ISOKINETIC TRUNK DYNAMOMETRY IN DIFERENT SWIMMING STROKES

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ABSTRACT

Objective: To compare the effect of asymmetric and symmetric swimming strokes on muscle activity of the trunk flexor and extensor muscles. Methods: Fourteen elite speed swimmers, specialists in one of four swimming styles, all without any history of spinal cord injury, were divided in two groups: 1) asymmetric group, consisting of five athletes specializing in the freestyle stroke and three in the backstroke; and 2) symmetric group, consisting of four athletes specializing in the butterfly stroke and three in the breaststroke. All the swimmers were assessed using a Cybex 6000 isokinetic dynamometer. Results: The acceleration time for the trunk flexor group at a speed of 120° per second was greater in the symmetric group (p=0.054). The power of the extensor group at speeds of 90° and 120° per second was greater in the asymmetric than in symmetric group (p=0.053 and 0.052), respectively. There was no significant statistical difference for any of the other variables assessed. Conclusion: The asymmetric strokes (crawl and backstroke) provided a more efficient muscular response (recruitment) in the trunk flexor muscles, which may be due to the constant maintenance of isometric contraction of the abdominal muscles.

Keywords: Spine. Swimming. Exercise. Muscle strength.

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INTRODUCTION

In swimming, the most important biomechanical motion is the forward movement of the upper limb,[1] yet the trunk is important to keep the axis of movement of the development of swimming and support of the body in the water during arm strokes and the submerged undulation.[2] There is a low incidence of spinal injuries (3%) in swimming in general,[3] while in elite swimming these injuries affect up to 41% of athletes,[4] yet the movement of dissociation of the pelvic and shoulder girdles during trunk rotation movements and arm movements, whether alternated or symmetrical, may favor the appearance of muscular imbalances. The present muscular imbalance of the trunk is the main factor of injuries. According to McGregor et al.[5] the trunk is important to maintain both stability and balance, particularly when the upper limbs develop movements of considerable amplitude and high speed, but the distinction of force and speed of contraction between symmetric and asymmetric swimming styles is questionable in literature.

The aim of this study is to compare the parameters of the isokinetic dynamometry of the trunk flexor and extensor muscles of symmetric style (butterfly stroke and breaststroke) and asymmetric (freestyle stroke and backstroke) speed swimmers.

MATERIAL AND METHODS

CASUISTRY

The study subjects were 20 swimmers with five years of federation and a record of participation in contests for more than ten years, speed swimmers (50, 100 and 200 meters) in one of the four swimming styles. They all trained five to six days a week for two hours, performed physical conditioning (coordination, flexibility and muscle strengthening) twice a week and did not have a past history of diseases or injury of the spinal column.
There was an evaluation of 12 athletes from the Asymmetric Swimming Group (GNA) with nine freestyle athletes and three ba-

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ckstroke athletes and of 8 from the Symmetric Swimming Group (GNS) with four breaststroke swimmers and four swimmers butterfly style swimmers.

The anthropometric data of groups GNS and GNA are mentioned in Table 1.

Table 1 – *Mean, standard deviation and statistical difference of the anthropometric data between groups GNA and GNS*

	GNA	GNS	(p)
AGE (years)	20.5 3	21.3 5.5	0.7
BODY MASS (kg)	77.1 5.8	71.0 11.1	0.12
STATURE (cm)	183 4.2	175 7.7	*0.0081

Student's T-test: * p= 0.0081

METHOD

The swimmers were evaluated at the Laboratory for the Study of Movement – LEM of the Institute of Orthopedics and Traumatologia - IOT of Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo - HCFMUSP where they signed the consent term for the evaluation.

The swimmers performed warm-up exercises on the *Movement Bioclycle 2600* ergometric bicycle, followed by brief 30-second stretching exercises involving the target musculature evaluated, according to Perrin's protocol.[6] The swimmers were assessed with the *Cybex 6000* isokinetic dynamometer. Two submaximal trunk flexion and extension contractions were performed. Five repetitions were executed at the speed of 90º/second with five repetitions at the speed of 120º/second with an interval of 30 seconds between the tests at the two speeds. The range of motion was 105º (-15º of complete extension of the trunk up to 90º of trunk flexion). The parameters evaluated at the speeds were: torque peak (Newton/meter), power (watts), work (joules) and acceleration time (milliseconds). The ratio of maximum torque between the flexor and extensor groups was evaluated only at the speed of 90º/second. After the test a report was issued by the equipment software, HUMAC® 2007 Version 7.1.18.

STATISTICAL ANALYSIS

The *Kolmogorov-Smirnov* normality test was used to discover the normality of the data, and the Student's T-test was used for the comparison of parameters between the symmetric and asymmetric swimming groups. The statistical tests were conducted through *SigmaStat 3.5* software.

RESULTS

The acceleration time of the flexor muscles at the speed of 120º/second was lower in the GNA group.

The power of the extensor group at the speeds of 90 and 120º/second was greater in GNA than in GNS. There was no significant statistical difference in the other variables analyzed.

The descriptive data of the variables of the isokinetic dynamometry of GNA and GNS are expressed in Table 2.

Table 2 – *Mean and standard deviation of the variables of the isokinetic dynamometry of the flexor and extensor muscles of the trunk in the Asymmetric Swimming Group (GA) and Symmetric Swimming Group (GS): peak torque (PT), torque in maximum repetition (TMR), power (P), acceleration time (AT) and agonist/antagonist ratio (agon/ant ratio) of the flexor and extensor muscles.*

Flexion	GNA	GNS	Extension	GNA	GNS
PT 90º/s	356.4±105.7	265.1±146.0	PT 90º/s	454.0±140.1	359.4±139.9
PT 120º/s	329.4±102.7	268.5±153.1	PT 120º/s	432.6±129.	340.9±153.1
TMR 90º/s	317.6±109.8	298.3±156.7	TMR 90º/s	442.2±115.5	359.3±111.2
TMR 120º/s	303.8±94.5	282.1±140.7	TMR 120º/s	424.6±104.3	342.5±118.4
P 90º/s	271.5±80.3	243.4±122.9	P 90º/s	+370.1±98.9	282.4±82.2
P 120º/s	349.1±100.6	301.3±146.3	P 120º/s	++464.8±121.3	351.4±116.5
AT 90º/S	0.28±0.06	0.31±0.1	AT 90º/S	0.31± 0.04	0.32±0.06
AT 120º/S	0.24±0.05	*0.30±0.07	AT 120º/S	0.32±0.03	0.33±0.05
agon/ant R 90º/s	0.82±0.31	0.71±0.3	Ag/ant R 120º/s	0.78±0.3	0.78±0.4

Student's T-Test: * p= 0.054 + p= 0.053 ++p=0.052

DISCUSSION

The trunk promotes the support of the body during the act of swimming.[2] In asymmetric swimming, freestyle and backstroke, the contraction of the musculature leaves the body suspended during the alternation of strokes while the legs kick rhythmically. In symmetric swimming styles, butterfly and breaststroke, the athlete keeps up the flexion and extension of the trunk throughout the propulsion phase and in arm recovery (when the arms appear above the surface), the swimmer propels the trunk forward, sustained in an isometric manner by the dorsal musculature of the spine and by the propulsive musculature of the shoulder (internal adductors and rotators). The maintenance of posture and positioning during the alternation of movements between leg kick and arm stroke in a synchronous manner, without both hindering the drag of the swimmer, occurs through vigorous contraction of the trunk, mainly of the dorsal musculature of the swimmer.

GNA showed greater muscular power of the trunk extensor muscles at the speeds of 90 and 120º/s with lower acceleration time (time required to reach the angular speed) of the trunk flexors (abdominal) at the speed of 90º/s. The dorsal muscles of the trunk are comprised mainly of type I-A fiber of oxidative metabolism and slow contraction. They are postural muscles with antigravitational action, capable of remaining contracted for longer periods, but that can be trained to act for shorter periods and with a shorter response time (as phasic muscles). The use of the trunk musculature in asymmetric swimming to maintain the trunk during propulsion may justify the results of the isokinetic dynamometry. There was no difference in the parameter of muscular torque of the trunk flexors and extensor muscles in the comparison between groups GNA and GNS, or in the flexion/extension ratio. This fact shows that none of the styles predisposes to imbal-

ance, and there is no more or less adequate muscular biotype for a specific style.
Acceleration time is time that the musculature takes to reach angular speed and the flexor group of GNA took less time to reach the speed of movement with a faster response time, but there was no difference in the values of torque, work and power. The proprioceptive response and the greater muscular readiness may be more significant, in asymmetric swimming styles, than the muscular force parameter and may indicate that more specific work that optimizes the muscular response time can help to improve performance, functioning both as a primary restrictor for extension, and in the maintenance of posture through the proprioceptive information.
The non-difference in the parameters of the flexor group, in the comparison between GNS and GNA, may be justified by the fact that all the swimmers evaluated were speed swimmers, hence the need for substantial recruitment of the abdominal musculature in the expiration movement for elimination of CO_2.
Freestyle stroke and backstroke are more dynamic swimming styles and require continuous isometric contraction of the trunk musculature for maintenance of posture at the surface of the water and better propulsion, as well as the facilitation of alternated movements of the arms. In breaststroke and butterfly stroke, the two arms move simultaneously during the propulsion phase and the forward thrust of the trunk is performed in a paced manner with the arm stroke and the technique of the swimmer. The forward thrust in symmetric swimming is provided by the movement of the arms and legs and the trunk is not called upon to such an extent in postural maintenance.
An important topic as regards training may be the volume and intensity of training in the constitution of the findings such as increased power and decreased acceleration time in the asymmetric styles. All the athletes included in this study form part of a team where training is applied equally by the same coach, who does not distinguishes the swimmers by styles, but according to necessity and priority in the school year of competitions. Factors like training as the main agent for the acquisition of muscle mass through movements, and the individual chacteristics of the swimmers do not interfere in the findings, as the swimming motion is common to all, and the level of motor learning is already developed, considering that they all have more than 10 years of practice and 5 years of federation.
In conformity with the findings of this study and with no athlete having previous injuries, it was not possible to correlate the isokinetic parameters with the injured athletes, providing an open opportunity for research.
Our study is pioneer in the comparison between symmetric and asymmetric swimming styles. The lack of studies on the trunk and swimming topics in literature rules out the possibility of comparison with other studies. The evaluation of swimmers that target recreation or physical conditioning and the evaluation of long distance swimmers may produce more information to supplement and improve the understanding of the results of this study.

CONCLUSION

The extensor muscles of the trunk of swimmers with asymmetric styles have greater muscle power (muscular work by unit of time) than those of symmetric style swimmers, and this difference is related to muscular activity during swimming. The response time of trunk flexor muscles is shorter in asymmetric swimming due to the greater demand for proprioceptive control of these muscles than in symmetric swimming.

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