Sport Mont 14 (2016) 2: 13–16
Original scientific paper
UDC 796.332:796.015.1(497.6)

Functional Strength Training Effects on Knee Flexors and Extensors Power Output in Football Players

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A B S T R A C T

Study aim was to compare and reevaluate effects of additional strength training program in football players after eight week application. Program was design to increase power and strength of knee extensors and flexors using neuromuscular adaptation. In overall, 18 senior level football players completed intervention in preparation period executing program as part of warm up 2-3 times per week. Using t-test for dependent samples statistical significance of the possible change was evaluated in peak torque, total and average work changes measured using Biodex isokinetic dynamometer. All measuring procedures were done for both limbs. Results are suggesting that statistically significant change observed in both limbs for the peak power output and average work load in flexion and extension, respectively. Other research papers are suggesting that increase of power and strength of knee muscles can help in preventing of injurie occurrence. LCA injurie can be prevention when femoral biceps strength is increase. This training modality based on neuromuscular adaptation is noninvasive with good effects in performance increase. Using training loads with body weight intensity is a good way to establish prevention to possible knee injurie with simultaneous power increase, with minimum of chance to reach unwanted overtraining.

Key words: *effects, isokinetic, football, knee stabilizers, training*

Introduction

Football includes specific activities of cyclic and acyclic type intended for offence and defense. Short sprints, jumps, quick stops, landings, turns, kicks and duels are specific activities of high intensity which footballers often repeat during the game. During the game these activities are followed chronologically, for example, after jump footballer does the sprint and after sprint comes duel or kick. Different factors like tactics, position of a player in team and level of competition can affect average frequency of repetitions of specific football activities with or without a ball. The biggest difference among footballers of top and average quality is in the amount of activities of high intensity (Verheijen, 1998). In order to have quality performance players needs to have high level of specific strength and football condition. In football, there is a risk of injuries because of the great influence of external forces during the realization of football activities. Heidt et al. (2000) concluded that 61.2% of the injuries of lower limbs is related to the injuries of knees and ankles. For that reason muscles and ankles of footballers must be able to absorb these forces. Some of the causes of injuries of knees of footballers can be mechanical and functional instability of knee joint, insufficient muscle strength and endurance and disturbed balance and flexibility of muscle of quadriceps. Neuromuscular training of strength can have positive effect on the strength of knee joint and sprint performances of footballers (Mendiguchia et al., 2015). Exercises of strength should be integrated into regular training on order to improve efficiency and prevent injuries during performance of complex movement activities of high intensity. Individual resistance can provide additional advantages in traditional procedures of training of strength in order to improve muscle imbalance and stability of knee joint of elite footballers (Śliwowski et al., 2015). The aim of this study was to examine the effects of experimental program of exercises of strength integrated into regular training on the level of isokinetic strength of dynamic knee stabilizers.

Methods

Experimental Approach

Study was designed as a test–retest procedure to disclaim possible improvement of power and strength output of knee muscles as an effect of the functional strength training, respectively. In overall, training program was conducted for eight consecutive weeks with frequency of 2-3 sessions per week lasting around 20 minutes. Functional strength training has been conducted prior to the main tactical training. Specificities of the training (Table 1 and Table 2) suggests intensive pre workout with possible post activation potential. Training loads were similarly distributed in each session as well as in weekly microcycle, respectively. Overall process was supervised using verbal communication and information's obtained from players in real time during exercise performance. Pain and comfortability was marked as low, moderate and high rated by player's individual perception. If the player at any time marks exercise as hard immediate termination was made. All the exercises modalities were suitable to the temporal demands of the football game, optimally stimulating functional demands, motivating and not excessive for avoiding possible over training occurrence.

Subjects

Eighteen senior level football players (mean±SD: age: 23±1.2; height: 178±6.5 cm; weight: 70.5±11.3 kg) from local club voluntary agreed to participate in study. All the procedures and training were conducted in spring time during preparation

Received for publication March 17, 2016

period for the competition season. Inclusion criteria for participants were: i) at least 15 games played in previous competitive part of the year, ii) participation on at least 70% training sessions, iii) three years of playing experience. All participants were healthy without knee or ankle injuries in last 10 months or other conditions that might affect the study procedures and outcomes. All subjects signed written consent approved by Ethical Committee of the Faculty of Sport and Physical Education - University of Sarajevo. Procedures, testing's and training interventions were made according the ethical standards proposed by the Helsinki Declaration.

Table 1. Training program features

Contents	Specifics
Duration	8 weeks
Part of the training	Warm up
Training frequency	2-3 per week
Intervention time range	15 – 30 min.

Isokinetic testing procedures

Strength and power output of the knees extensors and flexors were evaluated using Biodex Isokinetic System (Shirly New York). Standard procedure of five maximal voluntary contractions at speed of 60 °/s in concentric (CON/CON) mode has been applied (Drouinet al., 2004). This procedure is most commonly used by the practitioners in training of football players. After five minute form up of riding bicycle ergometer at 100W subjects were asked to perform five dynamic stretching exercises in preordered sequences. After initial screening subjects performed isokinetic testing procedures in range of motion (ROM) at 80º in extension direction from flexed angle at 90º. Correction of gravity was done according to the recommendations (Anderson et al., 2010). Power and strength variables obtained from testing were monitored as follows: – Peak torque of the left knee extensors (EXTLEF60); Peak torque of the right knee extensors (EXTRIG60); Total work of the left knee extensors (EXTWLF60); Total work of the right knee extensors (EXTWRG60); Average power output of the left knee extensors (AVGPELF60; Average power output of the right knee extensors (AVGPERG60); Peak torque of the left knee flexors (FLXLEF60); Peak torque of the right knee flexors (FLXRIG-60); Total work of the left knee flexors (FLXTWLF60); Total work of the right knee flexors (FXTWRG60); Average power output of the left knee flexors (AVGPFLF60); Average power output of the left knee flexors (AVGPFRG60).

Table 2. Exercises performed

Exercises
Back Squat
Half squat isometric
Front lounge
Side lounge
Lounge + power step
Lateral movement – knee angle 30 deg.
Lounge behind static leg
Walking against leaning
on the opponent (rambling)
Leg hops with 10m run

Statistical analysis

Normality of data distribution was tested using Kolmogorov–Smirnov test. To determine statistical differences in power and strength output from baseline till study end t-test for dependent samples was used. All data were reported as mean and standard deviation values unless otherwise stated. Conventional statistical significance of $p<0.05$ noted significantchange of the mean between trials. Statistical software package SPSS 21.0 was used.

Results

Data distribution did not significantly differ from the normal data distribution assumptions, respectively. Results of the research showed statistically significant differences between initial and final measurements ($p<0.05$) in favor of final measurement (Table 3). Quantity statistically significant changes on univariant level occurred in variables of maximum strength of extensors of right and left leg (EXTLEF60), (EXTRIG60), then in overall work, strength of extensors of right leg (EXTWRG-60), and maximum strength of flexors of left leg (FLXLEF60). Significant training effects manifested through statistically significant changes occur in overall work of strength of flexors of left and right leg (FLXTWRG60), (FLXTWLF60), and in the change of the average strength of flexors and extensors of both legs (AVGPFRG60), (AVGPFLF60), AVGPELF60), (AVG-PERG60).

Discussion

Experimental program of exercises integrated into regular football training with the type of resistance, intensity and volume can improve level of isokinetic strength of dynamic stabilizers of knee. The possibility of generating the optimal level of strength is important for quality realization of specific football activities of high intensity. Aagaard et al. (1996) state that different regimes of muscle work can improve isokinetic strength of knee extensors and flexors (quadriceps - hamstring), followed by better performance of complex leg movements and ball kicks. The aim of improvement the level of isokinetic strength of dynamic stabilizers of knee of footballers is better performance of specific football activities during the game, reduction of risk of injuries and reduction of negative effects tiredness. However, trainer always needs to have in mind that football is a sport of timing and collaboration and factors which determinate the success of the game. Because of that, apart from the exer-

cise of strength of knee stabilizers, we used situational stimulus 1 against 1 in this experimental program. Combined program of training of strength and speed running gives better results than the conventional training of strength in terms of performance of strength of footballers (Kotzamanidis et al., 2005). The skills of strong and coordinative performance are necessary and important in all football activities. Apart from the exercises of strength, this experimental program included stimulus of proprioception and flexibility of muscles and ankles and neuromuscular stimuli in terms of jumps and short sprints. Neuromuscular training includes increased activity of medial hamstring which can potentially reduce risk of injuries without contact (Zebis et al., 2008). During the realization of exercises of strength and stabilization, exercises on sagittal, frontal and transversal plane were also performed. Apart from this there are exercises with changed angles and speed performance. In order to move to another, more complex exercise, footballer needs to acquire the previous one. In other words, each proceeding exercise is extension of the previous one. Problem which condition trainers are exposed to during the realization of the program is that footballers have good performance of certain exercise in a different period (Komes, 2006). Exercises of strength and endurance are performed in that way that the feet are set parallel. The advantage of parallel set of feet is in setting the load on longitude of instep which is stronger than the internal. This removes the possibility of lowering insteps which results with flat feet which causes additional instability. During the creation of the program of strength with focus on strengthening the knee stabilizers the situations like low movement control (new exercises, new demands, current tiredness or tiredness from a previous game or training, insufficient warm-up, motivation etc) were predicted. Also the effects of the program depend on the flows and the limitations which are discovered by diagnostics of strength, coordination and flexibility. Finding the disbalance and creation of adequate program is the best prevention (Komes, 2006). Apart from determination of current disbalance, it is necessary to detect knee injuries and similar injuries from the past. Football skills are one-sided and demand asymmetric motor patterns and can improve of asymmetric adaptations in locomotor functions of lower limbs (Fousekis et al., 2010). Some segments of knee are not according to its natural positions after which knee becomes unstable which can cause injury and therefore disturb continuance of desired form. It is well known that footballers after injuries have difficulties in achieving top form during the season. There is a need for development of preventive programs in training of footballers, which will prevent the injuries of lower limbs. These programs should be applied as soon as possible. Studies conducted in different sports showed promising results in reducing the frequency of injuries during performance of different procedures which included one or more exercises with focus on trainings of balance, strength and agility (Caraffa et al., 1996; Heidt et al., 2000). Better strength of knee of a footballer can improve control of movements, better stops and delay of tiredness. Additional training of strength should be part of football training, so that knee injuries and all other injuries are reduced to minimum. It is recommended that future researches include trainings which start with inhibition of tense muscles by working with special rollers. It is known that tense muscles are the problem which causes dysfunction of knee joint. This study did not treat the quality of level of specific activities after performance of experimental program in order to see the effects in the situations of the game. Also, the study did not treat the reduction of potential injuries, which is a flaw of this study.

Table 3. Differences in power and strength isokinetic output after the training intervention

	Initial n=16		Final n=16		CI95% Diff		t	p
	Mean	±SD	Mean	±SD	Lower	Upper		
EXTLEF60	209.77	28.7	216.9	23.3	-18.22	3.97	-1.35	0.19
EXTRIG60	211.06	32.09	221.44	27.51	-20.92	0.16	-2.07	0.05*
EXTWLF60	499.97	95.66	586.4	117.13	-161.26	-11.57	-2.43	0.026*
EXTWRG60	521.65	96.9	604.41	92.71	-133.41	-32.11	-3.44	0.003**
AVGPELF60	130.76	19.24	144.56	20.99	-23.12	-4.48	-3.12	0.006**
AVGPERG60	137.14	23.85	146.03	20.55	-16.22	-1.55	-2.55	0.02*
FLXLEF60	117.16	16.51	125.74	16.9	-15.94	-1.21	-2.45	0.02*
FLXRIG60	122.5	17.76	133.35	20.16	-17.05	-4.63	-3.68	0.002**
FLXTWLF60	337.33	83.35	421.03	99.18	-145.24	-22.14	-2.86	0.01*
FXTWRG60	345.91	63.2	423.32	61.91	-114.82	-40	-4.36	0.001**
AVGPFLF60	83.82	12.03	95.09	12.88	-17.58	-4.95	-3.76	0.002**
AVGPFRG60	89.01	11.28	101.25	16.28	-17.25	-7.21	-5.13	0.001**
AGANLF60	56.55	8.44	66.18	16.24	-17.44	-1.82	-2.6	0.01*
AGANRG60	58.55	7.75	60.76	6.63	-5.61	1.17	-1.37	0.18

Legend: * *p<0.05, ** p<0.01*

Research show that use of functional football movements with own body weight (squats, front lounge, duels, jumps, sprints, lounge) specific for football with the adequate distribution of loadings and periodization improve the performances of strength without disturbing the football performance. It is important to find such training contents which are similar to the demands and movements of real situational performance and to create adequate components of loadings.

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