

IMPACTS OF THE PNF TECHNIQUE ON FLEXIBILITY AND STRENGTH IN MARTIAL ARTS ATHLETES



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IMPACTOS DA TÉCNICA PNF SOBRE FLEXIBILIDADE E FORÇA EM ATLETAS DE ARTES MARCIAIS

IMPACTO DE LA TÉCNICA PNF SOBRE LA FLEXIBILIDAD Y LA FUERZA EN ATLETAS DE ARTES MARCIALES

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ABSTRACT

Introduction: Joint flexibility and muscle strength play a vital role in the training process of martial arts athletes. The proprioceptive neuromuscular facilitation (PNF) technique encourages the neural receptors, through the application of manual resistances, in the gain of functional range of motion and stability to its patients. It is believed that this technique can be adapted to the sports environment. **Objective:** Evaluate the impact of stretching using the PNF technique on martial arts athletes' flexibility and muscle strength. **Methods:** Through a controlled experiment, 100 martial arts athletes, without significant differences, were selected as experimental subjects, and randomly divided into two groups for a 4-week experiment. The experimental group added a protocol with PNF stretching exercises in the training, while the control group performed the usual training without interventions. Indicators of flexibility, functional activities, and strength were measured before and after the intervention, compared, and statistically analyzed. **Results:** Joint flexibility with the shoulder rotation test evolved from 21.88±5.71 to 19.22±5.94, and the left and right division was from 16.90±5.36 to 10.57±3.75; as for muscle strength, the flexor peak moment elevated from 210.36±51.18 to 251.37±45.72, and flexor power had a gain from 111.76±30.63 to 135.20±2.42. The extensor peak moment also showed expressive evolutions from 179.47±43.96 to 221.52±33.60. **Conclusion:** The PNF stretching exercise technique effectively optimizes martial arts athletes' joint flexibility and muscle strength. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

Keywords: Martial Arts; Proprioceptive Neuromuscular Facilitation (PNF) Stretching; Range of Motion, Articular; Muscle Strength.

RESUMO

Introdução: A flexibilidade articular e a força muscular desempenham um papel vital no processo de treinamento dos atletas de artes marciais. A técnica de facilitação neuromuscular proprioceptiva (PNF) incentiva os receptores neurais, através da aplicação de resistências manuais, no ganho da amplitude de movimento funcional e da estabilidade aos seus pacientes. Acredita-se que essa técnica possa ser adaptada ao meio esportivo. **Objetivo:** Avaliar os impactos do alongamento utilizando a técnica de PNF sobre a flexibilidade e a força muscular dos atletas de artes marciais. **Métodos:** Através de um experimento controlado, 100 atletas de artes marciais, sem diferenças significativas, foram selecionados como objetos experimentais, divididos aleatoriamente em dois grupos para um experimento de 4 semanas. Ao grupo experimental foi adicionado um protocolo com exercícios de alongamento PNF no treinamento, enquanto o grupo de controle efetuou o treinamento habitual sem intervenções. Indicadores de flexibilidade, atividades funcionais e força foram aferidos antes e depois da intervenção, comparados e analisados estatisticamente. **Resultados:** A flexibilidade articular com o teste de giro do ombro evoluiu de 21,88±5,71 para 19,22±5,94, sendo a divisão esquerda e direita de 16,90±5,36 para 10,57±3,75; quanto a força muscular, o momento de pico do flexor elevou-se de 210,36±51,18 para 251,37±45,72, e a potência do flexor teve um ganho de 111,76±30,63 para 135,20±2,42. O momento de pico do extensor também demonstrou evoluções expressivas de 179,47±43,96 para 221,52±33,60. **Conclusão:** O exercício de alongamento com a técnica PNF demonstrou ser efetivo em otimizar a flexibilidade articular e a força muscular dos atletas de artes marciais. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

Descritores: Artes Marciais; Alongamento por Facilitação Neuromuscular Proprioceptiva (FNP); Amplitude de Movimento Articular; Força Muscular.

RESUMEN

Introducción: La flexibilidad articular y la fuerza muscular desempeñan un papel vital en el proceso de entrenamiento de los atletas de artes marciales. La técnica de facilitación neuromuscular propioceptiva (FNP) estimula los receptores neurales, a través de la aplicación de resistencias manuales, en la ganancia de rango funcional de movimiento y estabilidad a sus pacientes. Se cree que esta técnica puede adaptarse al ámbito deportivo. **Objetivo:** Evaluar el impacto de los estiramientos con la técnica PNF en la flexibilidad y fuerza muscular de atletas de artes marciales. **Métodos:** A través de un experimento controlado, 100 atletas de artes marciales, sin diferencias significativas, fueron seleccionados como sujetos experimentales, divididos aleatoriamente en dos grupos para un experimento de 4 semanas. Al grupo experimental se le añadió un protocolo con ejercicios de estiramiento PNF en el entrenamiento, mientras que el grupo



de control realizó el entrenamiento habitual sin intervenciones. Se midieron indicadores de flexibilidad, actividades funcionales y fuerza antes y después de la intervención, se compararon y se analizaron estadísticamente. Resultados: La flexibilidad articular con la prueba de rotación del hombro evolucionó de $21,88 \pm 5,71$ a $19,22 \pm 5,94$, siendo la división izquierda y derecha de $16,90 \pm 5,36$ a $10,57 \pm 3,75$; en cuanto a la fuerza muscular, el momento pico flexor se elevó de $210,36 \pm 51,18$ a $251,37 \pm 45,72$, y la potencia flexora tuvo una ganancia de $111,76 \pm 30,63$ a $135,20 \pm 2,42$. El momento máximo del extensor también mostró evoluciones expresivas de $179,47 \pm 43,96$ a $221,52 \pm 33,60$. Conclusión: El ejercicio de estiramiento con técnica PNF demostró ser eficaz para optimizar la flexibilidad articular y la fuerza muscular de los atletas de artes marciales. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

Descriptores: Artes Marciales; Ejercicio de Estiramiento PNF; Rango del Movimiento Articular; Fuerza Muscular.

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INTRODUCTION

PNF technology is a kind of rehabilitation therapy technology researched by an American physiologist in the 1940s.¹ At the initial stage of its creation, PNF technology mainly used to stimulate related muscle and joint feelings for contact, traction and extrusion. PNF technology can also be called proprioceptive neuromuscular facilitation method.² After certain traction, traction, resistance and other technologies have improved the motor mode of muscles, the development therapy that uses spiral diagonal lines to promote muscle recovery is called PNF technology. This technology can not only treat multiple sclerosis, but also play a role in the rehabilitation, curative effect and sports performance of patients.³ As one of the most basic techniques in the rehabilitation therapy, the training and stretching are usually combined to increase the effectiveness. In the training process, the main training modes include contraction and relaxation, and keeping relaxation.⁴ In the process of muscle contraction, if there are some differences between the purpose of training and the principle used in the actual process, it is necessary to stretch the PNF stretching method in the process of use through training and with the cooperation of peers.⁵ In order to increase the characteristics and flexibility of the muscle, it is necessary to increase a certain resistance to the muscle's contraction ability. At the beginning of the last century, in the field of Chinese martial arts, mass sports originated from competitive martial arts, and no clear division was made.⁶ However, in recent years, with the improvement of martial arts technology, the competition rules of martial arts and the different mass martial arts movements have all presented unexpected heights.⁷ In this case, it is necessary to put forward higher requirements for some professional athletes in competitive martial arts training, otherwise it will affect the development of martial arts. In order to make athletes' muscle strength and flexibility reach a certain standard, we need to explore measures to optimize the flexibility of Wushu athletes.⁸

METHOD

Research object

In this paper, 100 martial arts athletes with no significant difference were selected as the experimental subjects. The study and all the participants were reviewed and approved by Ethics Committee of Beijing Sport University (NO.BJSU21P056). The average age of the experimental subjects was 20 years old, the average height was 1.7m, the average weight was 67kg, the average BMI was 22.5, and the average training period was 8 years. And for martial arts athletes in the body joint flexibility, muscle strength training. In order to further understand whether the flexibility of the body joints and muscle strength of martial arts athletes can be optimized after PNF stretching exercises are added to daily martial arts training. The specific conditions of the subjects in this experiment are shown in Table 1.

Table 1. Comparison of basic characteristics between two groups of wushu athletes.

Index	Experience group	Control group	t value	p value
Age	20.142 \pm 0.897	20.255 \pm 0.762	0.6147	0.5511
Height (m)	1.776 \pm 0.042	1.689 \pm 0.043	2.1312	0.0520
Weight (kg)	67.290 \pm 6.296	66.098 \pm 5.401	1.1262	0.2795
BMI index	22.606 \pm 1.755	22.460 \pm 1.311	0.0915	0.9357
Training years (years)	8.283 \pm 1.573	1.948 \pm 7.620	0.5827	0.5868

Experimental methods

Before the experiment, 100 subjects were measured. Table 1 shows that the t value of age is 0.6147, p value is 0.5511, t value of height is 2.1312, p value is 0.0520, t value of weight is 1.1262, p value is 0.2795, t value of BMI index is 0.0915, p value is 0.9357, t value of training years is 0.5827, p value is 0.5868. 100 martial arts athletes were randomly divided into two groups, the experimental group and the control group, to carry out daily martial arts training for 4 weeks. Among them, the experimental group added PNF stretching exercise when carrying out daily martial arts training, while the control group carried out daily martial arts training. Collect and sort out the experimental data obtained after training in time to facilitate the subsequent analysis of the experimental data results.

Experimental control

In order to ensure the accuracy of the experimental data, the 100 martial arts athletes should keep the same training content in the daily martial arts training experiment process, except that the experimental group joined the PNF stretching exercise, and ensure that there is no flow of personnel during the experiment process. After the training, timely record and sort out the experimental data to ensure the authenticity of the data.

RESULTS

Optimization of PNF stretching exercise on joint flexibility of Wushu athletes

After the 4-week experiment, the data in Table 2 were obtained after sorting out and analyzing. From Table 2, we can see the impact of PNF stretching exercise on the flexibility of various joints of martial arts athletes.

It can be seen from the experimental data in Table 2 that after the end of the experiment, the t value of the experimental group and the control group in the shoulder rotation test changed from -0.7467 before the experiment to -0.5479 after the experiment, and the p value changed from 0.4638 before the experiment to 0.5908 after the experiment; The t value of the left and right splits changed from -0.2986 before the experiment to -2.2384 after the experiment, and the p value changed from 0.7814 before the experiment to 0.0365 after the experiment; The t-value of the front and rear right split before the experiment was -0.8554, which changed to -2.7058 after the experiment, and the p-value changed from

0.4023 before the experiment to 0.0143 after the experiment; The t value of the front and rear left leg changed from -0.6746 before the experiment to -2.7173 after the experiment, and the p value changed from 0.5084 before the experiment to 0.0139 after the experiment; The t value of sitting forward flexion changed from 1.5070 before the experiment to 2.6024 after the experiment, and the p value changed from 0.1487 before the experiment to 0.0168 after the experiment; The t value of posterior bending bridge was changed from -0.5879 before the experiment to -2.1853 after the experiment, and the p value was changed from 0.5656 before the experiment to 0.0479 after the experiment. Therefore, it can be seen from the experimental results that, except for the shoulder turning test, the P values of left and right split, front and rear right split, front and rear left split, forward bending of sitting body, and backward bending bridge construction are all less than 0.05, indicating that the data of the experimental group and the control group have significant differences in left and right split, front and rear left split, forward bending of sitting body, and backward bending bridge construction. The control group also changed, but the change was not very significant. Therefore, it can be well explained that PNF stretching exercise plays a good role in left and right split, front and rear right split, front and rear left split, sitting forward, and back bending bridge building. PNF stretching exercise can improve the flexibility of martial arts athletes' joints, and the data of the experimental group is significantly better than the experimental data of the control group.

Optimization of PNF stretching exercise on muscle strength of Wushu athletes

After the 4-week experiment, the data in Table 3 were obtained after sorting out and analyzing. From the data in Table 3, we can see the influence of PNF stretching exercise on the muscle strength of martial arts athletes.

It can be seen from Table 3 that after the experiment, the t value of flexor peak moment in the experimental group and the control group changed from -8.7584 before the experiment to -6.8940 after the experiment, and the p value changed from 0.0086 before

the experiment to 0.0173 after the experiment; The t value of flexor power changed from -7.0286 before the experiment to -2.7464 after the experiment, and the p value changed from 0.0052 before the experiment to 0.0288 after the experiment; The t value of extensor peak moment changed from -7.6629 before the experiment to -7.7386 after the experiment, and the p value changed from 0.0314 before the experiment to 0.0377 after the experiment; The t value of extensor power changed from -7.1823 before the experiment to -2.9461 after the experiment, and the p value changed from 0.0208 before the experiment to 0.0241 after the experiment. It can be seen from the experimental results that the P value of the experimental group has obvious changes in the peak moment of flexor and the power of flexor. Although the P value changes little in the peak moment of extensor and the power of extensor, it can also be seen that there is an increase. Although there were changes in the control group, the changes were not particularly obvious. From the experimental results, we can see that PNF stretching exercise also has a good impact on the muscle strength of Wushu athletes.

DISCUSSION

In the Chinese martial arts competitive sports, if the strength performance of the athletes does not differ too much from the conventional standards, then it means that they can maintain a certain sense of beauty in the training process. Excessive emphasis on the increase of strength will make the athletes' muscles tense and stiff, so it is necessary to focus on the strength parts and movement skills of athletes during training. In order for the athletes to show enough ease in the training process, the coaches need to make detailed branch explanations of each action, especially the method of strengthening the strength of the athletes based on the principle of force sequence. The performance of some athletes is messy, which leads to the lack of continuity of the overall movement. Another part of athletes will choose to turn their arms first and then stretch their waist, which is characterized by scattered points of force. A small number of athletes will stretch their elbows at the same time, causing some of

Table 2. Influence of PNF Stretching on Joint Flexibility of Wushu Athletes.

Index	Time	Experience group	Control group	t value	p value
Shoulder rotation test (cm)	Before experiment	21.886 ±5.712	23.412 ±4.709	-0.7467	0.4638
	After experiment	19.227 ±5.945	20.691 ±4.023	-0.5479	0.5908
Left and right split (cm)	Before experiment	16.901 ±5.363	17.218 ±6.286	-0.2986	0.7814
	After experiment	10.578 ±3.751	14.813 ±4.719	-2.2384	0.0365
Front and rear right leg (cm)	Before experiment	8.742 ±2.370	9.388 ±1.752	-0.8554	0.4023
	After experiment	6.164 ±1.975	8.284 ±1.977	-2.7058	0.0143
Front and rear left split (cm)	Before experiment	10.067 ±2.327	10.668 ±2.309	-0.6746	0.5084
	After experiment	7.132 ±1.701	9.196 ±1.835	-2.7173	0.0139
Forward bending of sitting body (cm)	Before experiment	17.645 ±3.775	15.209 ±2.696	1.5070	0.1487
	After experiment	23.704 ±3.650	20.762 ±3.267	2.6024	0.0168
Posterior bending bridge (cm)	Before experiment	29.895 ±6.588	31.428 ±8.466	-0.5879	0.5656
	After experiment	22.902 ±4.973	27.881 ±6.641	-2.1853	0.0479

Table 3. The Influence of PNF Stretching on Muscle Strength of Wushu Athletes (60°).

Index	Time	Experience group	Control group	t value	p value
Flexor peak moment (N · m)	Before experiment	210.361 ±51.183	237.112 ±50.609	-8.7584	0.0086
	After experiment	251.379 ±45.729	255.961 ±48.501	-6.8940	0.0173
Flexor power (W)	Before experiment	111.762 ±30.636	117.987 ±26.528	-7.0286	0.0052
	After experiment	135.201 ±24.428	128.104 ±22.221	-2.7464	0.0288
Extensor peak moment (N · m)	Before experiment	179.471 ±43.961	213.646 ±39.464	-7.6629	0.0314
	After experiment	221.528 ±33.601	221.497 ±36.452	-7.7386	0.0377
Extensor power (W)	Before experiment	107.694 ±23.121	119.577 ±24.218	-7.1823	0.0208
	After experiment	125.469 ±14.492	127.981 ±22.657	-2.9461	0.0241

their movements to be stiff. In view of the above situation, coaches need to lead athletes to warm up before the formal competition for each athlete, so as to better complete the competition. In order to avoid the athletes losing points due to the movement of their feet, coaches should consider the connection of all training actions. If the instantaneous action affects the muscle power point, it is necessary to coordinate the muscles of all parts of the trainer. Analyze the difficulties encountered in each kind of routine training, in order to solve the shortcomings of each athlete's action, so that athletes can complete a fixed amount of action according to the requirements of the rules and indicators, so as to ensure that martial arts athletes can perform the specified action perfectly.

This article explains PNF stretching method, which can fully highlight the importance of this stretching method for martial arts athletes and enhance their muscle strength and flexibility. When the muscles stretch to the maximum extent, the muscle tension will increase with the increase of muscle time. At this time, the athletes' muscles are still stretching to the maximum extent. In the process of nerve transmission, repeated stimulation of central nervous system by nerve factors will make nerve transmission very easy. In order to enhance the muscle strength of athletes, the stretching method in this paper can stimulate the muscle tissue of athletes. When athletes train flexibility, their muscles can show a very obvious contraction phenomenon. The muscles of the human body can achieve maximum isometric contraction after continuous exercise lasting about 10 seconds. However, when the muscles do not reach their maximum extension, they need to relax the muscles to enhance their flexibility.

CONCLUSION

In the process of martial arts training, there is a certain danger for martial arts athletes. Therefore, martial arts athletes need to strengthen the flexibility of joints and muscle strength, so that they can better protect their bodies. PNF stretching exercise is a stretching method that can restore joint activity and relax muscles. PNF stretching exercise can be added to daily martial arts training to optimize the flexibility of body joints and muscle strength of martial arts athletes. It can be seen from the experimental results in this paper that by adding PNF stretching exercise in the process of martial arts training, it has played a significant role in the aspects of joint flexibility, such as left and right splits, front and rear right splits, front and rear left splits, sitting forward bends, and back bending bridges, which proves that PNF stretching exercise can improve joint flexibility very well. In the experimental test results of muscle strength, it can be seen that the muscle strength has been improved in terms of flexor peak moment and flexor power, which proves that PNF stretching exercise can also improve muscle strength. Therefore, in the process of martial arts training, PNF stretching exercises can be carried out before martial arts training to improve the flexibility of martial arts athletes and avoid injuries during training, or PNF stretching exercises can be carried out after staying in martial arts training to relax tense muscles and avoid muscle soreness after training. By using PNF stretching exercise, you can optimize the flexibility of joints, strengthen the strength of muscles, better protect martial arts athletes and avoid their injuries.

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