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The Acute Effects of Dynamic and Static Stretching on Tennis Serve Targeting Performance

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Abstract

The study investigates the acute effects of dynamic and static stretching on the tennis serve targeting performance of amateur tennis players. Twenty male athletes who were between the ages of 16-24 years and played tennis for at least 1 year (21.40±2.16 years, 181±0.06 cm, 71.85±7.42 kg, tennis playing time 1.55±0.88 years) voluntarily participated in the study. Prior to the pre-tests and after applying the traditional warm-up protocol, serve targeting test (STT) was applied to all participants. In the post-tests, STT was used after applying three different warm-up methods on three different days (48-hour rest interval). The warm-up stages included No Treatment (NT) (jogging, rally), Static Stretching (SS) and Dynamic Stretching (DS). In the statistical analysis, the homogeneity of the data was investigated using the Shapiro Wilk test. The Wilcoxon test was used to compare the pre-test and post-test results of the non-homogeneous data; Friedman test was used to compare the three different stretching methods with each other; in the paired comparisons of the groups, the paired samples t-test was used for the homogenous data and Wilcoxon test was used for the non-homogeneous data. In conclusion, stretching exercises before serving increased the serve targeting performance and the increase in the dynamic stretching exercises was higher than that in static stretching exercises.

Key words: Tennis, Static Stretching, Dynamic Stretching, Warm-up, Targeting

INTRODUCTION

Trainers apply various innovative training methods by following recent developments in sports sciences and using sub-branches such as training science, sport psychology, etc. to improve the performances of athletes. Using the findings of these studies and tests certain conclusions are reached (2, 5, 23, 35). Studies investigating the factors affecting performance to bring out the best performance of athletes in various sports branches have also been carried out for tennis. In tennis, physical fitness parameters such as coordination skills, aerobic and anaerobic capacity, speed, agility, flexibility and static and dynamic balance, as well as high-intensty short-distance jogging and change of direction are among the most important traits affecting performance (21, 32, 45, 46).

Human body is in great balance and can adapted (1, 11). Technical and tactical skills are among performance-defining elements (39). Recently small differences make athletes winner (38). To give a good performance in tennis, all techniques (ground stroke, volley, serve) should be delivered in top quality. Putting emphasis on the speed and accuracy of the ball is also of importance for a good performance (6). Serve is one of the most important techniques that affect the score of a tennis match (26). The strength and flexibility of the upper extremity and nerve-muscle coordination are required for a high-level power production during serve. A strong upper extremity increases the speeds of the racket and ball during serve and, hence, positively affect the performance (22,34). In addition, choosing the best warm-up protocol before a match is one of the most important issues affecting serve performance (28). Since stretching exercises increase the flexibility of the athlete, they are expected to improve the sportive performance in tennis (24). A good warm-up not only improves the performance but also eliminates the risk of injury. A good warm-up can prevent the injuries caused by

the challenging movements required in practice or during competition period (7, 18, 43). Stretching exercises are divided into two groups as static and dynamic stretching exercises. Static stretching exercises include static stretching, passive stretching, active stretching, proprioceptive neuromuscular facilitation (PNF) and isometric stretching. Dynamic stretching exercises are classified as ballistic stretching, dynamic stretching and isolated active stretching (37, 42). Static stretching exercises have been reported to reduce maximal muscle performance when applied before maximal muscle activities (14, 42). The mechanism as to why static stretching causes loss of strength is not yet understood, but strength loss has been associated with the viscoelastic changes in tendons, neuromuscular factors, decreases in the activation of the motor unit and reflex sensitivity (9). According to Bompa (8), static stretching exercises negatively affect strength due to the decrease in myotatic reflex sensitivity when applied especially over 15 minutes. New combinations of warm-up protocols have been investigated to eliminate the negative effects of static stretching exercises. The post-activation potentiation (PAP) method is one of these methods (12, 15, 40). The precise physiological mechanisms that contribute to PAP are not clear, but the dominant theory argues that phosphorylation occurs at a higher level in the potentiated myosin regulatory light chain, which makes actin and myosin more sensitive to Ca2+ (17) Dynamic stretching has a positive effect on muscle strength development. Although the action mechanisms in strength development are not fully identified, emphasis is put on two possible explanations (7). One of the possible explanations is that the increase in the temperature in muscles positively affects the relationship between strength and speed by increasing the delivery rate and increases glycogenesis, glycolysis and high-energy phosphate degradation. Another possible explanation is that the neuromuscular activities stemming from dynamic stretching exercises contribute to other factors that increase muscle strength (7). In both, sensory discharge occurs after the muscle contraction of PAP (29).

In conclusion, the effects of different stretching exercises differ as well. Thus, the addition of stretching methods that are suitable for a specific activity to exercise programs is a factor affecting the performance (42). The study investigates the effects of different warm-up methods applied before tennis serve targeting performance measurements on acute targeting performance.

MATERIAL AND METHOD

This Twenty amateur male tennis players who were between the ages of 16-24 years and played tennis for at least 1 year were included in the study after filling the "informed consent form". The participants were randomly divided into three groups as No Treatment (NT), Static Stretching (SS) and Dynamic Stretching (DS). The pre-tests were applied to all groups after the warm-up period comprising 5-min jogging and 5-min rally; the post-tests were applied following the application of the 3 different warm-up protocols to the relevant groups after a 2-min rest interval. In all tests, the serve performance measurement section of the ITN was used to determine the serve targeting performance. The post-tests were repeated after applying the 3 different warm-up protocols to the participants in 3 groups on 3 different days with 48-min rest intervals. The stretching protocols before the post-tests were applied in 3 sets for 20 s and with 10-15-s rest intervals. In the static warm-up protocol, a total of 10 stretches comprising 5 upper extremity stretches and 5 lower extremity stretches were performed; in the dynamic warm-up protocol, a total of 10 stretches comprising 5 upper extremity stretches and 5 lower extremity stretches were performed.

Table 1. The Static And Dynamic Stretches In Stretching Exercises

Lower Extremity Static Stretching	Upper Extremity Static Stretching	Lower Extremity Dynamic Stretching	Upper Extremity Dynamic Stretching
Calf Static Stretching	Pectoral Static Stretching	Leg Swing	Arm Swing in the Frontal Axis
Hamstring Static Stretching	Latissimus Dorsi Stretching	Spiderum Hamstring Stretching	Arm Swing in the Frontal and Sagittal Axis
Quadriceps Static Stretching	Trapezius Static Stretching	Dynamic Pigeon Stretching	Diagonal Shoulder Rotation
Static Pigeon Stretching	Subscapular Static Stretching	Lunge	Flexion Extension Dynamic Stretching
Adductor Stretching	Shoulder Rotator Cuff Stretching	Squat Stretching	Internal and External Shoulder Rotation

Serve Test

ITN was developed by the International Tennis Federation. Rather than the athletes' technical skill in tennis strokes, the test measures the elements of stability, depth and power of the serves, groundstrokes and volleys, which are among the five game situations in tennis, and mobility of the players. The serve assessment given in the ITN test was used to determine the tennis targeting performances of the athletes (http://www.iftennis.com/media/113844/113844.pdf)

The test is illustrated below. P shows the position of the player. The player (P) hits 12 serves: 3 serves to the wide area of the first service box; 3 serves to the middle area of the first service box; 3 serves to the middle area of the second service box; 3 serves to the wide area of the second service box. If the ball lands outside the service box or fails to clear the net, the player receives 0 points. If the serve lands inside the service box, the points are awarded based on the first and second bounce. If the first serve lands in the correct service box, no second serve is required. The serve is repeated if the serve is a let.

First Serve:

2 Points – When a ball lands in the correct service box area.

4 Points – When a ball lands in the target area of the correct service box.

Second Serve:

1 Point – When a ball lands in the correct service box area.

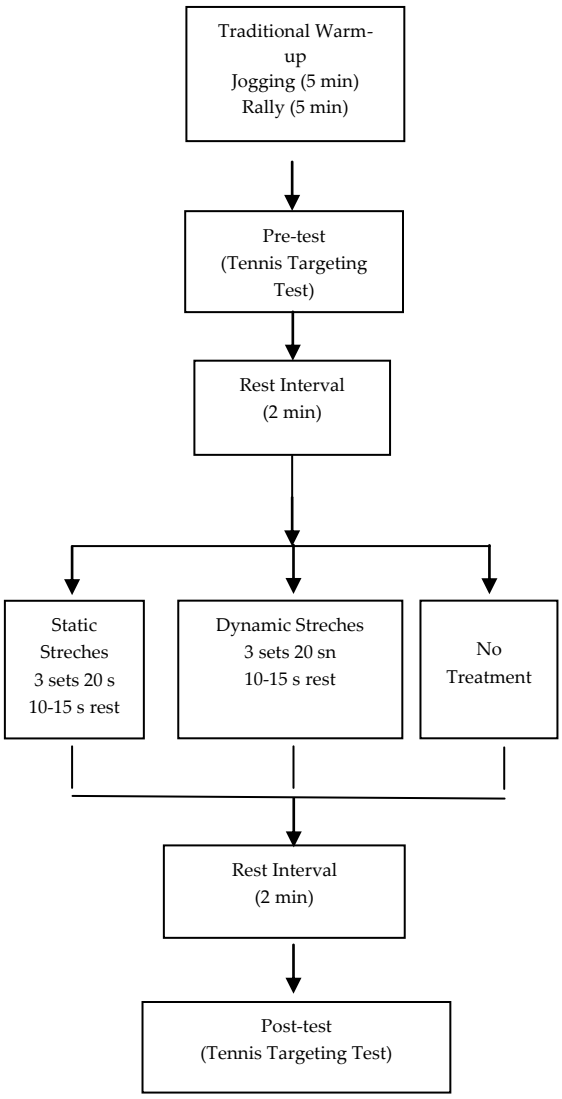
2 Points – When a ball lands in the target area of the correct service box.

Power Points are awarded as follows:

Power Area – 1 Bonus Point – When a ball lands in the correct service box area and the second bounce lands between the baseline and the power line, 1 bonus point is awarded.

Power Area – Double Bonus Points – When a ball lands in the correct service box and the second bounce lands beyond the power line, double points are awarded.

The maximum possible score is 108 (12x4x2+ 12)



INTERPRETATION OF ANALYSIS AND FINDINGS

Table 2. Physical Characteristics of The Athletes

(n=20)	Min.	Max.	Mean	SD
Age (year)	18.00	26.00	21.40	2.16
Sport age (year)	1.00	4.00	1.55	.88
Boy (cm)	173.00	194.00	181.00	.06
Weight (kg)	60.00	82.00	71.85	7.42
BMI (kg/m²)	17.27	26.78	21.93	2.64

Table 3. Shapiro-Wilk Normality Test Results For The Serve Targeting Performance Test

	Warm-up Protocol	Mean	SS	p
Pre-Test (score)	No Treatment	33.80	11.23	.003
	Static Stretching	35.90	11.71	.001
	Dynamic Stretching	35.95	11.73	.002
Post-Test (score)	No Treatment	34.20	10.48	.011
	Static Stretching	38.40	9.91	.119
	Dynamic Stretching	41.90	12.67	.399

The homogeneity analysis showed that the results obtained in pre-tests of all measurements and post-test NT measurements were not distributed homogeneously ($p<0.05$), while the post-test SS and DS measurements distributed homogeneously($p>0.05$).

Table 4. Comparison Between The Pre-Test And Post-Test Measurements In The Serve Targeting Tests

n=20			Mean Rank	Sum of Ranks	z	p
Static Stretching Pre-Test & Static Stretching Post-Test	Negative Ranks	6[a]	7.83	47.00	-2.182	.029*
	Positive Ranks	14[b]	11.64	163.00		
	Ties	0[c]				
	Total	20				
Dynamic Stretching Pre-Test & Dynamic Stretching Post-Test	Negative Ranks	3[d]	7.33	22.00	-3.102	.002*
	Positive Ranks	17[e]	11.06	188.00		
	Ties	0[f]				
	Total	20				
No Treatment Pre-Test & No Treatment Post-Test	Negative Ranks	7[g]	10.00	70.00	-.683	.495
	Positive Ranks	11[h]	9.18	101.00		
	Ties	2[i]				
	Total	20				

p<0.05. a. Static Stretching Post-Test< Static Stretching Pre-Test
b. Static Stretching Post-Test> Static Stretching Pre-Test
c. Static Stretching Post-Test= Static Stretching Pre-Test
d. Dynamic Stretching Post-Test< Dynamic Stretching Pre-Test
e. Dynamic Stretching Post-Test>Dynamic Stretching Pre-Test
f. Dynamic Stretching Post-Test=Dynamic Stretching Pre-Test
g. No Treatment Post-Test< No Treatment Pre-Test
h. No Treatment Post-Test> No Treatment Pre-Test
i. No Treatment Post-Test= No Treatment Pre-Test

The results obtained by comparing the pre-test and post-test results in the STT showed that there was a significant difference between the Static Stretching pre-test ($p=0.029$) and Dynamic Stretching pre-test ($p=0.002$). The comparison between the pre-test and post-test results for the test involving No Treatment revealed that there were no significant differences ($p=0.495$).

Table 5. Comparison Between The Serve Targeting Performance Tests With Respect To The Warm-Up Protocols

Warm-up Protocol	Test	Mean Rank	X^2	p
No Treatment	Post-Test	1.33	18.500	.001*
Static Stretching	Post-Test	2.03		
Dynamic Stretching	Post-Test	2.65		

There were significant differences between the STs after different warm-up protocols (p=0.001).

Table 6. Comparison Between The Post-Test Results Of Serve Targeting After The Dynamic And Static Warm-Up Protocols

	n	Mean	Std. Deviation	t	p
Static Stretching Post-Test	20	38.40	9.91	-2.703	.014*
Dynamic Stretching Post-Test		41.90	12.67		

Table 7. Paired Comparisons Between The Serve Targeting Performance Tests

		n=20	Mean Rank	Sum of Ranks	z	p
No Treatment Post-Test & Static Stretching Post-Test	Negative Ranks	15[a]	9.77	146.50	-2.660	.008*
	Positive Ranks	3[b]	8.17	24.50		
	Ties	2[c]				
	Total	20				
No Treatment Post-Test & Dynamic Stretching Post-Test	Negative Ranks	17[d]	10.56	179.50	-3.404	.001*
	Positive Ranks	2[e]	5.25	10.50		
	Ties	1[f]				
	Total	20				

There were significant differences between the serve targeting performance after static and dynamic warm-up and serve targeting performance after NT (p=0.008; p=0.001).

CONCLUSION AND EVALUATION

Recent studies have shown that preferring dynamic stretching rather than static stretching during stretching exercises before practice or match positively affected various elements of performance (speed, agility, jumping ability, strength).

In their study, Chaouachi et al. (9) investigated the effects of warm-ups involving static and dynamic stretching on the agility, sprinting and jumping performance of trained individuals. The researchers recommended applying branch-specific dynamic exercises for at least 5 minutes before the sporting activity for the athletes who use static stretching. Yamaguchi et al. (44) determined that 15-minute dynamic stretching exercises before isokinetic strength test increased the performance. In their study, Young and Behm (48) divided the athletes into four groups as aerobic stretching group, only static stretching group, general aerobic stretching group and static stretching group. The results showed that the explosive force of the athletes in the static stretching group was relatively lower and the explosive forces of the athletes in other groups were higher. Torres et al. (41) investigated the effects of stretching exercises on upper-body muscular performance and argued that static stretching did not have any effect on upper-body muscle strength. In their study, Turna (42) recommended applying static and dynamic stretching together in light of its advantages, which are absent in static stretching and PNF, and on the grounds that the negative effects of static and PNF stretching before a match or training will thereby be eliminated. Another result obtained with this study was that dynamic stretching exercises positively affected speed and strength performance, while static stretching possibly had a negative effect. On the other hand, the researchers determined that static stretching had a positive effect on flexibility. The results of our study revealed that dynamic stretching improved serve targeting performance to a greater degree than static stretching.

There is also evidence opposing the performance-increasing effects of stretching exercises before an activity. The studies carried out by Cornwell et al. (10), Avela et al (4), Fowles et al. (13), Kokkonen et al. (27) and Nelson et al. (30) Akyuz et al (3), Yıldız et al (47) showed that stretching exercises, in fact, caused acute decreases in strength and jumping performance. Fowles et al. (13) observed that this negative effect lasted about 60 minutes and attributed it to the changes in either reflex sensitivity, muscle stiffness or neuromuscular activation. Knudson et al. (26) reported that, if this effect was in fact valid, a tennis player who performs stretching exercises before a match can only reach their full performance near the end of the second set. Knudson et al. (25) recommends static stretching during warm-up for recreational tennis players. The researchers reported that stretching muscles using static stretching was important in maintaining flexibility at its normal level and physical activities should occur during the cooling period. No studies were found on the effects of different stretching exercises on targeting performance. The results of our study revealed that both static and dynamic stretching improved

targeting performance. Moreover, the serve performance without stretching was lower than that after stretching. The results indicated that stretching exercises positively affected targeting performance in tennis.

There are some studies investigating the effects of stretching exercises on performance in tennis. In their study, Kaya and Polat (20) found that applying tennis and stretching exercises together positively affected stroke power but had a negative effect on agility and concluded that tennis training alone positively affected both agility and stroke power. Suna et al. (36) reported that there was a significant difference between stroke accuracy and technical training positively affected the tennis skills of individuals. Gelen et al. (14) investigated the effects of different warm-up methods on serve speed. In the study, the tennis players were divided into four groups and a different warm-up method was applied to each group. Jogging, rally and practice, traditional warm-up and high-intensity upper extremity plyometric activity were performed after 5-min low-intensity aerobic jogging. Jogging, was followed by 5-min moderate-intensity forehand and backhand strokes. Lastly, the participants practiced swings without a ball at a moderate rate. The results indicated that static stretching exercises applied immediately after traditional warm-up did not have an effect on serve speed in tennis. The researchers reported that the use of PAP, which emerges as a result of dynamic and high-intensity upper extremity plyometric exercises, creates a potential field for the enhancement of athletic performance and tennis players should apply dynamic exercises along with high-intensity upper extremity plyometric exercises. The results of the study indicated that dynamic and upper extremity plyometric warm-up exercises were beneficial to enhance the serve performance of young elite tennis players. The results obtained by Gelen et al. (14) agrees with the results obtained in our study, which showed the positive effect of dynamic stretching on serve performance. On the other hand, in their study in which the acute effects of static stretching, dynamic warm-up and high-intensity upper extremity plyometric activities on the speed of tennis ball after jogging, rally and serve targeting were investigated, Haag et al. (16) found that the static stretching exercises for upper extremity did not have an acute effect on ball speed and serve performance. The researchers reported that serve speed was not affected by static stretching. The findings of the study carried out by Knudson et al. (26) showed that a five-min traditional warm-up in tennis was sufficient for maximum serve performance and the stretching exercises to improve performance before match did not have any effect on the improvement of serve performance. According to the researchers, the decrease in maximum muscle performance after stretching exercises, as notable as it was in previous studies, was not observed in tennis serve performance and despite the benefits of stretching exercises before an activity in injury prevention, as shown by the current data, there was little evidence to recommend static stretching exercises for tennis-players. They determined that tennis players didn't need to abandon light stretching exercises in the later stages of a general warm-up routine, since serve performance was not affected by the stretching exercises.

In conclusion, the study investigated the importance and advantages of stretching movements that should be preferred during warm-up in tennis and determined that stretching exercises before serve improved serve targeting performance. The study also found that dynamic stretching had a higher positive effect on serve targeting performance than static stretching. Further studies can be carried out with elite tennis players. When carrying out similar studies, measuring the ball speed during targeting will help elucidate the effects of stretching exercises on performance through strength parameters.

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