Examining the relationship between joint range of motion and serve speed and hit

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Abstract

Purpose:	In this study, the relationship between the joint range of motion, and the serve speed and hit rate of tennis players was examined. The voluntary participants of this study are tennis players in the university tennis team.
Material:	Twelve male students aged 18-25 voluntarily participated in the study. Participants were individuals, who professionally played tennis with a license. Certain parameters of the participants such as the upper extremity joint range of motion, extension and flexion angles of the elbow joint, abduction angle of the shoulder joint, and flexion and extension angles of the wrist were measured through standard plastic 12 goniometers. Similarly, the hit values were examined via the Revised Dyer Wall Test and serve speed values were examined by using the Stalker solo 2 brand radar. Pearson correlation analysis was used to examine the relationship between the joint range of motion and the serve speed and hit rate of the participants. The values below p <0.05 were considered as significant.
Results:	In the study, it was determined that there was a moderate positive correlation between wall test and shoulder abduction (p <0.05, r =.599); similarly, there was a high positive correlation between wall test and wrist extension (p <0.05, r = 671); there was a high positive correlation between wall test and wrist flexion (p <0.05, r = 638); there was a high positive correlation between abduction of the shoulder and wrist extension (p <0.05, r =, 603); there was a very high positive correlation between wrist extension and wrist flexion (p <0.001, r = 819), and it was determined that there was no significant relationship between the other parameters (p> 0.05).
Conclusions:	In conclusion, in this study, it was determined that the joint range of motion has a positive relationship with both serve speed and hits.
Keywords:	tennis, joint range of motion, agility, serve speed.

Introduction

Tennis serve requires optimal force, flexibility, timing and coordination of various parts of the human body. Therefore, serve performance depends on the complexity of many interdependent factors. Among these, one of the most important is undoubtedly the muscle strength and joint range of motion [1]. The mobility of the human body is provided by the muscles, the skeletal system, the ligaments and the tendons. Mobility is the ability to make the movement in different directions with a joint range of motion [2]. Range of motion is the intended movement that can be achieved at the required speed and in a wide angle. In another definition, it is the range of motion of joints and soft tissues as a response to active and passive tensions. Motions occur under the conditions defined by the joints, muscles, ligaments and tendons and under the neurophysiology directing conditions. Flexibility is very important in sport. It is one of the key basic requirements for an athlete to perform his/her skills easily with large angles. Faster and more ergonomic movements depend on the range of motion, in other words, the flexibility. Factors affecting the range of motion can be listed as; Joint structure (anatomical and biomechanical properties), gender and age difference, psychological status, environmental conditions and circadian rhythm (time of the day, heat status), training level, fatigue, and warming up [3]. The mobility of the human body is provided by the muscles, the skeletal system, the ligaments and the tendons. Mobility is the ability to make the movement in different directions with a joint range of motion [2]. ROM (Range of Motion) values are important for arranging the exercise programs for the training of active athletes and in the follow-up of the performance of the athletes [4]. In general, the goniometer has been used for measuring the joint ranges [5]. Since the serve speed of professional tennis players has reached 250 km/h, in modern tennis, serve has become very significant because of its mechanical advantage [6]. Strength and joint range of motion are among the most important parameters of serve and they should be improved through trainings. It has been reported by various authors that the strength and joint range of motion training increase functional goals and athletic performance in tennis [7].

The aim of this study is to determine the effect of the joint range of motion and some physical characteristics on the serve speed of tennis players.

Materials and Method

Participants.

Twelve male students between 18-25 years old voluntarily participated in the study. Participants were individuals, who performed tennis professionally with a

license. Volunteers were informed before they participated in the study and their consent was taken.

Research Design.

Measurement of height and weight

Tape measure with a sensitivity of 0.01 cm was used for the height measurements of the volunteers. The measurements were conducted while the volunteers were barefoot. Measurements were carried out while the participants were head upright, with bare feet on the ground, the knees stretched, the heels adjacent and the body upright. The body weights were measured with bare feet and the minimal clothing through a weighing scale with 0.1 kg precision.

Measurements of Joint range of motion

In line with the purposes of the tests, 20-minute warm-up exercises were conducted by the participant subjects before the measurements. All measurements were performed at the determined positions and at the maximal points where the subjects reached and kept this position for two seconds. During the measurement, the subjects were bare feet and wearing shorts. The pivot points used in the goniometric measurements of joint range of motion were taken as reference in this study [1, 8]. Certain parameters of the participants such as the upper extremity joint range of motion, extension and flexion angles of the elbow joint, abduction angle of the shoulder joint, and flexion and extension angles of the wrist were measured through standard plastic 12 goniometers. Elbow flexion and extension was performed and evaluated while the elbow bent while the volunteer was at sitting or standing and neutral position, wrist and interphalangeal joints extended and the elbow range of motion aligned. The distal arm of the Goniometer was aligned parallel to the axis of the forearm. The proximal arm of the Goniometer was aligned parallel to the humerus. Then the volunteer was asked to actively stretch and extend. 0 ° was accepted as the starting point. In measuring the shoulder abduction, the volunteer was in the upright position. The shoulder and elbow were fully extended with the wrist and the forearm and hand were pronated slightly while the arm was slightly rotated inside. The volunteer was asked to raise his upper extremity and the measurement was performed on an axial plane [9].

Vertical jump test

Vertical jump performances of athletes were measured by electronic smart speed lite system. Vertical jump test was applied after 15 minutes of active warming; 5-minute running, 5-minute short sprints, and 5-minute stretching moves. When the athletes felt ready, they jumped to the highest point they could. Then they landed on the mat. Jumping distances of the athletes were measured electronically in cm and the best of 3 attempts were recorded [10].

Medicine ball throwing test

For the medicine ball throwing test, the athlete was asked to stand at the designated starting point. On his knees, the athlete was asked to throw the medicine ball forward over his head in a throw-in position. The first point of contact of the medicine ball with the ground was determined. The distance between the starting point and the first spot where the ball hit the ground were measured and recorded. The best of the two trials were taken into consideration [11, 12].

Revised dyer wall test (RDD)

This test was developed to determine tennis skills against a board or wall. In this test, as many hits as possible on the board or wall are recorded within the designated time. Application of the test: a 7-cm thick net line is drawn on the wall or board (3 m height - 4.5 m wide). The line must be 91.7 cm above the floor. A border line is drawn on the floor 20 feet (6 m) away from the panel or wall. The subject who starts the test will stand behind the border line and hits the ball over the net for 30 seconds. After a trial, 3 consecutive tests are performed. Each hit to the wall is a score and the total score of 3 tests is evaluated [13, 14].

Serve speed

Ball Speed Measurement in Serve; for the measurement of the ball speed, all the serves are shot in a closed tennis court in order to control the effect of the air. Subjects were asked to warm up until they reached the highest serve speed. 3 minutes after the warm up, the test phase was started and they were asked to perform 5 serves at the highest speed possible. Radar (Stalker solo 2) was used for the measurement of the ball speed. The radar used in the measurement of the ball speed was fixed to the middle (net) line. In accordance with the rules of tennis, backhand serve was required sending the ball to the return point, and the serve was not recorded as valid if the ball was dropped out of the net or outside the service box (out). The feedbacks of the speeds were reported to the players for the highest effort. All serves were placed in the left service box (right side) for right-handed players, and in the right service box (left side) for left-handed players. All tennis players were instructed to use the straight serve technique and were evaluated by three tennis trainers. For the data analysis, the fastest (km / h) of the 5 serves players scored was analyzed as the maximal service (Vmax) [15, 16].

Statistical Analysis.

In this study, SPSS 24 package program was used to obtain statistical results and the mean and standard deviation of the measured and tested variables of all subjects were calculated. Statistically, values below $p < 0.05$ were accepted as significant. Pearson correlation analysis was used to examine the relationship among the data.

Results

Examining the Table 1, we determined that the age average of participants was 22.00 ±2.13 years, their average height was 180.16±2.85 cm, and their body weight average was 73.33±2.93 kg.

Examining the Table 2, it was determined that the vertical jump average was 45.08±4.46, Medicine Ball throw average was 6.05±.34, serve speed average was 117.57±8.01, and the wall test average was 63.75±4.30.

Examining the Table 3, it was determined that the

Table 1. Demographical Characteristics of Participants

Variables	n	X±SD	minimum	maximum
Age (year)	12	22.00±2.13	18.00	25.00
Height (cm)	12	180.16±2.85	175.00	185.00
Body Weight (kg)	12	73.33±2.93	69.00	78.00

Table 2. Average results of selected motor characteristics of participants

Variables	n	X±SD	minimum	maximum
Vertical jump	12	45.08±4.46	38.00	52.00
Throwing medicine ball	12	6.05±34	5.47	6.60
Serve speed	12	117.57±8.01	106.40	136.80
Wall test	12	63.75±4.30	52.00	68.00

Table 3. Average results of participant's joint range of motion

Variables	n	X±SD	minimum	maximum
Shoulder abd	12	156.41±6.73	148.00	173.00
Shoulder add	12	31.66±1.77	29.00	35.00
Elbow flexion	12	145.16±2.95	136.00	152.00
Wrist extension	12	69.00±4.30	63.00	74.00
Wrist flexion	12	74.83±3.15	70.00	79.00

Table 4. Analysis of correlation between the Tennis Serve Speed and other variables

Variables		1	2	3	4	5	6	7
Serve speed	r	1						
	p	-						
Wall test	r	-.263	1					
	p	.408	-					
Shoulder abd	r	-.176	**.599***	1				
	p	.584	**.040**	-				
Shoulder add	r	.169	-.154	-.322	1			
	p	.600	.632	.308	-			
Elbow flexion	r	-.223	.127	.131	-.558	1		
	p	.486	.695	.686	.059	-		
Wrist extension	r	-.175	**.671***	**.603***	-.069	.406	1	
	p	.586	**.017**	**.038**	.830	.190	-	
Wrist flexion	r	-.114	**.638***	.478	.314	.206	**.819***	1
	p	.724	**.026**	.116	.321	.521	.001	-

*p<0.05 **p<0.001

shoulder abduction average was156.41±6.73, shoulder adduction average was 31.66±1.77, elbow flexion average was 145.16±2.95, wrist extension average was 69.00±4.30, and wrist flexion average was 74.83±3.15.

When Table 4 was examined; it was determined that there was a moderate positive correlation between wall test and abduction of the shoulder (p <0.05, r =.599); similarly, here was a high positive correlation between wall test and wrist extension (p <0.05, r = 671); there was a high positive correlation between wall test and wrist flexion (p <0.05, r = 638); there was a high positive correlation between abduction of the shoulder and wrist extension (p <0.05, r =.603); there was a very high positive correlation between wrist extension and wrist flexion (p <0.001, r = 819); there was no significant relationship between the other parameters (p> 0.05).

Discussion

Flexibility, which is defined as the amount of motion of the joints within the normal range, is known to affect the quality of life and sport performance of the individual [17]. The aim of this study is to determine the effect of the joint range of motion and some physical characteristics on the serve speed of tennis players.

In the study, average height values of subjects was found as 180.16 ± 2.85 and average body weight as 73.33 ± 2.93.

Elbow joint flexion angles were determined as 145.16 ± 2.95, shoulder joint abduction value as 156.41 ± 6.73 and shoulder joint adduction angle as 31.66 ± 1.77. The wrist flexion angle was 74.83 ± 3.15 and the wrist extension angle was 69.00 ± 4.30.

In the literature, it was seen that the number of studies conducted on joint range of motion was very limited. When the similar age group values were considered for a similar study, the average of elbow joint extension values was 52^0 and average flexion angle values were 53^0, wrist flexion was 20^0, and extension angle value was 16^0. The speed of the ball in the serve was reported as 145.0 km / h [1]. These values are not similar to those of our study, and they can be explained by the fact that athletes have different joint angles.

In the study, the vertical jump values of the subjects were determined as 45.08 ± 4.46. Göral et al. determined that the anaerobic power values of the university tennis players were 149.41 ± 17.47 kg-m / sec [17]. In another study, Gelen et al., determined the average of anaerobic power values of the first league tennis players as 135.1 ± 5.67 kg-m / sec and the second league tennis players as 100.4 ± 14.5 kg-m / sec [18]. In the study, the average of medicine ball throwing values of the volunteers was determined as 6.05 ± 34. In another study, Kovacs et al., determined that the average of medicine ball throw values was 7.50 m in the pre-test, whereas this value was 7.69 m in the post-test [19]. Although these values are related with our study, the low number of numerical values is due to the fact that our study group did not perform adequate strength training.

As a result; accuracy and sustainability of each hit, the correct technique, the conditional factors and the kinematic parameters implemented during the hit are considered to have a significant role for success. The moderate positive relationship between wall test and shoulder abduction can be explained by the fact that the angle of the shoulder joint is large in abduction, and it has a significant quality in terms of hit quality and reaching the targeted point. In addition, it is seen that wrist extension and flexion have a high positive relationship with the hit accuracy. Extension of the wrist joint in the forehand stroke and the flexion of the wrist joint in the backhand stroke influence the success in meeting of the ball and the racket and the success of the hit. In the study, although there was a positive relationship between the range of motion of the shoulder joint and wrist, there was no correlation between the range of motion of the shoulder joint and wrist and the speed of hit. Finding no correlation in the hit speed can be explained by the inadequacy of participants' strength parameters.

Conclusion

This study was aimed to make an important contribution to the sports science by investigating the effect of force and stabilization trainings on joint range of motion, serve speed and hit by performing the foms test with 6-week individual force and stabilized training program and conducting the foms test before and after the training period.

Conflict of interest

The authors declare no conflict of interest.

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