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EFFECT OF DOUBLE HORIZONTAL SQUAT JUMP TRAINING ON PERFORMANCE AND TECHNICAL OF SWIMMING START

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SUMMARY

This study analyzed the effects of double horizontal squat jump training on the performance and spatio-temporal parameters of swimming jump start. Ten elite athletes participated in training program that included progressive overload (1RM) associated with regular training routines for 9 weeks. Kinematic parameters were assessed to determine modifications on performance indicators. The horizontal displacement increased 7.0% ($p=0.03$) and the angular velocities from 8 to 16% ($p=0.02$; $p=0.04$). The joint angular parameters did not differ after training ($p>0.05$). The larger horizontal reach and faster angular velocities indicated the effectiveness of specific plyometric training on performance, whereas the absence of the intersegmental angular changes suggests that such results did not induced modifications in movement organization.

INTRODUCTION

Swimming jump start performance depends on the direction and the magnitude of the resultant vector, which is ultimately influenced by the segmental actions [1]. Thus, changes in segmental actions may influence the performance and are also believed to be modulated (adjusted) in response to training stimulus [2]. High performances may be viewed as the interaction between the force-generating properties (i.e., force) and the topological characteristics of the movement (i.e., coordination) [3].

Several training methods designed to improve swimming jump start have been proposed, but segmental action changes are still unexplored. The aim of the study was to analyze the effect of double horizontal squat jump training (DHSJ) on performance and movement organization (spatio-temporal parameters) of swimming jump start.

METHODS

Ten experienced athletes (7 men; 22$\pm$1.4 years; 69.8$\pm$4.8 kg; 1.78$\pm$0.06 m and 3 women; 21.3$\pm$7.6 years; 59.9$\pm$2.9 kg; 1.70$\pm$0.05 m) that participate of Local and National official competitions volunteered to participate and signed an informed consent previously approved by the Ethics Committee of the University.

Three identical assessment sessions 15 days before (INI), immediately before (PRE) and after (POS) the training program were performed. The INI and PRE assessments and allowed to determine no changes in performance during the control period (from INI to PRE; $p>0.05$).

The swimming start performance test was conducted from a start block secured to the border of the swimming pool in accordance to FINA (2009) standards. Kinematic data was collected using a 2D video approach (Casio, model EX-FH20. 210 Hz) perpendicularly positioned in the left sagittal plane. A set of markers was drawn on the skin and X and Y coordinates were obtained by manual digitizing. Raw data were filtered (Butterworth 2nd order with a cutoff frequency of 8 Hz) and the following variables determined: vertical and horizontal center of mass displacement and velocity and peak joint angular velocities of the hip and knee. In addition, the take-off and segmental angles of knee and hip at take-off and water entrance instants.

Participants were instructed to perform a maximal swimming jump start as if they were in a real competition. In addition, they were also requested to reach as fast as possible the distance of 15 m from the edge of the pool. Two maximal trials were recorded, but only the one with the best performance (greatest distance) was further analyzed. Two minutes was imposed between trials.

The double horizontal squat jump training was associated with regular swimming training routine and conducted during 9 weeks, with two sessions per week and intervalled 48 h between sessions. Progressive overload of 5% (1RM – squat movement) was applied, with 5% of increment every 3 weeks. The long jumps were performed from a platform that replicated the angle of the block using a posture identical to that assumed in the start jump on swimming. Each movement was followed by a second maximal countermovement jump.

A One-way ANOVA was applied to determine differences in response to training (INI, PRE and POS) and was followed by the Tukey test to determine where differences occurred ($p\leq0.05$).

RESULTS AND DISCUSSION

Performance parameters, defined according capacity to influence the outcome [4], indicated that the training method was effective to improve the swimming jump start (Table 1). The increase of 7% (p=0.03) in the horizontal displacement observed after the training period of DHSJ is higher when compared to others that have described performance [5] or determined training effectiveness from block start training [6,7]. The results indicated that specific plyometric training for DHSJ as a stimulus (i.e., that resembles the demands of the performance) is more effective than using block jump start as a stimulus. It is likely that improved contractile function caused large changes in the magnitude of the resultant vector and is likely to explain performance gains [8]. Improvements in contractile capacity are also evidenced by the increases in peak angular velocity of knee and hip (8 [p=0.02] and 16% [p=0.04], respectively).

There were no changes in the segmental joint angles after the training period (p>0.05), which suggests that there was not coordination changes after training. The stable spatial arrangement reveals that no changes in technique occurred [3].

CONCLUSIONS

The efficiency of the proposed training was assessed and observed by the improvement in performance parameters. In addition, the fixedness of segmental joint angles suggests that the method is effective to provide performance improvements without technique modifications, possibly the ideal training proposal for highly trained athletes.

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Table 1: Mean ± SD) of the kinematic parameters of the swimming jump start 15 days prior starting training (INI), before (PRE) and after (POS) training.

Variables	PRE (mean±SD)	POS (mean±SD)	p (PRE-POS)
CMx (m)	2.56 ± 0.21	2.74± 0.4	*0.03
CMy (m)	1.49± 0.05	1.44 ± 0.07	*0.04
PVLH (°.s^{-1})	421.71 ± 78.55	490.90 ± 97.50	*0.02
PVLK (°.s^{-1})	558.23 ± 120.18	603.59 ± 162.44	*0.04
TOA (°)	19.86 ± 3.66	21.14 ± 4.67	0.06
HIPTO (°)	154.42 ± 11.35	151.63 ± 8.84	0.16
KNEETO (°)	180.77 ± 5.52	179.78 ± 3.34	0.65
HIPENT (°)	165.81 ±12.58	169.49 ±10.93	0.15
KNEEENT (°)	182.31 ±8.98	180.55 ±8.48	0.24

CMx - horizontal center of mass displacement; CMy - vertical center of mass displacement; PVLK and PVLH - peak of joint angular velocities of the knee and hip; TOA - take-off angle; HIPTO and KNEETO - hip and knee angles at take-off; HIPENT and KNEEENT - hip and knee angles at water entrance.