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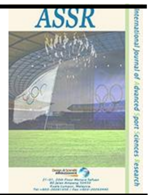

Effect of biomechanical exercises on improving some of shot variables of serve in tennis

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ABSTRACT

The purpose of the present study was to evaluate the effect of biomechanical exercises on improving some of shot variables of serve in Kuffa tennis player's team. Six male athletes (19.03 ± 1.64 years) were intentionally assigned to a machine based biomechanical exercises group (n = 6) no control group. For a period of six weeks, biomechanical exercises group trained two days per week in addition to their regular tennis training. Study concluded that mean angles of service increased significantly more in post- test when compared to pre- test.

Keywords: **Biomechanical exercises, Shoot variables of serve, Tennis.**

1. Introduction

As a result of increasing popularity of tennis, the sport is getting more competitive at all age sets. Since technique, tactical skills, and physical abilities are important predictors of success in competition, it looks reasonable to improve those core capabilities early in training. Hence, finding effective training modalities for youth tennis athletes is of particular importance.

The serve is often considered to be the most important shot in tennis and increasing its velocity and precision is an ongoing target of training programs in tennis practice. In a recently published meta-analysis, it could be shown that biomechanical exercise is effective in order to enhance serve velocity in youth (Mohamad., *et al*., 2011). Due to the fact that upper-body kinematics of throwing are similar to the movement of the tennis serve, it seems reasonable that biomechanical exercises are also capable of positively affecting this important tennis shot in youth. While several methods of throwing velocity enhancement have been investigated by previously published studies (Derenne and Murphy., 2001, Saeterbak et al., 2011, Escamilla *al*., 2012), data on effects of biomechanical exercises on shot variables of tennis serve in this age group are light.

Consequently, it remains to be determined, if effects gained from biomechanical exercise programs are transferable to the tennis serve in pubertal tennis players and if precision of service is affected by such interventions. Particularly, it remains unclear to what extend training needs to improve technique performance coordinate of tennis serve velocity.

Commonly, maximal service velocity (Vmax), defined as the mean speed of only a few consecutive serves, is used to measure training effects on service velocity (Ferrauti and Bastions., 2007). However, during long lasting tennis matches, muscle fatigue will settlement mean ball velocity and changing angle of ball fall down (Kovacs., 2006) of which the serve looks to be the most affected hit of all (Davey*et al*., 2002). From this viewpoint, biomechanical exercises relevance might be increased, if the biomechanical exercise of serves on which the service velocity assessment is based on is increased. That is, it might be more valuable to know whether an applied biomechanical exercises program enables participants to perform accurate serves at a higher velocity with different angles.

Therefore, the primary aim of the present study was to investigate the effects biomechanical exercises on improving some of shoot variables of serve in tennis players. The applied training programs comprised a biomechanical exercises program that was in line with current guidelines for progression during training for shoot angles. Exercises by definition are performed fast and explosively and are therefore closer to the contraction velocity of a tennis serve. Therefore, researcher hypothesized that biomechanical exercises will improve service velocity and angle of ball fall down more than traditional training. Even if alterations in service precision were not expected, this parameter of service performance was assessed due to the fact that benefits of developed service velocity would be reduced if precision is negatively affected by the applied interventions.

2. Methodology

Study used experimental approach because it is suitable to solution the research problem and the duration of study is from 15/2/2013 to 5/4/2013. The study utilized a one group design with intentional assignment. Baseline testing was conducted prior to training and included assessment of angular velocity, peripheral velocity, highest shot point of ball, ball shot angle, and ball shot velocity. Subjects followed the 6-week training, which was prescribed by researcher of the professional biochemical exercises to which the subjects were contracted. Subjects were retested post-tests (week 7) in a manner identical to baseline testing.

2.1 Participants

Six male tennis players (19.03 ± 1.64 years) were selected as a sample of convenience from Kuffa university team in tennis, Iraq. Participants were excluded from the study if they had any cardiovascular diseases, metabolic disorders (e.g. diabetes mellitus) or recently experienced musculoskeletal injuries. All participants of the experimentation provided informed consent prior to participating in the study.

An intentional way was used to allocate participants to one group (biomechanical exercises group) and no control group. A drop-out of one subject per group (one subject reported an injury that was not related to the intervention and one subject dropped out because of a viral infection), resulted in group sizes of n = 6. No training-related injuries were recorded throughout the intervention.

At baseline, no statistically significant differences were found in height, weight, body mass index (BMI) or pubertal stage between the intervention group. Further, no pre-training differences in ball shot angles (angular velocity, peripheral velocity, highest shot point of ball, ball shot angle, and ball shot velocity) measures were present. Follow-up assessment revealed no significant change of aforementioned physical subject characteristics after six weeks of intervention. Time of experience in the sport of tennis averaged 8.3 years over all included participants and did not differ significantly between samples of group.

2.2 Pre-tests

Participants were instructed to perform 5 maximum velocity serves from the baseline into the service court, following a 5min warm-up protocol. An audio signal was used to help participants keeping the service frequency constant at 5 serves per minute. Angular velocity, peripheral velocity, highest shot point of ball, ball shot angle, and ball shot velocity were measured by two cameras (made in USA) that was positioned 7 min front of the net and another camera was positioned 9.40 m right beside the player.

2.3Training program

Training units were completed 2 days a week on Sunday and Tuesday (between 12 and 2 pm) for group. All training sessions were completed in the same court in University of Kuffa. Prior to the intervention period, all participants were familiarized with the equipment at the court and with biomechanical exercises techniques. Anatomical definitions in terms of movement velocity and joint positions were delivered for all of the included exercises. Even though intensity of training intervention group was improved after 6 weeks of training. Intervention group underwent the normal tennis program of two training sessions per week (1.5h).

All training sessions were supervised and all tests were conducted by an accredited sports scientist with specialization in tennis and long standing experience in youth tennis training. An intervention group According to a needs analysis by Reid *et al*. (2007), who identified service angles in tennis service, five different biomechanical exercises was selected for the group of study. These included: Jumping on 60 cm box, Elbow angle exercise, Wrist angle exercise, Wrist angle exercise at the moment of strike, and Exercise of maximum changeable. All machines could appropriately be adjusted for height of participating youth. The considerable amount of time is needed to teach proper technique for biomechanical exercises and the associated potential for injury during performance.

Due to the fact that participants had lake in parts of serve, guidelines for novices were chosen. That is, exercises were performed with two sets of 10-15 repetitions each. Rest intervals between sets lasted one to two minutes, and two training sessions were performed per week. After a period of two weeks, intensity was increased from 65% of 1RM to 85% (referring to the estimated 1RM as described below) and number of repetitions was decreased to 6.

Prior to all training sessions, a 10min warm up protocol was performed by all participants. This protocol was subdivided in a non-specific (e.g. shuttle-run variations, sidesteps or running backwards) and a sport specific part. The latter consisted of movements that were actually part of the particular training session. The biomechanical exercise training-session itself (main part) lasted about 45min and was followed by a five minute cool-down protocol (jogging and static stretching).

2.4 Post-tests

Participants were instructed to perform 5 maximum velocity serves from the baseline into the service court, following a 5min warm-up protocol. An audio signal was used to help participants keeping the service frequency constant at 5 serves per minute. Angular velocity, peripheral velocity, highest shot point of ball, ball shot angle, and ball shot velocity were measured by two cameras (made in USA) that was positioned 7 min front of the net and another camera was positioned 9.40 m right beside the player. The characteristic of test was similar to characteristic of pre-test and applied with the same time.

2.5 Statistical analyses

A T test for one group was used to compare the effects of the applied biomechanical exercises. Significance level was set to ≤ 0.05. Tests were conduct by SPSS Statistics version 21 (IBM Corporation, Somers, NY).

3. Results & Discussion

The effects of the 6-week training intervention of biomechanical exercises on measures of service performance are presented in Table 1. While the specific training program of biomechanical exercises induced a great significant increase in mean peripheral velocity of 427, improvements of peripheral velocity were significantly greater in study group when compared to pre-test value. Participants who trained with biomechanical exercises made significantly greater gains in angular velocity as compared to the pre-test. Mean angular velocity of 629.76. Significant changes could be found for the mean of the conducted highest ball shot point test of 267.24 when compared to the pre-test.

Therefore, show changes in study group prior to and at the end of the 6-week intervention. In ball shot angle post-test revealed that mean value was significantly greater than pre-test value of 28.44. Such changes could be found in study group. Furthermore, T test indicated significant group by time interaction for shot velocity value. Mean shot velocity was significantly greater than pre-test of 43.5.

Table (1)
show significant of biomechanical changes of pre and post-tests for serve

Changes	Pre-tests		Post-tests		T test	Significant
	Mean	Standard Deviation	Mean	Standard Deviation		
Peripheral Velocity	378	1,32	427	0,868	12.22	S
Angular Velocity	523.30	1.038	629.76	2.59	17.13	S
Highest ball shot point	221.27	2.42	267.24	2.34	4.11	S
Ball shot angle	45.51	2.24	28.44	2.67	8.06	S
Shot velocity	27.32	0.38	43.5	0.38	9.14	S

T tabulate (2.5) at significant level 0.05 and free degree 5.

To our knowledge, the present study was the first to investigate the effect of biomechanical exercises on measures of ball shot angles in Kuffa university tennis players. The main finding of the present investigation was that a six week biomechanical exercise training significantly improved mean ball shot angles when compared to pre-test. That is, effects from the applied biomechanical exercise program could be transferred to the angles of tennis service. This potential benefit of biomechanical exercise training on ball shot angles should be taken into account by tennis coaches when planning training programs for tennis athletes.

It could be argued that the study group by time interaction was based solely on the fact that biomechanical exercise group developed. However, as mentioned earlier, sport activities (i.e. tennis training) other than the applied training programs were the same for study group throughout the intervention. Therefore, it is more likely that ball shot angles at post-test was affected by some external influences in study group (i.e. biomechanical exercises). In other words, we hypothesize that biomechanical exercises would have presented a comparable increase in ball shot angles at post-test as applied intervention. Our data reveal a shorter rest period (~ 24h) prior to the post-test when compared to the pre-test situation (~ 32h) possibly impacting the fatigue in our study group. However, lifestyle factors such as sleep, hydration, nutrition, etc. had been recorded to be clear if one or a combination of those factors affected the outcome. Therefore, further studies with longer intervention periods, a larger sample size and a control group are needed to confirm the present finding.

Interestingly, other studies showed that main target of right position for elbow angle is to do correct movement in throwing arm. One example is the study of Finch*et al*., (2001), that investigated the effects of a right throwing intervention with light or heavy loads on service quality of young tennis players. Service angle velocity in that study was increased in both intervention groups after the intervention phase of six weeks.

In deed that biomechanical exercises training success to increase mean angular velocity, peripheral velocity, highest shot point of ball, ball shot angle, and ball shot velocity in the present study might be due to specific movement of that exercises modality in regard to the tested movement of tennis service. That is, the achieved angles gains from that specific training program could be transferred to the tennis service performance. This would be in concordance with the current position statement of the NSCA (Faigenbaum *al*., 2009), indicating the need for specificity of training. However, it should be noted that other studies succeeded in improving the throwing angles, by applying comparable biomechanical training programs, in high school and elite collegiate baseball players (Potteiger *al*., 1992).

Others even found conventional ball shot angles training to be superior to a biomechanical exercises program (Ammar, 2010). The reason for the observation that biomechanical exercise straining programs positively affect ball shot angles in children (previous literature) but not in youth (present study) remains unclear.

However, it could be speculated that technical maturity is needed to effectively transfer training gains from an unspecific biomechanical exercises training program to a sport specific movement. That is, immaturity of studied participants possibly provided an effective strength transfer from the applied unspecific biomechanical exercise straining protocol to ball shot angles in the present study. The fact that elbow and shoulder joints are basic axis in the main part and strike moment so we observe the players try to reduce their circle radius in the main part to increase angular velocity of a strike arm and get a point.

4. Conclusion

The findings of the present study demonstrate that ball shot angle straining necessarily based biomechanical exercises program are effective in enhancing service angular velocity and other changes in tennis players. Since the tennis serve is considered to be the most important shot in tennis and increasing its mean velocity seems to be a favorable training goal, biomechanical exercise straining should be taken into account when planning training and conditioning programs of tennis players. The results of current study showed that specific exercises need less time in training to develop serve technique performance.

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