29 - THE CONTRIBUTION OF A RESISTANCE TRAINING PROGRAMME ON THE GRAB AND TRACK STARTS TECHNIQUES IN COMPETITIVE SWIMMING.

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INTRODUCTION

The swimming start can be between 0.8% to 26.1% of the total overall race time depending on the event distance (Cossor and Mason, 2001), and on average, the improvement of the start technique can reduce the event's total time at least 0.1 s (Maglischo, 2003). In this context, the author points out that the three requirements for an effective start are a fast reaction time, great jumping power and a low resistance during underwater gliding. Although little can be done to improve reaction time, the other two factors can be improved by training (Breed and Young, 2003). Some researchers have shown a significant positive correlation between the performance of the vertical jumping (VJ) and starting performance (Zatsiorsky et al., 1979, Pearson et al., 1998). Thus, greater muscular leg power and improved jumping ability may be important in reducing the starting time and, consequently, overall race time (Lyttle and Ostrowski, 1994).

As Breed and Young (2003), research has been limited on lower limb (LL) leg strength and power in relation to swimming start performance. Miyashita et al. (1992) found significant correlation between leg extensor power and flight distance (r = .76) and performance to 5m (r = - .68). Some researchers have reported a significant correlation between VJ without upper limbs (UL) countermovement and the starting performance over a criterion distance (Zatsiorsky et al., 1979; Counsilman, 1986). Although relationships have been observed in descriptive research, only Breed and Young (2003) seem to have made an experimental research, using some kinematic variables, which determine whether the training to enhance the ability of VJ improves starting techniques performance.

The grab (GS) and track start techniques (TS) are common in swimming races (Holthe and McLean, 2001). The two swimming start techniques have different starting mechanisms, thus resistance training might have a different effect on each. Hence, the purpose of this study was initially determine whether the resistance training programme designed to the increase VJ ability could enhance the performance parameters in the GS and TS starting techniques, and then tries to identify the relationships between the VJ and starting techniques performance.

METHODS

Subjects

Two groups of 10 swimmers volunteered to participate in this study. Their mean (± SD) age, body mass, height and years of training were, respectively, 19.5 ± 2.8 years old, 75.6 kg ± 7:51, 1.79 ± .09 m, 9.3 ± 4.46). The swimmers were equally divided into control group (C) and experimental (E). All the swimmers were informed about the details of the experimental protocol before beginning the measurements procedures.

Experimental protocol

Dive technique training

The order of the swimming starts was randomised. During practice sessions, subjects had specific coaching feedback on mechanical factors considered to be important from diving literature and on opinions from experienced coaches, such as: initial pre-tension of UL and LL muscles when in the set position (Costill et al. 1992), to pull forcelly on the block with the UL in response to the starting signal (Bowers and Cavanagh, 1975), thrusting the UL out hard and fully extended when leaving the block (Fitzgerald, 1973 ; Woelber, 1983), leaving forward with pre-tension in the UL for the GS to move the swimmer's center of gravity (CG) further to a more forward position (Maglischo, 2003), to drive hard off the blocks with the LL (Guimaraes and Hay, 1985) to project themselves at an appropriate angle off the block and enter the water cleanly to maintain momentum in the glide phase (Wilson and Marino, 1983).

Swimmers were instructed at GS to stand with the toes curled over the front edge of the block and feet were .15 to .30 m apart. The TS technique was carried out with LL dominant forward, the other limb was placed behind, and the CG moved forward.

Test protocol

The test sessions before and after the training programme consisted of two parts: (i) jumping ability testing and (ii) performance of the two dive starts types. Dry-land testing was performed after the resistance the resistance training programme with starts tests 2 days later (Breed and Young, 2003).

After the pre-test, participants were assigned at random to the C group (n = 10) or E group (n = 10). Both groups continued their normal activities, but E group and participated in a resistance program designed to enhance jumping ability for 12 weeks.

Dry-land test

It was determined the VJ test with UL countermovement, and this test has been standardized by Komi and Bosco (1978). Each subject performed three VJ, starting from the position with UL in extension, by flicking a position with the LL in flexion (angle about 90 degrees at the knee joint), before performing the VJ.

Dive testing

The athletes performed a warm-up of 5 min of light swimming and three practice trials of each technique. The anatomical reference points were the corresponding vertex lobe of the ear, acromion, lateral condyle of the humerus, styloid process of the wrist, 3rd distal phalanx, fifth rib, anterior iliac spine, hip trochanter, femoral lateral epicondyle, lateral malleolus and hallux. The participants were videotaped in the sagittal plane using an aerial camera (Sony DCR-HC42E) operating at a frequency of 50 Hz with digital shutter speed of 1 / 250 and was fixed to a tripod positioned 2.5m from the edge of the pool deck, 7m from the plane of movement and 0.6m above water surface.

A two-dimensional metal structure with dimensions of 2.1 x 3m and four calibration points was recorded in the plane of movement to allow reconstruction. The error associated with the reconstruction was calculated using the Root Mean Square (RMS), while the reliability of the calibration volume was evaluated by SD. The error associated with the horizontal coordinate was 3.1 ± .2 mm and 2.8 ± .1 mm for the vertical coordinate.

The anatomical landmarks were digitized at a frequency of 50 Hz using APASystem (Ariel Dynamics, USA). The digitize-redigitize reliability was r = .96 ± .02. We used a digital filter to the coordinates (Digital Filter Algorithm - APAS, fourth-order Butterworth low pass frequency, average cut of 5 Hz).

The anthropometric model was the one from Seluyanov and Zatsiorsky (1983) adapted by de Leva (1996). The signals were in accordance with the swimming rules and were produced trough a synchronizer. This equipment is programmed simultaneously produce the starting sound and export a LED signal (duration higher than .1 s to the video system).

Six biomechanical variables were measured: total start time (TT) - from the start signal to the start end; reaction time (RT) - time between the start signal and the first movement observed; block time (BT) - interval between the start signal and the last instant of contact of the feet with the bock; flight time (FT) - the period between the take off instant and CG water entry; water reach of the CG measured as the difference of horizontal coordinates of starting wall and the CG water entry (rCGw); resulting velocity of the CG at the take-off instant (VrCGTO).

Resistance training

Three practice sessions per week were performed for 12 weeks using the protocol adapted from Santo et al. (1997). Participants were excluded from the analysis if more than four sessions were not performed (Breed and Young, 2003).

Table 1. Resistance training programme.

Organization	Training 1	Training 2	Training 3
Type	Jump training	Depth jumps	Jumps with additional weight
Duration	5 weeks	4 weeks	3 weeks
Frequency	3x/week	3x/week	3x/week
Series	2/3	3/4	4
Rest time:	25"/30"	60"/90"	60"/90"
repetitions/series	1'	3'/4'	3'/4'
Material	Swedish bench (height 30 cm); barriers (height 50cm)	Box drills (heigth 40 and 70 cm)	Ankle weights (8Kg) Box drills (alt. 40 cm)
Exercises			
N°1	6 lateral and sprint jumps	6 jumps	5 barriers
N°2	15 jumps	6 jumps	8 jumps
N°3	High steps 4 steps each lower limb	6 jumps	8 jumps (4 lateral and 4 frontal)
N°4	5 barriers	6 jumps	10 jumps
N°5	10 jumps		
N°6	8 jumps (4 lateral and 4 frontal)		

Statistical analysis

Mean and standard deviation (SD) were obtained for the descriptive analysis of all variables and the normality of distribution with the Shapiro-Wilk test. We used the Student's t test for paired samples. The Person correlation coefficient was also used. All statistical procedures were conducted with SPSS 17 and a level of significance of 5% was accepted.

RESULTS AND DISCUSSION

Table 2 presents the mean (±SD) values of six biomechanical parameters studied in GS and TS techniques, in the conditions of pre and pos intervention in groups C and E, as well as the percentage change between the instants. The results obtained in the temporal parameters indicate that BT decreased in both groups at TS technique. Issurin and Verbistky (2001) and Miller et al. (2003) reported a lower BT at TS technique on a national team sample. In addition, Breed and Young (2003) point out that UL contribute one third of the total horizontal impulse produced in the TS technique, while in the LL, GS technique seem to produce the entire impulse. With respect to TR, the plyometric training seems to have increased the observed performance of the GS swimmer performers. Villas-Boas et al. (2003) reported lower TR at GS technique, and this result is assigned to the exposure of UL from the edge of the block, which probably promoted an imbalance in the early beginning of the start signal. For the FT and TT was recorded effect of plyometric training for both techniques. In fact, Adams (1986) had already pointed out that the increased power of LL is essential for faster times.

The plyometric training seems to have contributed to the increase in rCGw in both techniques, but E group of the GS technique seems to indicate higher increase. Robertson and Stewart (1998) observed similarities in the pattern of VJ movement and GS technique. For the VrCGTO, it was noted that in both swimming start techniques practice to the E group the percentage of increase was above 90%. Oddson (1989) indicates that the VrCGTO determines the increase in the performance of VJ, therefore (Breed and Young, 2003) mentioned that the increase of the VJ performance could lead to an increase in VrCGTO and a decrease of FT.

Table 2. Mean ± SD values of the 11 biomechanical parameters analyzed at GS experimental group (GSE) and control (GSC) and track start at experimental group (TSE) and control (TSC), before and after the resistance training programme.

Variables		GSE	GSC	TSE	TSC
rCGw (m)	Before	3.28 ± 0.10	3.29 ± 0.08	3.27 ± 0.13	3.28 ± 0.11
	After	3.31 ± 0.10**	3.51 ± 0.13	3.34 ± 0.10**	3.32± 0.13**
	% change	94	4	86	79
BT (s)	Before	0.86 ± 0.01	0.86 ± 0.01	0.87 ± 0.03	0.87 ± 0.03
	After	0.82 ± 0.02	0.83 ± 0.02	0.84 ± 0.02**	0.85 ± 0.03**
	% change	86	22	82	90
RT (s)	Before	0.16 ± 0.03	0.17 ± 0.02	0.18 ± 0.01	0.18 ± 0.01
	After	0.14 ± 0.03**	0.14 ± 0.02	0.15 ± 0.01	0.16 ± 0.02**
	% change	92	88	42	85
FT (s)	Before	0.35 ± 0.01	0.35 ± 0.02	0.40 ± 0.02	0.39 ± 0.01
	After	0.33 ± 0.02**	0.32 ± 0.02	0.36 ± 0.03*	0.37 ± 0.03
	% change	82	77	49	12
TT (s)	Before	1.51 ± 0.07	1.50 ± 0.06	1.51 ± 0.02	1.50 ± 0.03
	After	1.44 ± 0.06**	1.49 ± 0.05*	1.48 ± 0.02**	1.49 ± 0.03**
	% change	98	90	90	92
VrCGTO (m.s⁻¹)	Before	3.79 ± 0.22	3.66 ± 0.16	3.50 ± 0.12	3.50 ± 0.12
	After	3.96 ± 0.16**	3.69 ± 0.18	3.63 ± 0.11 *	3.56 ± 0.16
	% change	96	98	94	56
VJ (m)	Before	59.41 ± 6.36	---	---	---
	After	63.04 ± 3.29*			
	% change	39			

Note. rCGwCG: water reach of the CG measured as difference of horizontal coordinates of starting wall and the CG water entry. BT: block time, interval between the start signal and the last instant of contact of the feet with the block. RT: reaction time, interval between start signal and movement observed. FT: Flight time, period between the take-off instant and CG water entry. CG. TT: total start time, period between the start signal to the start end. VrCGTO: resulting velocity of the CG at take-off instant. VJ: vertical jump performance. Significant differences * P <0.05, ** P <0.01.

Correlation coefficient of Pearson between VJ and biomechanical parameters are described in Table 3. For both techniques was noted statistically significant correlation between rCGw and VJ (r = .70, p <0.05, r = .58, p <0.05) and FT and VJ (r = - .57, p <0.05, r = - .60, p <0.05). It means that a higher value obtained in VJ performance with UL countermovement increases the rCGw performance at the two techniques. Breed and Young (2003) found significant correlation coefficients between VJ and rCGw at both techniques. Corroborating the idea, Miyashita et al. (1992) found a significant correlation between the strength of the LL extensor muscles and flight distance (r = 0.76) and between the power of the extensor LL muscles and starting

performance to 5m. Additionally, Miller et al. (1984) and Robertson and Stewart (1998) indicate that the time and distance are important variables in the swimming start performance, particularly as the body can travel considerably faster through the air than in water.

Table 3. Correlation values between performance in the vertical jump and biomechanical parameters of the GS and TS technique: rCGwCG: water reach of the CG measured as difference of horizontal coordinates of starting wall and the CG water entry. BT: block time, interval between the start signal and the last instant of contact of the feet with the block. RT: reaction time, interval between start signal and movement observed. FT: Flight time, period between the take-off instant and CG water entry. CG. TT: total start time, period between the start signal to the start end. VrCGTO: resulting velocity of the CG at take-off instant. Significant differences ($p<0.05$).

Variables	GS r (p)	TS r (p)
rCGw (m)	0.70 (0.02)	0.58 (0.03)
BT (s)	0.25 (0.30)	0.32 (0.18)
RT (s)	0.17 (0.50)	- 0.08 (0.75)
FT (s)	-0.57 (0.03)	- 0.60 (0.02)
TT (s)	- 0.06 (0.79)	0.33 (0.17)
VrGCTO (m.s^{-1})	- 0.53 (0.03)	0.00 (0.97)

CONCLUSIONS

The resistance training programme contributed to the increase in rCGw and VrCGTO, as well as to reduce FT and TT in both swimming start techniques. Correlation analysis showed that the highest vertical jump seems to determine the highest rCGw and lowest FT at the two starting techniques studied.

The results presented indicate that the starting technique preferred by swimmers should be practiced throughout the resistance training to re-optimize the ability and control mechanisms of the neuromuscular system. Control tests should also be conducted throughout the program of resistance training for monitoring the results of jumping ability in dry and diving skills.

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THE CONTRIBUTION OF A RESISTANCE TRAINING PROGRAMME ON THE GRAB AND TRACK STARTS TECHNIQUES IN COMPETITIVE SWIMMING.

ABSTRACT

The swimming start is generally known to be a significant component for success in competitive swimming, especially in the shorter sprint races. The purpose of this study was to establish the effectiveness of a resistance training programme, designed to improve the vertical jumping (VJ) ability on the grab and front-weighted track starts techniques and identify the relationship between performance in the VJ and swimming start techniques. Twenty male swimmers participated in this study (mean ± SD: 19.5 ± 2.8 years). Participants were randomly assigned to a control group (n = 10) or experimental group (n = 10), which trained three times a week for 12 weeks. The tests before and after training programme were composed of grab and front-weighted track swimming start techniques and a vertical countermovement jump. The data were obtained from video images assessed using a camera positioned in the sagittal plane of motion. It was observed in both swimming start techniques the resistance training seems to increase the horizontal water reach of the CG (rCGw) during the air trajectory and resulting velocity of the CG at the take off instant, as suggested reducing the time spent in flight (FT) and total start time (TT). Significant correlation coefficients were observed between the VJ and rCGw and between FT and VJ in both swimming start techniques. Therefore, it is possible to speculate that coaches should consider the inclusion of regular resistance training concomitant with training swimming starts techniques to retrain the changed neuromuscular properties.

KEYWORDS: swimming start techniques, swimming, vertical jump.

LA CONTRIBUTION D'UN PROGRAMME DE RÉSISTANCE DANS TÉCNIQUE ENGRUPADA ET TYPE L'ATHLÉTISME DANS LA NATATION DE COMPÉTITION.

RÉSUMÉ

Le départ de natation est généralement connu pour être un élément important pour réussir dans la natation de compétition, surtout dans les courses de sprint court. Le but de cette étude était d'établir l'efficacité d'un programme d'entraînement en résistance, conçu pour améliorer le saut vertical (VJ) sur la capacité de saisir et de première piste commence pondérée des techniques et identifier la relation entre la performance dans la VJ et de commencer des techniques de nage. Vingt nageurs masculins ont participé à cette étude (moyenne ± SD: 19,5 ± 2,8 ans). Les participants ont été aléatoirement affectés à un groupe témoin (n = 10) ou d'un groupe expérimental (n = 10), qui sont entraînés trois fois par semaine pendant 12 semaines. Les tests avant et après le programme de formation ont été composées de saisir et de front-pondéré des techniques de nage piste de départ et un saut vertical countermovement. Les données ont été obtenues à partir d'images vidéo évaluée à l'aide d'une caméra placée dans le plan sagittal du mouvement. Il a été observé dans les deux techniques de nage commencer la formation semble accroître la résistance de l'eau portée horizontale de la CG (rCGW) au cours de l'air résultant de trajectoire et la vitesse du CG à l'instant le décollage, comme le suggère la réduction du temps passé en vol (FT) et heure de départ total (TT). Coefficients de corrélation significative n'a été observée entre la VJ et rCGw et entre la télévision et VJ commencer à nager dans les deux techniques. Par conséquent, il est possible de spéculer que les entraîneurs devraient envisager l'inclusion de la résistance à une formation régulière concomitante avec la formation des techniques de natation commence à recycler les propriétés neuromusculaires changé.

MOTS CLEF: le techniques de departune dan natation, la natation, le saut vertical.

LA CONTRIBUCIÓN DE UN PROGRAMA DE ENTREINAMIENTO DE RESISTENCIA EM LAS TÉCNICAS DE SALIDA DE AGARRE y TIPO AGARRE DE ATLETISMO EN LA NATACIÓN COMPETITIVA.

RESUMEN

El salida de la natación es generalmente conocida por ser una componente importante para el éxito en la natación competitiva, especialmente en las probas más cortas. El propósito de este estudio fue establecer la eficacia de un programa de entrenamiento de resistencia, diseñado para mejorar el salto vertical (VJ) en la apropiación de la capacidad y el frente ponderado pista empieza técnicas e identificar la relación entre el desempeño en el VJ y empezar las técnicas de natación. Veinte nadadores varones participaron en este estudio (media ± SD: 19,5 ± 2,8 años). Los participantes fueron asignados al azar a un grupo control (n = 10) o el grupo experimental (n = 10), que entrenó tres veces por semana durante 12 semanas. Las pruebas antes y después del programa de formación se compone de agarrar y frente ponderado iniciar técnicas de natación y una pista de salto vertical con contramovimiento. Los datos fueron obtenidos a partir de imágenes de vídeo evaluó mediante una cámara situada en el plano sagital del movimiento. Se observó tanto en las técnicas de natación iniciar el entrenamiento de resistencia parece incrementar el agua alcance horizontal de la CG (rCGw) durante el aéreo debido a la trayectoria y velocidad de lo CG en el momento de despegar, como se sugiere reducir el tiempo de permanencia en vuelo (FT) y hora de inicio total (TT). Los coeficientes de correlación significativa fue observada entre el ejército yugoslavo y rCGw y entre FT y VJ comenzar a nadar en ambas técnicas. Por lo tanto, es posible especular que los entrenadores deben considerar la inclusión de regular la resistencia a la formación concomitante con la formación comienza a nadar técnicas para reciclar las propiedades neuromusculares cambiado.

PALABRAS CLAVE: técnicas de salida en la natación, natación, salto vertical.

A CONTRIBUIÇÃO DE UM PROGRAMA DE TREINO DE RESISTÊNCIA NAS TÉCNICAS DE SAÍDA ENGRUPADA E DE ATLETISMO NA NATAÇÃO COMPETITIVA.

RESUMO

A saída é geralmente conhecida por ser uma componente significante para o sucesso em natação competitiva, especialmente em eventos de curta duração. O propósito deste estudo foi estabelecer a efetividade de um programa de treino de resistência, designado para incrementar a habilidade do salto vertical (SV), nas técnicas de saída engrupada e tipo atletismo com projeção do centro de gravidade (CG) à frente, e identificar as relações entre o desempenho no SV e as técnicas de saída. Vinte nadadores do sexo masculino participaram deste estudo (média ± DP: 19.5 ± 2.8 anos de idade). Os participantes foram aleatoriamente divididos em grupo de controle (n = 10) ou grupo experimental (n = 10), que treinaram três vezes semanais durante 12 semanas. Os testes pré e pós-programa de treino foram compostos das técnicas de saída engrupada e tipo atletismo com projeção do centro de gravidade (CG) à frente e um teste de SV com movimento dos membros superiores. Os dados foram obtidos através de imagens de vídeo registradas por uma câmera posicionada no plano sagital do movimento. Foi verificado nas duas técnicas de saída que o treino de resistência parece ter incrementado o alcance horizontal do centro de gravidade (AxCG) durante a trajetória aérea e a velocidade resultante do CG no instante da perda de contato dos pés com o bloco, assim como sugeriu a redução dos tempos despendidos no vôo (TV) e na totalidade da saída (TT). Coeficientes de correlação significantes foram observados entre o AxCG e o SV e entre TV e SV em ambas técnicas. Portanto, é possível especular que os treinadores deveriam considerar a inclusão da prática regular do treino de resistência concomitante ao treino das técnicas de saída para requalificar às alterações nas propriedades neuromusculares.

PALAVRAS-CHAVE: técnicas de saídas, natação, salto vertical.

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