middle Blocker (N=19)**
	Mean±Sd	**Mean±Sd**	**Mean±Sd**
Age (year)	23,00±4,14	22,92±3,79	22,89±2,72
Height (cm)	185,57±8,43	185,11±9,76	188,94±8,94
Weight (kg)	74,97±12,50	76,49±13,44	81,63±13,78

Table 2. Comparison of the isokinetic knee muscle peak torques in terms of players' positions

(Nm)	**Position**	**N**	**Mean±Sd**	**Sequence Mean**	**X^2**	**p**
D60°s^{-1}Q	Hitter	26	234,19±59,54	27,63	1,855	,39
	Setter	14	243,07±63,80	28,43		
	Middle Blocker	19	263,05±69,79	34,39		
ND60°s^{-1}Q	Hitter	26	219,34±56,60	26,48	3,217	,20
	Setter	14	228,28±55,25	28,86		
	Middle Blocker	19	248,05±65,00	35,66		
D60°s^{-1}H	Hitter	26	124,76±40,24	26,87	2,052	,35
	Setter	14	130,42±39,28	30,00		
	Middle Blocker	19	137,10±36,88	34,29		
ND60°s^{-1}H	Hitter	26	116,84±38,56	27,12	1,172	,42
	Setter	14	121,92±36,79	30,07		
	Middle Blocker	19	127,94±35,91	33,89		
D180°s^{-1}Q	Hitter	26	174,50±50,46	26,62	1,892	,38
	Setter	14	191,42±64,64	31,64		
	Middle Blocker	19	198,05±64,84	33,42		
ND180°s^{-1}Q	Hitter	26	163,00±46,84	26,92	2,564	,27
	Setter	14	171,92±56,36	28,82		
	Middle Blocker	19	188,68±60,97	35,08		

D180°s^{-1}H	Hitter	26	97,65±35,25	26,67	2,034	,36
	Setter	14	101,07±28,53	30,75		
	Middle Blocker	19	107,89±32,32	34,00		
ND180°s^{-1}H	Hitter	26	98,69±32,83	26,15	3,490	,17
	Setter	14	101,14±26,10	29,29		
	Middle Blocker	19	110,94±27,82	30,97		

p<0,05 D= Dominant ND= Nondominant H=Hamstring Q=Quadriceps

When Table 2 was analyzed, no significant difference was found in the isokinetic knee muscle peak torques in terms of player's positions (p<0,05).

Table 3. Comparison of the isokinetic knee muscle relative strengths in terms of players' positions

(Nm/kg)	**Position**	**N**	**Mean±Sd**	**Sequence Mean**	**X^2**	**p**
D60°s^{-1}Q	Hitter	26	3,10±,43	27,69	,839	,65
	Setter	14	3,18±,57	31,79		
	Middle Blocker	19	3,19±,43	31,84		
ND60°s^{-1}Q	Hitter	26	2,91±,46	27,35	1,117	,57
	Setter	14	2,99±,49	32,39		
	Middle Blocker	19	3,03±,48	31,87		
D60°s^{-1}H	Hitter	26	1,63±,28	27,15	1,279	,52
	Setter	14	1,68±,29	32,43		
	Middle Blocker	19	1,66±,23	32,11		
ND60°s^{-1}H	Hitter	26	1,53±,27	27,69	,842	,65
	Setter	14	1,57±,27	32,00		
	Middle Blocker	19	1,54±,25	31,68		
D180°s^{-1}Q	Hitter	26	2,30±,35	27,62	1,051	,59
	Setter	14	2,48±,55	33,25		
	Middle Blocker	19	2,38±,40	30,87		
ND180°s^{-1}Q	Hitter	26	2,15±,36	27,46	1,066	,58
	Setter	14	2,23±,50	31,21		
	Middle Blocker	19	2,27±,43	32,58		
D180°s^{-1}H	Hitter	26	1,27±,28	27,69	,854	,65
	Setter	14	1,30±,19	31,39		
	Middle Blocker	19	1,46±,62	32,13		
ND180°s^{-1}H	Hitter	26	1,29±,24	26,65	2,220	,33
	Setter	14	1,30±,17	30,29		
	Middle Blocker	19	1,34±,20	34,37		

p<0,05 D= Dominant ND= Nondominant H=Hamstring Q=Quadriceps

When Table 3 was analyzed, no significant difference was found in the isokinetic knee muscle peak torques in terms of players' positions (p<0,05).

Table 4. Comparison of isokinetic H/Q ratios in terms of the players' positions

	Group	N	Mean±Sd	Sequence Mean	X^2	p
D60°s^{-1}H/Q	Hitter	26	,53±,08	29,67	,095	,95
	Setter	14	,53±,10	29,29		
	Middle Blocker	19	,52±,05	30,97		
ND60°s-1H/Q	Hitter	26	,53±,10	29,58	,065	,96
	Setter	14	,53±,09	31,00		
	Middle Blocker	19	,51±,08	29,84		
D180°s-1H/Q	Hitter	26	,55±,06	31,33	,537	,76
	Setter	14	,53±,09	27,18		
	Middle Blocker	19	,55±,09	30,26		
ND180°s^{-1}H/Q	Hitter	26	,60±,09	30,92	,317	,85
	Setter	14	,61±,15	27,79		
	Middle Blocker	19	,60±,13	30,37		

p<0,05 H/Q= Hamstring quadriceps ratio D= Dominant ND= Nondominant

When Table 4 was analyzed, no significant difference was found in isokinetic H/Q ratios in terms of the players' positions (p<0,05).

Discussion

This study was conducted to compare the isokinetic knee muscle strengths and H/Q ratios in terms of the positions of female volleyball players. According to the findings, it was determined that there was no significance difference between the positions of the players in the game (hitter, setter and middle blocker) and isokinetic knee muscle strength. While there is no study in the literature analyzing isokinetic strength in terms of the players' game positions, there are few studies evaluating strength in term of game positions. In one of these studies, Marques, Van den Tillaar, Gabbett, Reis & Gonzalez-Badillo (2009) find that there are serious anthropometric and strength differences between the game positions of male volleyball players, and that squat performances of the setters are lower than the players' playing in other positions. In a similar study, Küçükbaycan, Yenigün, Yenigün & Dinçer (2003) divided female volleyball players into two as corner and middle players, and compare their leg strengths before and after the preparation period. As a result of the study, while no difference is found between the corner and middle players' leg strengths before the preparation, it is determined that the leg strength in middle players is significantly higher after the preparation period. In another study, Schaal, Ransdell, Simonson & Gao (2013) state that hitters have a higher strength of lower extremity than liberos, and also setters, hitters and liberos produce similar lower extremity strength.

In volleyball, hitters and middle players have important roles in both offense (spike) and defense (block) organizations. The high take off height of hitters and middle blockers is among the determining factors in the success of these organizations. On the other hand, athletes playing in the setter position require less take off height in offensive and defensive duties. When teams attack in volleyball, the second passes are mostly met with the setter (Game area number 3). Thus, the player in the setter position has to run towards the game area number 3 several times throughout the game and usually make a take off action in the passes. Therefore, the reason of the similarities in the isokinetic knee muscle strengths of volleyball players in terms of their positions can arise that although the take off action, which increases lower extremity muscles strength (especially quadriceps), is performed by hitters and middle blockers very intensively, setters perform take off action less intensively but many more times. Sattler, Sekulic, Hadzic, Uljevic & Dervisevic, (2012) state that despite the hitters in

volleyball have the highest capacity of taking off among all players, their take off number is fewer than the players in other positions due to the tactical positions in the game.

Another variable in the study is that the comparison of H/Q ratios of the players in terms of their positions. Isokinetic H/Q ratios provide information about strength balances instead of muscle strength. It is stated that the H/Q ratio obtained as a result of the comparison of knee flexors with the knee extensors (Alexander, 1990; Kannus & Jarvinen, 1990) must be at the ratio of 2/3 (Steindler, 1955). As a result of the performed analysis, it was determined that there was no significant difference between the isokinetic H/Q ratios of the players in terms of their positions. This result may arise from that volleyball players perform the same trainings since volleyball is a team sport. The fact that the studies analyzing H/Q ratios in the literature mostly investigate injury risks and there is no study for players' positions limited the comparison of our results.

In the study, it was determined that the H/Q ratio of the female players was under the required level. Similarly, in a study conducted on elite volleyball players, H/Q ratios of female players were stated to be low[11]. In another study conducted on volleyball players, Yenigün et al. (2008) determined that H/Q ratios of the players were below the desired level, similarly with our study. Studies in the literature support the result of our study, and this situation is thought to be the result of the strengthening of the quadriceps muscle more than the hamstring muscle due to the excessive take off action in volleyball.

Consequently, it was determined that knee muscles isokinetic strength and H/Q ratios of the elite women volleyball players did not differ in terms of their positions in the game (hitter, setter and middle blocker). It is thought that this result is due to the fact that although the take off height of the hitters and middle blockers is high, the number of setters' position changes, runs and take offs in different directions in the game are in higher numbers, and that all players encounter similar loads in training.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

Akarçeşme, C., Aktuğ, Z. B., Aka, H., İbiş, S. (2017). An investigation of leg and shoulder muscle strength ratios of elite female volleyball players. *Turkish Journal of Sport and Exercise*, 19(2), 284-88.

Alexander, M. J. L. (1990). Peak torque values for antagonist muscle groups and concentric and eccentric contraction types for elite sprinters. *Archives of Physical Medicine and Rehabiliton*, 71(5), 334-339.

Almeida, T. A., Soares, E. A. (2003). Nutritional and anthropometric profile of adolescent volleyball athletes. *Revista Brasileira de Medicina do Esporte*, 9(4), 198-203.

Dal Pupo, J., Detanico, D., dos Santos, S. G. (2012). Kinetic parameters as determinants of vertical jump performance. *Brazilian Journal of Kinathropometry Human Performance*, 14(1), 41-51.

Gabbett, T., Georgieff, B., Anderson, S., Cotton, B., Savovic, D., Nicjolson, L. (2006). Changes in skill and physical fitness following training in talent-identified volleyball players. *Journal of Strength & Conditioning Research*, 20(1), 29-35.

Grgantov, Z., Milic, M., Katic, R. (2013). Identification of explosive power factors as predictors of player qualityin young female volleyball players. *Collegium Antropologicum*, 37(2), 61-68.

İbiş, S., İri, R., Aktuğ, Z. B. (2015). The effect of female volleyball players' leg volume and mass on balance and reaction time. *Journal of Human Sciences*, 12(2), 1296-1308.

Kannus, P., Jarvinen, M. (1990). Knee flexor/extensor ratio in follow-up of acute knee distortion juries. *Archives of Physical Medicine and Rehabiliton*, 71(1), 38-41.

Küçükbaycan, Ç., Yenigün, N., Yenigün, Ö., Dinçer, Ö. (2011). Comparison of pre-season and post-season leg strenght of volleyball players in the blocker and the spiker players. *İstanbul Üniversitesi Spor Bilimleri Dergisi*, 11(3), 137-140.

Lidor, R., Ziv, G. (2010). Physical characteristics and physiological attributes of adolescent volleyball players-a review. *Pediatric Exercise Science*, 22(1), 114-134.

Malliou, P., Ispirlidis, I., Beneka, A., Taxildaris, K., Godolis, G. (2003). Vertical jump and knee extensors isokinetic performance in professional soccer players related to the phase of the training period. *Isokinetic and Exercise Science*, 11(3), 165-169.

Marques, M. A. C., González-Badillo, J. J., Kluka, D. A. (2006). In-season resistance training for professional male volleyball players. *Strength & Conditioning Journal*, 28(6), 16-27.

Marques, M. C., Van den Tillaar, R., Gabbett, T. J., Reis, V. M., Gonzalez-Badillo, J. J. (2009). Physical fitness qualities of professional volleyball players: determination of positional differences. *Journal of Strength & Conditioning Research*, 23(4), 1106-1111.

Sattler, T., Sekulic, D., Hadzic, V., Uljevic, O., Dervisevic, E. (2012). Vertical jumping tests in volleyball: reliability, validity, and playing-position specifics. *Journal of Strength & Conditioning Research,* 26(6), 1532-1538.

Schaal, M., Ransdell, L. B., Simonson, S. R., Gao, Y. (2013). Physiologic performance test differences in female volleyball athletes by competition level and player position. *Journal of Strength & Conditioning Research,* 27(7), 1841-1850.

Schons, P., Da Rosa, R. G., Fischer, G., Berriel, G. P., Fritsch, C. G., Nakamura, F. Z., Baroni, B. M., Peyre-Tartaruga, L. A. (2019). The relationship between strength asymmetries and jumping performance in professional volleyball players. *Sports Biomechanics,* 18(5), 515-526.

Sheppard, J. M., Gabbett, T. J., Stanganelli, L. C. R. (2009). An analysis of playing positions in elite men's volleyball: considerations for competition demands and physiologic characteristics. *Journal of Strength & Conditioning Research,* 23(6), 1858-1866.

Steindler, A. (1955). Kinesiology of the human body under normal and pathological conditions. In: Charles, C, eds. Springfield: Thomas Publisher.

Şimşek, B., Ertan, H., Göktepe, A. S., Yazıcıoğlu, K. (2007). The effects of knee muscle strenght on jumping height in female volleyball paleyers. *Egzersiz,* 1(1), 36-43.

Yenigün, Ö., Çolak, T., Bamaç, B., Yenigün, N., Özbek, A., Bayazıt, B., Çolak, E. (2008). The determination of isokinetic performance values of knee joint and hamstring (flexor)/quadriceps (extensor) ratios differences in volleyball players. *Journal of Human Sciences,* 5(1), 1-13.