IMPACTS OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION ON FLEXIBILITY IN CHINESE BOXING ATHLETES

IMPACTOS DA FACILITAÇÃO NEUROMUSCULAR PROPRIOCEPTIVA NA FLEXIBILIDADE DOS ATLETAS DE BOXE CHINÊS

IMPACTOS DE LA FACILITACIÓN NEUROMUSCULAR PROPIOCEPTIVA EN LA FLEXIBILIDAD DE LOS ATLETAS DE BOXEO CHINO

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ABSTRACT

Introduction: Flexibility is one of the essential physical qualities of athletes and Chinese boxing. Proprioceptive neuromuscular facilitation stretching is an effective method to improve flexibility. This method is widely used in various sports. Objective: Analyze the practical effects of stretching by proprioceptive neuromuscular facilitation on Chinese boxing athletes. Methods: This work selected 12 male athletes as research subjects. The athletes were randomly divided into two groups. Flexibility in one group of athletes trained with PNF stretching. Another group of athletes underwent regular training. Mathematical statistics were used to process the flexibility data of the two groups. Results: There were significant differences in the maximum linear velocity in the ankle joint and in the maximum linear velocity in the knee joint between the athletes after training with the experimental stretching (P<0.05). Conclusion: This paper concludes that the application of stretching method with proprioceptive neuromuscular facilitation can improve the flexibility of athletes. The research results of this paper provide background for flexibility training in competition and teaching. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Athletes; Flexibility; Sports; Proprioceptive Neuromuscular Facilitation (PNF) Stretching.

RESUMO

Introdução: A flexibilidade é uma das qualidades físicas essenciais dos atletas e boxe chinês. O alongamento por facilitação neuromuscular proprioceptiva é um método eficaz para melhorar a flexibilidade. Este método é amplamente utilizado em vários esportes. Objetivo: Analisar os efeitos práticos do alongamento pela facilitação neuromuscular proprioceptiva sobre os atletas de boxe chinês. Métodos: Este trabalho seleciona 12 atletas masculinos como objetos de pesquisa. Os atletas foram divididos aleatoriamente em dois grupos. Flexibilidade em um grupo de atletas treinados com o alongamento PNF. Outro grupo de atletas foi submetido a treinamento regular. Foram utilizadas estatísticas matemáticas para processar os dados de flexibilidade dos dois grupos. Resultados: Houve diferenças significativas na velocidade linear máxima da articulação do tornozelo e na velocidade linear máxima na articulação do joelho entre os atletas após o treinamento com o alongamento experimental (P<0,05). Conclusão: Este artigo conclui que a aplicação do método de alongamento com facilitação neuromuscular proprioceptiva pode melhorar a flexibilidade dos atletas. Os resultados da pesquisa deste trabalho fornecem embasamento para o treinamento de flexibilidade em competições e ensino. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Atletas; Flexibilidade; Esportes; Alongamento por Facilitação Neuromuscular Proprioceptiva.*

RESUMEN

Introducción: La flexibilidad es una de las cualidades físicas esenciales de los atletas y del boxeo chino. Los estiramientos de facilitación neuromuscular propioceptiva son un método eficaz para mejorar la flexibilidad. Este método se utiliza ampliamente en varios deportes. Objetivo: Analizar los efectos prácticos de los estiramientos mediante facilitación neuromuscular propioceptiva en atletas de boxeo chino. Métodos: En este trabajo se seleccionaron 12 atletas masculinos como sujetos de investigación. Los atletas fueron divididos aleatoriamente en dos grupos. Flexibilidad en un grupo de atletas entrenados con estiramientos PNF. Otro grupo de atletas fue sometido a un entrenamiento regular. Se utilizaron estadísticas matemáticas para procesar los datos de flexibilidad de los dos grupos. Resultados: Hubo diferencias significativas en la velocidad lineal máxima de la articulación del tobillo y en la velocidad lineal máxima en la articulación de la rodilla entre los atletas después del entrenamiento con el estiramiento experimental (P<0,05). Conclusión: Este trabajo concluye que la aplicación del método de estiramiento con facilitación neuromuscular propioceptiva puede mejorar la flexibilidad de los atletas. Los resultados de la investigación de este trabajo proporcionan una base para el entrenamiento de la flexibilidad en las competiciones y la enseñanza. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

***Descriptores*:** *Atletas; Flexibilidad; Deportes; Ejercicio de Estiramiento PNF.*

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INTRODUCTION

The PNF method was initially used as a kind of rehabilitation in rehabilitation medicine. Technology. The idea is to help the human body develop its most significant potential function to the highest level. But so far, very few PNF pulling methods have been applied to Sanda projects. In the Sanda technique, whip legs can be divided into front and rear legs. There are significant differences in many aspects, such as movement structure, movement range, actual combat use, and actual combat effects.[1] The author analyzes the data of the maximum linear velocity of the ankle joint and the knee joint, the maximum and minimum angle of the knee joint, and the maximum and minimum angle of the hip joint. This paper attempts to apply the PNF method and quantitatively analyze the front and rear whip legs from the perspective of exercise biomechanics. Find out the characteristics of each action. This paper provides a theoretical basis for the scientific training of the PNF method training technology.

METHOD

Research objects

The experiment subjects were 12 male Sanda athletes above the first level of the sports college team. Weight 57 ~ 64kg. The details are listed in Table 1.

Experimental equipment

1. 1 LED light-emitting diode. 2. 1 accelerometer. 3. Motion Analysis System is the equipment software for recording and analyzing video data provided by the American Motion Analysis Company. It is the most advanced motion information measurement system in the world. It consists of computer software and hardware. The instrument can collect and process data quickly and accurately. The Motion Analysis system includes four high-speed infrared cameras, one force measuring platform, five infrared tracking monitors, one normal-speed Sony camera, one video camera, and a computer. A synchronizer connects the camera and the force platform. The shooting frequency efficiency of the camera is 120 frames/s.

Experimental method

PNF stretch training

PNF stretches are best performed with the cooperation of a partner or coach. There are three main classical methods: static-relaxation, static-relaxation/active muscle contraction, and contraction-relaxation.[2] In this experiment, Sanda athletes used the static-relaxation method to develop the hamstrings. The specific operation method is as follows: First, statically stretch the muscle for about 10 seconds. Next, contract the muscle isometrically for 6 seconds. Finally, stretch the muscle again for 30 seconds. Sanda athletes use static-relaxation techniques. First, the athlete performs a passive stretch for 10 seconds. This makes the athlete feel moderately uncomfortable. The peer coach applies external force to flex the athlete's hip. At this point, the athlete must resist the force with force and keep the position of the leg from moving. The athlete performs an isometric (static) contraction for 6 seconds. The athlete then relaxes the leg for passive stretch and holds for 30 seconds.

Test indicators

Each athlete does three front whip legs and three rear whip legs. The kick height is the athlete's eye level. The light-emitting diode (LED) is fixed directly above the foot target. The height is about 2.2m. When the diode emits a signal (light), the subject quickly performs a kicking action of the whip leg. The accelerometer is placed in the foot target to record the kick time. The kick time starts from the signal from the diode to the signal from the accelerometer. The digital processing and analysis of the video and video data are carried out on the Motion Analysis System. The Motion Analysis System raw data digitally processes the following data: the maximum linear velocity of the ankle joint and the knee joint, the maximum and minimum angles of the knee joint, and the maximum and minimum of the hip joint.[3] The knee joint's angular range (ROM) can be calculated using the maximum and minimum knee angles. We compared the difference between the front and back whip legs. The Pearson test was used to determine the relationship between the ROM of the knee joint and the maximum angular velocity of the knee joint. Motion Analysis System and EVAHIRES automatically collected the kinematic parameters. Statistical data were processed by SPSS software.

Table 1. Athlete Profile.

Average height/cm	Average weight/kg	Average age	Average training years	Average training time/(h)
170.4±6.42	60.68±8.42	22.1±2.2	6.6±1.1	21.5±4.5

The positioning of the action arc trajectory of Sanda athletes

In this paper, the method of multi-layer wavelet decomposition is used to analyze the internal structure information of Sanda athletes' action images.[4] In this paper, the uniform quantization coefficient of the action distribution pixel $Uw_{i,j}$, $Sw_{i,j}$, $Vw_{i,j}$, of Sanda athletes is obtained through the decomposition of multi--dimensional pixel information:

$$c = L(a, b_m) \geq S_l S_n G_b \tag{1}$$

$S_l S_n G_b$ respectively represents the position, scale, main direction, and other information of the action arc trajectory of Sanda athletes.[5] We perform linear fitting on the action arc trajectory sequence of Sanda athletes to obtain the motion capture, output model:

$$\upsilon_i = \sum_{i=1}^{n} R_i + TU(y) + c \tag{2}$$

$\sum_{i=1}^{n} R_i$ is the search threshold for the arc trajectory of Sanda athletes. $TU(\dot{y})$ is the uniform block coefficient. In this paper, the three-dimensional viewpoint switching method is used to correct the action arc trajectory of Sanda athletes adaptively:

$$\dot{x} = \upsilon_i + \psi_V \dot{y}(n + v) \tag{3}$$

$$\dot{z} = k^{i+u} + \sum_{y}^{o} Ki \tag{4}$$

x, y, z is the edge information point positioned by the action arc trajectory of Sanda athletes. ψ_V is the offset feature quantity for the positioning of the action arc trajectory of Sanda athletes. $n + v$ represents the transmission law of the movement trajectory information of Sanda athletes. k^{i+v} represents the sampling of action information of Sanda athletes. Based on the multi-scale wavelet fusion results, the arc trajectory localization and adaptive offset compensation of Sanda athletes' action images are realized.[6] At this point we get the radian trajectory positioning output marker:

$$\sqrt{t^i + 8ui} \leq w^1 + w^2 + (m^i - m^2) = 0 \tag{5}$$

$t^i + 8ui$ represents the linear fitting coefficient of the radian trajectory positioning of Sanda athletes. w^1 represents the square fitting coefficient of the arc trajectory positioning of Sanda athletes. w^2 represents the information template matching degree. m^i represents the noise component in the action image of Sanda athletes. m^2 means to realize the arc trajectory positioning of Sanda athletes' movements.

There is no need for a code of ethics for this type of study.

RESULTS

Table 2 shows the data processing results of the front whip leg and the rear whip leg of Sanda athletes after PIN traction training.[7] From Table 2, it can be seen that the movement time of the front and rear whip legs, the maximum linear velocity of the ankle joint, and the maximum speed of the knee joint There was a significant difference in linear velocity (P<0.005). There were no significant differences in the minimum hip angle, the angular velocity of knee extension, and the range of knee angle change (ROM) between the two kicking methods.

The maximum linear velocities of the ankle and knee joints of the rear whip leg were 39.46% and 61.78% higher than those of the front whip leg, respectively. The ankle and knee joints of the rear whip leg of all subjects were the same.[8] Obtain a much greater linear velocity than the corresponding joint of the front leg. The maximum linear velocity of the ankle and knee joints for both kicks are maximized before the blow. The angular variation range (ROM) of the anterior and posterior whip leg knee joints and the correlation number of their angular velocity were 0.995 (P<0.001) and 0.792 (P<0.001), respectively.

Before the experiment, there was no difference in the average scores of the three flexibility qualities of the two groups of students. There was no significant difference by T-test (P>0.05). After the experiment, the average performance of the three flexibility quality indexes in the PNF group was better than that in the static stretching group. The data were significantly different by T-test (P<0.01). It shows a very significant difference between the PNF group and the static stretching group in the three flexibility quality indexes after the experiment. There was no significant difference between the two groups before the experiment. After the experiment, the scores of the two groups were significantly different.[9] The mean scores of the PNF group were significantly greater than those of the static stretch group. It has been proved that the PNF stretching method can more effectively develop flexibility quality. It showed its more significant superiority and found that the PNF pulling method was more acceptable in the experiment.

Table 2. Comparison of data related to front and back whip legs.

	Front whip leg	Back whip leg	Degrees of freedom	T
t/s	0.74±0.10	0.94±0.90	7	-4.449
v1/(m·s-1)	19.94±5.91	26.26±9.96	7	-4.559
v2/(m·s-1)	9.0±4.49	14.56±6.04	7	-4.777
α1/rad	1.70±0.45	1.69±0.46	7	0.177
α2/rad	2.99±0.24	2.97±0.14	7	0.549
β/rad	1.76±0.40	1.71±0.40	7	0.967
ω/(rad·s-1)	15.9±45.49	15.2±5.90	7	0.494
γ/rad	1.19±0.40	1.12±0.46	7	0.529

DISCUSSION

PNF stretching method uses the stretch reflex in the human body to make the body actively relax the muscles under the control of proprioception. This increases the athlete's flexibility, reduces pain and fatigue during stretches, increases muscle strength, and improves coordination and control. The ultimate goal is to improve the athlete's body stability and endurance.[10] At present, the PNF pulling method in sports mainly involves the function and method of enhancing the body's flexibility and the factors affecting the effect of the PNF pulling method. Compared with the traditional stretching method, the PNF stretching method is more efficient in improving the flexibility quality.

This research found that the maximum linear speed of Sanda athletes after the PNF traction method is obtained at the moment of hitting the target. In practice, it is difficult for athletes to achieve the maximum linear speed when hitting the target. The knee joint produces a self-protective conditioned reflex before it is fully extended. This ensures that the knee ligaments are not injured. Sanda is a two-player game.[11] Athletes use kick, throw, grid, block, hold, and other technical methods to carry out unarmed sports combat items. Sanda players need to take flexible and changeable actions during the competition to win the competition. Flexible movements often require the participation of more muscle groups and joints to achieve. Sanda athletes increase the flexion angle of the knee joint before the knee joint is extended to generate a more incredible rotational angular velocity. It can be known from the mechanical formula: Human Momentum Moment = Human Moment of Inertia × Human Body Link Angular Velocity. When the momentum distance of the human body is constant, the rotational inertia is negligible., the greater the link angular velocity of the athlete's limb. At this time, the blowing effect caused by Sanda players will be more significant. There are many different forms of the PNF stretching method in operation. Each has its characteristics and is aimed at different groups of people. In practice, using the PNF method to improve the flexibility of Sanda athletes should follow three processes: The athlete actively relaxes and pulls the target muscles. The athlete makes the target muscle perform maximal isometric contraction for more than six seconds. Pull the target muscle again while stimulating the antagonist muscle to contract. This stretch will give the target muscle a more excellent range of motion. It should also be noted that athletes should pay attention to warm-up preparations before stretching with the PNF method. When the assistant stretches the athlete, first slowly stretch the target muscle to the maximum range of motion. The athlete then continues to stretch for another six seconds. During the PNF method, the body's sensitivity to pain will be reduced, and the athlete's muscles in the stretching range will be enlarged. Athletes should not use the PNF stretch for muscle injuries.

CONCLUSION

Both PNF stretching and static stretching can improve the flexibility of Sanda athletes, but PNF stretching can develop the flexibility of Sanda athletes better than static stretching in training. Its effect is more pronounced. PNF stretching method can mobilize the enthusiasm of Sanda athletes more than the static stretching method in training.

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