

POSTURE OPTIMIZATION IN SWIMMING BASED ON SPORTS MECHANICS

OTIMIZAÇÃO DA POSTURA NA NATAÇÃO BASEADA NA MECÂNICA ESPORTIVA

OPTIMIZACIÓN DE LA POSTURA EN LA NATACIÓN BASADA EN LA MECÁNICA DEPORTIVA



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ABSTRACT

Introduction: Speed and posture are two determining factors for the success of swimmers. Posture optimization can make athletes' actions more standardized and improve their speed at a competitive level. **Objective:** Explore the optimization of swimming posture based on sports mechanics. **Methods:** In the controlled experiment, the control group was given routine training, while the experimental group was given sport mechanics-based swimming posture optimization training. A duration of 60 minutes daily, three times a week. The experiment was completed in 6 weeks. Data by computerized cinematography were extracted using the reflective marking ball technique. Its mechanical motion and time consumption characteristics were collected before and after the experiment, cataloged, compared, and discussed statistically. **Results:** Daily and posture optimization training can improve athletes' body extension range. The effect of the experimental group in improving the range of body extension was shown to be greater than the standard training and slightly greater than the daily training by shortening the action time. **Conclusion:** The posture optimization scheme for swimming based on sports mechanics can improve athletes' extension range and speed. Physical education teachers and coaches should further optimize and promote the swimming posture optimization scheme to improve the performance of their athletes. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

Keywords: Swimming; Biomechanical Phenomena; Physical Education and Training.

RESUMO

Introdução: Velocidade e postura são dois fatores determinantes para o sucesso dos nadadores. A otimização da postura pode não apenas tornar as ações dos atletas mais padronizadas como também pode melhorar a sua velocidade em um nível competitivo. **Objetivo:** Explorar a otimização da postura de natação baseada na mecânica esportiva. **Métodos:** No experimento controlado, o grupo de controle efetuou o treinamento de rotina, enquanto ao grupo experimental foi adicionado o treinamento de otimização da postura de natação baseado na mecânica esportiva. Numa duração de 60 minutos diários, três vezes por semana, o experimento foi completado em 6 semanas. Dados por cinematografia computadorizada foram extraídos utilizando a técnica da bola refletiva de marcação. Suas características mecânicas de movimento e características de consumo de tempo foram coletadas antes e depois do experimento, catalogadas, comparadas e discutidas estatisticamente. **Resultados:** Tanto o treinamento diário quanto o treinamento de otimização da postura podem melhorar o alcance da extensão corporal dos atletas. O efeito do grupo experimental em melhorar o alcance da extensão corporal demonstrou-se superior ao do treinamento padrão, sendo ligeiramente maior do que o do treinamento diário encurtando o tempo de ação. **Conclusão:** O esquema de otimização da postura para natação baseado na mecânica esportiva pode efetivamente melhorar a faixa de extensão e a velocidade dos atletas. Os professores e treinadores de educação física devem otimizar e promover ainda mais o esquema de otimização da postura de natação, visando melhorar o desempenho de seus esportistas. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

Descritores: Natação; Fenômenos Biomecânicos; Educação Física e Treinamento.

RESUMEN

Introducción: La velocidad y la postura son dos factores determinantes para el éxito de los nadadores. La optimización de la postura no sólo puede hacer que las acciones de los atletas sean más estandarizadas, sino que también puede mejorar su velocidad a nivel competitivo. **Objetivo:** Explorar la optimización de la postura de natación basada en la mecánica deportiva. **Métodos:** En el experimento controlado, el grupo de control realizó un entrenamiento rutinario, mientras que al grupo experimental se le añadió un entrenamiento de optimización de la postura de natación basado en la mecánica deportiva. Con una duración de 60 minutos diarios, tres veces por semana, el experimento se completó en 6 semanas. Los datos de la cinematografía computarizada se extrajeron mediante la técnica de la bola de marcado reflectante. Sus características de movimiento mecánico y de consumo de tiempo fueron recogidas antes y después del experimento, catalogadas, comparadas y discutidas estadísticamente. **Resultados:** Tanto el entrenamiento diario como el de optimización de la postura pueden mejorar el rango de extensión corporal de los atletas. El efecto del grupo experimental en la mejora del rango de extensión corporal se mostró superior al entrenamiento estándar, y ligeramente superior al entrenamiento diario al acortar el tiempo de acción. **Conclusión:** El esquema de optimización de la postura para la natación basado en la mecánica



INTRODUCTION

Swimming is the upward floating of people due to the force generated in the water. With the help of buoyancy, the regular movement of the human body can make the human body move regularly in the water.¹ Nowadays, due to the development of the times and the improvement of living standards, swimming is becoming more and more popular in China. The advantages of swimming are more reflected in the improvement of the internal function of the human body.^{2,3} The ability of athletes to absorb oxygen is also improved through the frequency of breathing in the water and the stimulation of deep breathing. Because the water density in the swimming pool is large, the respiratory muscles of swimmers travel in the water. Due to the pressure from the water. The swimmer's abdominal cavity and chest are under more pressure than usual, which makes the respiratory muscles exercise. So as to further improve their own vital capacity.⁴ At the same time, due to the difference between the temperature and body temperature in the pool, traveling in the water will consume the energy of the body through the resistance of the water to people. In the process of swimming, the swimmer's limbs and muscles will get full exercise in the process of traveling, which also makes the swimmer consume more energy than other sports in the process of swimming, so that the swimmer can get full exercise.⁵ Swimming is also roughly divided into the following three types: mass swimming, practical swimming and competitive swimming. Among them, there are different swimming postures for different swimming types. The commonly used swimming postures are freestyle, breaststroke, backstroke and butterfly. The teaching of swimming is also very helpful to the health of college students. Different postures have different postures and essentials.⁶ In daily teaching, different exercises should be carried out according to different technical essentials and postures of relevant swimming postures.⁷ Through the way of marker reflective ball image extraction, taking 40 athletes in the experimental group and the control group as an example, this paper analyzes the mechanical characteristics and dynamic time characteristics of sports, and discusses the influence of swimming posture optimization training on swimming posture, so as to provide a more effective reference basis for the development of swimming teaching in Colleges and universities.

METHOD

According to the principle of voluntariness, this paper selects 40 athletes as the research object among the students majoring in swimming in a university. By drawing lots and grouping, 40 subjects were divided into experimental group and sports group, with 20 athletes in each group, and there was little difference in height, weight, training years and sports performance. The study and all the participants were reviewed and approved by Ethics Committee of Dalian University (NO.2020DLUNS24).

This paper adopts the way of control experiment. The athletes in the control group keep their daily exercise unchanged. The athletes in the experimental group increase the swimming posture optimization teaching on the basis of daily training. The exercise frequency is one hour each time, three times a week, and the exercise lasts for six weeks. Swimming posture optimization teaching, in short, is to improve the

core stability of athletes, so that athletes can better grasp their own coordination and stability in the process of swimming, so as to facilitate the control and optimization of swimming posture. The training contents include bending elbow support, leg lifting, kneeling support, cross extension of upper and lower limbs, supine hip straightening, lateral diagonal support, rotary diagonal support and so on.

Before the experiment, the experimental group and the control group obtained the mechanical characteristics and time-consuming characteristics of the movement by extracting the marker reflective ball image, collected the relevant data again after the experiment, compared the four groups of data obtained before and after the experiment, and conducted the independent variance T-test.

RESULTS

Analysis of mechanical characteristics of swimming posture before and after the experiment

Swimming movement is realized by muscle contraction and relaxation driving bone joints and various tissues. The magnitude of force is related to the amplitude of muscle contraction and relaxation. Therefore, in the analysis of mechanical characteristics of swimming posture, trunk extension amplitude is selected as its judgment index, and the effectiveness of swimming posture optimization training is analyzed through intra group comparison and inter group comparison. The results are shown in Table 1 ~ Table 3.

Table 1 shows the analysis of motion mechanics characteristics of the experimental group before and after the experiment. Among them, the growth rate of trunk right rotation was 18.448%, with the highest growth rate; The second is the right flexion of the trunk, with a growth rate of 15.711%, the third is the left rotation of the trunk, with a growth rate of 14.375%, the fourth is the left flexion of the trunk, with a growth rate of 13.907%, the fifth is the abdominal forward flexion, with a growth rate of 13.182%, and the lowest growth rate is the back extension, with a growth rate of only 6.270%.

Table 2 shows the analysis of sports mechanical characteristics of the control group before and after the experiment. Among them, the growth rate of trunk right rotation was 5.301%, with the highest growth rate; The second is the abdominal flexion amplitude, with a growth rate of 3.559%, the third is the trunk left rotation amplitude, with a growth rate of 3.154%, the fourth is the back extension amplitude, with a growth

Table 1. Analysis of movement mechanics characteristics of experimental group before and after experiment (nm).

Project	Before	After	Growth rate	T	P
Back stretch	356.794±96.120	402.383±86.746	6.270%	-2.0552	>0.05
Trunk left	165.849±44.751	196.397±43.211	14.375%	-11.1662	<0.01
Trunk right rotation	182.085±43.698	221.033±54.073	18.448%	-4.5511	<0.05
Abdomen	189.057±87.612	220.962±80.078	13.182%	-2.3728	>0.05
Flexion on the left side of the torso	188.073±41.592	223.405±43.274	13.907%	-4.8244	<0.01
Flexide on the right side of the torso	214.045±50.521	258.985±57.652	15.711%	-4.3747	<0.01

Table 2. Analysis of movement mechanical characteristics of the control group before and after the experiment (nm).

Project	Before	After	Growth rate	T	P
Back stretch	346.312±24.525	380.695±27.664	2.910%	-1.7420	<0.05
Trunk left	163.981±28.507	174.814±19.476	3.154%	-1.3588	<0.05
Trunk right rotation	153.159±17.479	167.397±20.536	5.301%	-2.3740	>0.05
Abdomen	228.158±79.007	248.507±68.649	3.559%	-1.3644	<0.05
Flexion on the left side of the torso	183.622±27.984	192.036±23.520	0.597%	-0.4566	>0.05
Flexide on the right side of the torso	228.314±39.290	247.921±41.839	1.601%	-1.0668	<0.05

rate of 2.910%, the fifth is the trunk right flexion amplitude, with a growth rate of 1.601%, and the lowest growth rate is the trunk left flexion amplitude, only 0.597%.

Through the relevant comparison, it can be seen that the range changes of athletes in the experimental group and the control group have been improved before and after sports training, which shows that whether it is daily swimming training or swimming posture optimization training, it can effectively improve the mechanical characteristics of athletes in the process of sports and obtain better sports effect. The growth rate of the experimental group is much higher than that of the control group, and has an absolute advantage, which shows that the optimal training of swimming posture can more targeted improve the body extension range of athletes in the process of sports, so as to enable athletes to obtain greater strength support in swimming and improve their competitive performance.

Analysis of time characteristics of swimming posture before and after the experiment

Swimming is a sport judged by speed and skill. Therefore, the shorter the time of each decomposition action in the process of swimming, the shorter the time of completing an action link as a whole. The more action links completed within the same time, the faster the speed and the better the performance. Therefore, this section analyzes its movement time characteristics, and the results are shown in Table 4 and 5.

Table 4 shows the characteristic analysis of exercise time before and after the experiment in the experimental group. Among them, the kick time of backstroke decreased by 6.616%, ranking first; Freestyle rowing time decreased by 6.396%, ranking second; The third is the butterfly kick, with the time reduced by 6.105%, the fourth is the freestyle kick, with the time reduced by 6.051%, the fifth is the breaststroke kick, with the time reduced by 5.957%, and the lowest is the breaststroke rower, with the time reduced by 3.053%. Table 5 shows the Characteristic analysis of exercise time in the control group before and after the experiment.

Through the above experimental comparison, it can be seen that the action time of the experimental group and the control group has been reduced to a certain extent, indicating that posture optimization training and ordinary daily training can well shorten the action time, so as to improve the competitive level of athletes. Through the comparison of growth rate, it can be seen that in terms of time shortening, the experimental group has a slight advantage over the control group, but on the whole, the advantage is small, and there is no significant gap between the two. Therefore, it can be seen that the swimming posture optimization training has some advantages over the ordinary daily training, but there is still much room for improvement in shortening the exercise time.

DISCUSSION

In swimming, different strokes have different technical essentials and posture. For different posture, we need detailed analysis. Compared with

Table 3. Analysis of sports mechanical characteristics of two groups of athletes after the experiment (nm).

Project	Test group	Control group	T	P
Back stretch	402.383±86.746	380.695±27.664	0.6068	>0.05
Trunk left	196.397±43.211	174.814±19.476	1.1521	<0.05
Trunk right rotation	221.033±54.073	167.397±20.536	2.5814	>0.05
Abdomen	220.962±80.078	248.507±68.649	-0.6426	>0.05
Flexion on the left side of the torso	223.405±43.274	192.036±23.520	1.6181	<0.05
Flexide on the right side of the torso	258.985±57.652	247.921±41.839	0.3915	>0.05

Table 4. Characteristic analysis of exercise time before and after the experiment in the experimental group (s).

Project	Project	Before	After	Growth rate	T	P
Breaststroke	Scheme	73.845±10.129	66.843±10.470	-3.053%	5.6940	<0.01
	Leg	53.474±4.527	48.128±3.911	-5.957%	5.6255	<0.01
Free swimming	Scheme	45.065±4.857	40.690±3.807	-6.396%	4.4230	<0.05
	Leg	57.381±6.456	51.163±5.526	-6.051%	5.7143	<0.01
Butterfly	Leg	57.958±12.358	52.278±10.231	-6.105%	3.8070	<0.05
Backstroke	Leg	73.991±9.387	64.504±8.285	-6.616%	7.6200	<0.01

Table 5. Characteristic analysis of exercise time in the control group before and after the experiment (s).

Project	Project	Before	After	Growth rate	T	P
Breaststroke	Scheme	72.547±7.519	66.452±6.793	-1.987%	1.8631	<0.05
	Leg	58.070±6.204	51.510±4.766	-6.282%	3.1143	>0.05
Free swimming	Scheme	50.284±4.919	46.328±3.631	-3.763%	4.9745	<0.05
	Leg	61.155±8.795	54.255±6.127	-6.505%	2.5684	>0.05
Butterfly	Leg	61.002±4.884	57.064±3.880	-2.750%	2.4075	>0.05
Backstroke	Leg	80.659±12.329	70.425±4.983	-6.489%	1.8003	<0.05

other strokes, breaststroke is easier to learn, so it is suitable for beginners. In the process of moving, the body is parallel to the underwater, and the arms stretch out from the center of the chest and stroke to the side and bottom of the body. At the same time, the legs are shaped like frogs, bent and kicked out. When using breaststroke, you should pay attention to the coordination of waist strength and limbs. The posture of freestyle is reasonable to use the strength of limbs, and the resistance is small in the process of moving in the water, so it is a faster swimming style, and it is also the most labor-saving posture. When using freestyle, the body is parallel to the bottom of the water, the head and shoulders are slightly higher than the water surface, the palms are close together in the process of moving, and the shoulders drive the arms, wrists and elbows to cooperate and bend with each other. Through the rotation of the arm, lift the elbow joint to the high point, and the palm falls obliquely down to stroke. At the same time, the hips drive the legs, which is the water from the feet up and down. When using freestyle, we should pay attention to the rhythm of breathing and the reasonable cooperation between the upper and lower limbs. The butterfly stroke posture is changed by using the action essentials of breaststroke. After entering the water, when the arms are separated, the palm turns to the side. Then push the water to the lower side of the body, raise the hands of the rower, so that the arms have a better stroke posture. After the stroke of the arms, the hands extend out of the water on both sides of the body with the help of the inertia of the last force, and the arms move forward in the sinking curve in the air until the palms enter the water. When the upper limbs are rowing, the legs are close together and the waist is controlled. When the knees are bent, our lower legs and feet press hard against the water. Backstroke is the only swimming posture from the back to the

bottom. In the process of moving, swimmers should make their body parallel to the water, control well, balance their body, straighten their arms and try to be close to both sides of their head. Swing your arm clockwise for a stroke while bending your knees slightly. Use the thigh muscles to drive the calf muscles to draw water.

CONCLUSION

Through the research of this paper, it can be seen that purposeful swimming posture optimization training can effectively improve the core stability and coordination of athletes, improve their exercise extension range, shorten the exercise time, make athletes complete relevant actions in a shorter time, and the degree of action standardization is higher, so as to improve athletes' movement speed and action standard and improve their competitive level. However, there is still a large room for improvement in the shortening of sports time. Therefore, coaches and

physical education teachers should purposefully adjust the optimization scheme of sports posture according to the actual needs of students and their sports state, so as to improve the swimming posture of athletes more scientifically and improve their competitive performance.

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