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Research Article

THE EFFECTS OF CORE STABILISATION EXERCISES ON THE ATHLETIC PERFORMANCE IN AMPUTEE FOOTBALL PLAYERS

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Keywords

Amputee,
Core stabilization,
Football,
Performance.

ABSTRACT

Purpose: The aim of this study was to investigate whether a 6-week core stabilization training program induces measurable improvements in athletic performance parameters in amputee football players.
Methods: Twenty amputee football players aged 18-50 years were randomly allocated to a core stabilization group or a control group. Core stabilization exercise program (3 days/week over 6 weeks) was applied to the exercise group in addition to the routine training program, while control group followed the routine training program. Pre-and post training assessments included muscular endurans tests, sit and reach test and modified Thomas test, vertical jump test, functional reach test, and the 505 agility test.
Results: Core stabilization training yielded significant increases in trunk flexor and extensor endurance (dynamic push-up test repeats and static back extension time) within the exercise group ($p<0.05$). The 505 agility test and sit-and-reach test performance improved in both groups, whereas Thomas and Vertical Jump test performance did not change. The functional reach test was improved only in the control group ($p<0.05$).
Conclusion: Short-term core stabilization training enhances muscular but does not exceed the benefits of routie training for agility or jump performance in endurance amputee football players. Incorporation of core traninig into conditioning programs may support trunk endurance and functional capacity in this population.

INTRODUCTION

Balance and coordination are significantly affected in amputees following lower extremity amputations. Cutaneous inputs and proprioceptive information received from the plantar surface of the foot are of great importance for proper and balanced posture and ambulation. When a foot is disconnected from the ground, feedback and decreased proprioceptive sensation significantly reduce balance and coordination. Therefore people with lower extremity amputation have difficulty in movements such as standing, walking, running and jumping (1).

Amputee football is a form of football requiring sportive performance including endurance, strength, flexibility, speed and agility, which is played by the athletes by using

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forearm crutches (2). Amputation related loss of the extremity and muscle mass, changed sole-ground contact and impaired biomechanical configuration may affect sportive movements (2).

Body stabilization is required during sportive activities for creating maximal power in the distal segments and providing postural control (3). Maintenance of proper biomechanics is necessary for energy transfer from the body to the extremities (4, 5). It is crucial especially in order to decrease loads on the joints and maximise power generation in activities such as running, shooting and tackle (3). Core stabilization exercises are expected to improve sportive performance in movements including running, jumping, striking, turning and throwing (4). There are studies investigating the effect of stabilization exercise on balance, sprint and jumping performance in unhampered women and men football players (4, 6, 7). Although there are studies determining and comparing the factors affecting physical fitness and athletic performance in amputee football players (8-10), the effect of core stabilization exercise on the performance of amputee football players has not been studied. Therefore, the objective of this study was to investigate the effect of core stabilization exercise on athletic performance of amputee football players.

METHODS

Participants

A total of 20 amputee football players aged between 18-50 years who were playing in "Şahinbey Belediye Gençlik ve Spor Kulübü" (Sahinbey Municipality Youth & Sports Club) and "Şehitkamil Engelliler Spor Kulübü" (Sehitkamil Handicapped Sports Club). The athletes were randomly divided into two groups by coin toss as core stabilization exercise group (n=10; mean age: 30.00±10.81 years) and control group (n=10; mean age: 32.10 ±9.69 years).

Table 1. Information of Football Players About Amputation

		Exercise Group	**Control Group**
Amputation Side	Right	4	5
	Left	6	5
Amputation Level	Below The Knee	7	9
	Above The Knee	3	1

Football players with unilateral lower extremity amputation (Table 1) who had no injury in at least 6 months were included in the study. Athletes with significant visual and perceptual disorder, acute injury, those with mental and neurological problems, and the athletes who gave up playing football for any reason during the study period were excluded from the study. Before the beginning of the study, the players were informed in detail about the objectives and goals of the study and content of the training program. The study was approved by the Non-Invasive Research Ethics Committee of Hasan Kalyoncu University Faculty of Health Sciences by 11/10/2016 dated and 201612 number decision.

Assessments

Sociodemographic and physical characteristics (age, height, body weight, age of amputation and duration of using prosthesis) of the players were recorded at the beginning of the study. Physical fitness tests were performed within the season, at times where they took vacation and were not involved in strenuous activities. The measurements were made in the afternoon under the same environmental conditions and setting. Upper extremity muscular endurance was evaluated with push-up test, body endurance, dynamic, static and reverse sit-up test, flexibility, sit-and-reach test and modified Thomas test, jumping ability, vertical jump test, balance, functional reaching test, agility, and 505 tests. The evaluations were carried out in the beginning of the study and after 6 weeks.

Evaluation of Muscular Endurance

Dynamic sit-up test: Upper extremities of the football players were positioned according to the strength of the abdominal muscles by lying down in the supine hooked position with the knees bent. The player was asked to raise the head, neck, and shoulder towards the knees respectively, up to the scapular inferior angle. The number of movements that could be repeated and duration in seconds were recorded (10).

Push-up test: The players were asked to push-up face down with the elbows in flexion by bringing the elbows to the extension. The number of movements that could be repeated and duration in seconds were recorded (10).

Static reverse sit-up test: The players were positioned face down with the inguinal region on a stretcher and the hip smooth on the bed. They were then asked to raise anterior portion of the body with the hands along the smooth body. The duration during which this position could be maintained was recorded in seconds (10).

Static sit-up test: The player was given supine position with the knees bent as in the dynamic sit-up test. The player was then asked to raise the head, neck, and shoulder towards the knees respectively, up to the scapular inferior angle with the hands positioned according to the strength of the abdominal muscles. The duration during which this position could be maintained was recorded in seconds (10).

Evaluation of The Flexibility

The modified Thomas test: Hip joint of the player was positioned at a 28 cm distance from the bed and the extremity to be tested was left down the table. The other extremity was brought towards the chest by the examiner, and the distancing of the knee at the test side was recorded in centimeters (cm) (10).

Sit-and-reach test: The players were given a long sitting position with the knees in extension without shoes. They were then asked to reach the tapeline on a 25 cm width and 40 cm length wood piece. The knees were compressed to avoid flexion. The time during which the athletes could stay by extending their fingertips as far as they could was recorded. The test was repeated three times and the highest distance was used (cm) (17).

Evaluation of The Jumping Height

Vertical jumping test: The players were positioned as standing beside the wall. The maximal point at which players could reach by extending their arms near the wall was determined as the start point. They were then asked to jump without disrupting their body position. The distance between the start point and the point which the players could reach by jumping was recorded. The test was repeated three times and the highest value was used (9).

Evaluation of Balance

Functional reaching test: The football players were asked to stand beside the wall and to flex their arms near to the wall as the elbows being in the extension. The start point was determined from the tapeline on the wall. The players were then asked to go forward as far as they could without disrupting their balance, stepping and disconnecting the heel contact. The distance between the start point and the point which the players could reach by jumping was recorded. The test was repeated three times and the highest value was used.

Evaluation of Agility

505 Agility test: Photocell sensors (power Timer, New Test OY, Finland) were employed for this test (Figure 1). The photocell time was started as soon as the athlete started one meter behind the starting point and passed through this point, and was stopped after turning a 10 meters distance (on the right and left feet) and passing through the second photocell at 5 meters. The individual was given right for 3 trials and the lowest duration was recorded as the most

successful value (Figure 1). The evaluations were carried out on a grass ground with football boots (11).

Figure 1. 505 agility test

Training Program

Routine football training of the control and training groups included 15 minutes warming, 60 minutes technic-tactic work, and 10 minutes cooling period. Athletes in the training group received core stabilization exercise (10 minutes warming, 45-50 minutes core stabilization exercise training and 5 minutes cooling) 3 days a week for 6 weeks (Table 2) (Figure 2). The aim of the first week was to gain sensorimotor control by providing smoothness of the neutral spine. In the next weeks, the training was converted to dynamic and multiplane movements with maintained neutral spine position in order to raise awareness of motor control, endurance and kinesthetics. Core stabilization exercise training was planned as to be on a mat, sitting and standing positions with bilateral, unilateral and contralateral extremity movements (12).

Figure 2. Some mat exercise examples used during the training program

A follow-up chart was created to monitor attendance to the training. Exercise programs at the days when the athletes did not attend were completed before starting the new week program.

Statistical Analysis

Data obtained in this study were statistically analyzed using IBM SPSS Statistics v. 21.0 package software. Numerical variables were expressed as mean±standard deviation, and categorical variables as percentage. Normality of the data was studies using Kolmogorov Smirnow test. Since the data were non-normally distributed, comparisons between the groups were made with Mann-Whitney U test. Wilcoxon Rank test was used in the intragroup comparisons before and after the exercise program. $p<0.05$ values were considered statistically significant. Although non-parametric tests were applied due to the distributional characteristics of the data, effect sizes (Cohen’s d) were additionally reported to quantify the magnitude and practical relevance of group differences. Reporting effect sizes provides complementary information to p-values and facilitates a more comprehensive interpretation of the results.

Table 2. Exercise Training Program By Weeks

Exercise Program	**1. WEEK (3*15 repeats)**	**2. WEEK (3*15 repeats)**
Right plank	Elbow at flexion	Elbow at extension
Left plank	Elbow at flexion	Elbow at extension
Forward plank	Elbow at flexion	Elbow at extension
Backward plank	Elbow at flexion	Elbow at extension
Sit-up	Hands crossed over the shoulders	Hands on the nape
Backbend	Hands on the ground	Without hand contact
Exercise Program	**3. WEEK (3*15 repeats)**	**4. WEEK (3*15 repeats)**
Anterior- posterior pelvic tilt	Sitting on a chair	Sitting on a Swiss ball
Shoulder rise up	Sitting on a chair	Sitting on a Swiss ball
Right trunk lateral flexion	Sitting on a chair	Sitting on a Swiss ball
Left trunk lateral flexion	Sitting on a chair	Sitting on a Swiss ball
Right choops	Sitting on a chair	Sitting on a Swiss ball
Left choops	Sitting on a chair	Sitting on a Swiss ball
Exercise Program	**5. WEEK (3*15 repeats)**	**6. WEEK (3*15 repeats)**
Reaching forwards	Unilateral forearm crutch	Bilateral forearm crutches
Lateral reaching	Unilateral forearm crutch	Bilateral forearm crutches
Single leg squat	Unilateral forearm crutch	Bilateral forearm crutches
Contralateral reaching	Unilateral forearm crutch	Bilateral forearm crutches

RESULTS

Demographic features were similar between the two groups ($p<0.05$) (Table 3). None of the individuals in the groups was excluded during 6 weeks. Three players in the exercise group and 8 in the control group were playing in the National Amputee Football Team.

Table 3. Comparison of the anthropometric and demographic features between the groups

	Exercise group	Control group	p
Age (years)	30,00 ± 10,81	32,10 ± 9,69	0,570
Height (cm)	176,20 ± 6,36	173,60 ± 7,17	0,323
Body weight (Kg)	70,30 ± 12,15	71,00 ± 10,99	0,910
Body mass index (Kg/m²)	22,68 ± 4,08	23,44 ± 2,25	0,545
Age of amputation (years)	12,30 ± 7,90	12,00 ± 8,46	1,000
Duration of using prosthesis (years)	11,90 ± 11,23	11,50 ± 7,63	0,939

Abbreventions; * p<0.05; cm, centimeters; Kg, kilogram; Kg/m², kilograms divided by square meters

When physical parameters of the groups were compared before the training program; number of dynamic sit-up test repeats and time of reverse sit-up were higher in the control group (p<0.05), while the other parameters were similar (p>0.05). On the other hand when the physical parameters of the groups were compared after the training program; only time of dynamic sit-up test were higher in the exercise group (p<0.05).

When the groups were compared in themselves before and after the training program; number of dynamic sit-up repeats, time of static reverse sit-up test, sit-reach test and 505 test values were significantly improved in the exercise group after the training program (p<0.05). Whereas sit-reach and 505 test results were significantly improved after the training program (p<0.05) (Table 4).

Table 4. Comparison of The Parameters in The Both Groups

	Exercise Group			Control Group			Between Group	
							Pre	Post
	Pre-training	**Post-training**	**p**	**Pre-training**	**Post-training**	**p**	**p**	**p**
Dynamic sit-up test (repeats)	27,70±8,12	36,30±13,46	**0,022***	40,40±12,43	44,80±11,18	0,201	**0,025***	0,088
Dynamic sit-up test (seconds)	52,50±17,32	72,20±17,83	0,066	51,70±9,78	54,40 ±8,04	0,444	0,649	**0,017***
Push-up test (repeats)	24,00±11,71	26,30±11,41	0,240	24,90±12,56	23,70±10,30	0,610	0,909	0,676
Push-up test (seconds)	36,80±14,77	40,70±12,76	0,169	32,30±7,97	29,60±10,91	0,440	0,383	0,069
Static sit-up test (seconds)	58,00±24,35	60,30±17,52	0,507	85,30±26,45	98,90±42,84	0,619	**0,038***	0,054
Static reverse sit-up test (seconds)	34,50±15,79	51,70±22,63	**0,044***	54,70±21,99	63,00±29,78	0,173	**0,037***	0,198
Modified Thomas test-right (cm)	5,00±1,31	5,10±0,91	0,564	6,05±1,32	6,40±1,82	0,304	0,087	0,087
Modified Thomas test-left (cm)	5,45±1,14	5,45±0,90	1,000	6,20±1,84	6,00±1,47	0,526	0,424	0,465
Sit and reach test (cm)	16,90±9,54	19,35±9,55	**0,007***	19,40±6,77	22, 25±7,85	**0,009***	0,449	0,325
Functional reaching test (cm)	29,45±6,18	32,50±5,43	0,092	28,95±7,34	31,90±6,43	**0,040***	0,791	0,650
Vertical jumping test (cm)	6,62±0,41	6,72±0,51	0,386	7,80±2,19	6,37±0,68	0,059	0,733	0,233
505 test (seconds)	18,80±3,20	19,95±3,15	**0,050***	19,05±3,01	21,00±2,00	**0,041***	0,290	0,364

Abbreventions; cm; centimeters, * p<0.05

When the groups were evaluated in themselves; among the physical fitness parameters flexibility and vertical jumping values were significantly increased in both groups after the training program (both p<0.05). However, no significant difference was found between the groups in terms of the difference following the training program (p>0.05). Whereas 505 agility test results did not change in both groups (p>0.05), the difference was in favour of the control group in terms of the intergroup difference values (p<0.05) (Table 5).

Table 5. Comparisons of the groups in terms of the differences in the parameters evaluated.

	Exercise group	Control group	p	d
Dynamic sit-up test (repeats)	8,60± 9,28	4,40±9,85	0,384	0,43
Dynamic sit-up test (seconds)	19,70±26,22	2,70±12,02	0,241	0,83
Push-up test (repeats)	2,30±7,92	-1,20 ± 6,20	0,225	0,49
Push-up test (seconds)	3,90± 7,85	-2,70±8,91	0,140	0,80
Static sit-up test (seconds)	2,30± 21,54	13,60±27,12	0,290	0,46
Static reverse sit-up test (seconds)	17,20±22,30	8,30±20,29	0,472	0,41
Modified Thomas test-right (cm)	0,10±0,57	0,35±0,88	0,473	0,33
Modified Thomas test-left (cm)	0,00 ±1,25	-0,20±1,14	0,788	0,16
Sit and reach test (cm)	2,45±1,85	2,85±1,94	0,333	0,21
Functional reaching test (cm)	2,75±4,19	2,95±4,08	0,648	0,04
Vertical jumping test (cm)	1,15±1,47	1,95±2,35	0,445	0,40
505 test (seconds)	0,09±0,43	1,43±2,02	**0,013***	0,91

Abbreventions; cm; centimeters, * $p<0.05$

DISCUSSION

In this study, in which we investigated the effect of core stabilization exercise on the performance of amputee football players, it was found that core stabilization exercises increased muscular endurance and positively affected functional capacity in a short time.

It was observed that age, height, weight, and BMI values were similar between the exercise and control group, and thus the groups were homogenous. Physical features that we obtained showed similarity with the results of some studies conducted on amputee football (9, 13, 14). In our study, we found that trunk flexors and back extensors were more enduring and stronger in amputee football players in the control group. This was attributed to that 80% of the players in the control group were playing in the National Amputee Football Team and tackling at the elite level.

Muscle strength, balance and trunk stabilization are important factors in amputee football as in other sports. In this regard, muscular strength and trunk stabilization are needed in the upper extremities. It was reported in a study that amputee football players performed 54 repeats of sit-ups in 75 seconds and 45 repeats of push-up in 38 seconds on average (10). In our study, core stabilization exercises increased the endurance of trunk and back muscles in the training group, but these exercises were observed to have statistically similar effects with the routine training program. Significant increases were shown in the strength and endurance parameters of trunk muscles following an exercise training for core region performed with a Swiss-ball (15, 16). At the same time, routine football training programs also showed similar effects. Cosio-Lima et al. reported that a 5-week standard strength program increased back strength in the experimental group (17). Durall et al. performed strengthening exercises on 30 women athletes for 10 weeks and found that the performance of trunk and back muscles was increased (18). In our study, similar effects between the groups might be resulted from that our duration was insufficient for neuromuscular adaptation that would be created by core stabilization. It is not clear in the literature how long it takes for the acute effects of core stabilization training to take place at a physiological level (19).

In our study, the core exercise program showed improvement in ability of vertical jumping as high as the routine program. Given that the lower extremity strength is a more important parameter for vertical jumping performance, although the endurance of the trunk muscles of the footballers in the training group improved, it may be considered normal not to affect the vertical jump performance. Tse et al. performed core exercises in rowers and while the endurance of trunk muscles improved, athletic performance parameters (shuttle run, horizontal and vertical jumping, 40 meters sprint) did not change after the training program. Although we prioritized dynamism and functionality for advancing the exercises in our study, not to utilize free weight to develop strength might affect our results. There are numerous studies in the literature supporting our findings. Previous studies reported that core stabilization training did not change the factors affecting sportive performance such as 40-m sprint, vertical jumping and shuttle run (20), reaction force perpendicular to the ground and on a horizontal plane (21), and throwing health ball (20). It has been reported that core stabilization exercises should be included in fitness programs for rehabilitation or prevention of injuries, and these exercises can not come to the fore in performance training (22).

In our study, sit and reach tests showed improvements in both groups, however the changes during 6 weeks were similar between the groups. We believe that routine football training affects the development of flexibility exercises, especially those performed during the warming. A 6-week preparation period has been reported to improve flexibility in amputee football (23). In a study by Ozkan et al. conducted to determine physical fitness features of amputee football players, the players were found to have a good flexibility (9). In addition, given that the level of amputation is a factor affecting flexibility, we think that this might differ in amputations at a higher level such as above the knee and further studies are needed on this issue.

Looking at our study in terms of balance, the control group showed improvement in functional reaching during the study, but the difference in change was similar between both groups. Although a positive correlation has been shown between flexor trunk muscle strength and dynamic core stability, no correlation could be found between core stability and balance (14). Our exercise program progressed to dynamic exercise from static mat exercises, yet the expected improvement in balance was not observed. In a review by Behm et al. investigating the effects of static and dynamic core stabilization training on athletic performance, it was stated that the athletes concentrated on free weight lifting and effects of static or dynamic core training were not clear (24).

In our study, we found no significant difference in both groups in terms of agility before and after the training program, while the improvement was better in the control group. We think that experience with forearm crutches in amputee football caused this difference. In addition, better agility in the control group can be explained by the larger number of players who were involved in the National Amputee Football Team. Speeding in amputee football has been stated to be associated with increased pelvic tilt and short duration of standing with forearm crutches (25). Larger number of players in the control group involved in the National Amputee Football Team may indicate that these players were specialized in the use of aiding devices at the elite level. However, it was thought that these results might also be associated with the level of amputation. Energy expenditure is known to be higher in above knee amputees compared to below knee amputees (26). In the present study, 30% of the amputee football players in the training group had above knee amputation, while this rate was 10% in the control group. This factor may be important in terms of a higher energy expenditure in the training group.

We believe that acute adaptation of core stabilization exercises did not occur especially in muscle fibers in the neuromuscular system in the development of power or strength related performance characteristics. Similarly, in a systematic screening by Reed et al. questioning core-performance relationship, majority of positive performance improvements were reported to be resulted from sportive-purpose training programs (27). It has been argued that the changes in power requiring performances such as strength, sprint and jumping should be integrated with free weight works and sports specific core exercises (28). From this aspect, the exercises that we chosen might be not specific or did not reach a sufficient level. The importance of upper extremity movements and biomechanical adaptations developed by athletes as a result of the changes in kinetic chain should not be ignored. Core stabilization training supporting neutral spine should be developed for the needs of amputee football players rather than standard training (27).

In our study which was designed as randomized controlled, despite the fact that we created homogenous groups, the majority of the players in the control group being involved in the National Amputee Football Team was seen as a limitation. However, we think that our study is important, because the parameters evaluated and the effects of core stabilization on the performance of amputee football players were studied for the first time.

Amputee football has different dynamics since it is played with a lower extremity and forearm crutches, and studies on the other sportive areas may not provide sufficient knowledge on amputee football. Therefore, we think that different methods should be developed for physical fitness of the players according to the needs of amputee football, and longer and different exercise approaches should be tested to improve their performance.

CONCLUSION

This study demostrated that a 6-week core stabilization training led to meaningful improvements in trunk muscular endurance in amputee football players but did not provide superior gains in agility, balance or jumping compared with routine football training. Core exercises may still be a useful component of training programs to support trunk endurance and functional capacity. Further studies with longer intervention time and population size are needed to clarify their impact on broader performance outcomes.

Ethics Committee Approval: The study was approved by the Non-Invasive Research Ethics Committee of Hasan Kalyoncu University Faculty of Health Sciences by 11/10/2016 dated and 201612 number decision.

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