EFFECTS OF CYCLIC RESISTANCE TRAINING ON LOWER LIMB STRENGTH AND BALANCE IN BASKETBALL ATHLETES

EFEITOS DO TREINAMENTO CÍCLICO DE RESISTÊNCIA SOBRE FORÇA E EQUILÍBRIO DOS MEMBROS INFERIORES EM ATLETAS DE BASQUETEBOL

EFECTOS DEL ENTRENAMIENTO DE RESISTENCIA CÍCLICA SOBRE LA FUERZA Y EL EQUILIBRIO DE LAS EXTREMIDADES INFERIORES EN ATLETAS DE BALONCESTO

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ABSTRACT

Introduction: Cyclic resistance training allows that at the end of each movement cycle, all parts of the athlete's body return to the initial position, allowing the constant repeatability of the exercise. It is believed that this activity can significantly influence the physical capacity of the lower limbs of basketball athletes. Objective: Study the effects of cyclic resistance training on basketball players' lower limb strength and balance ability. Methods: 36 basketball players were selected and randomly divided into experimental and control groups. The experimental group received training for eight weeks combining routine training with cyclic resistance training, while the control group remained with routine training only. Relevant performance, strength, and balance data were analyzed before and after the procedure, undergoing statistical analysis and confrontation with current literature. Results: The peak flexor moment in the experimental group increased from 94.42 ± 28.20 Nm to 101.85 ± 23.30 Nm; the peak torque of the extensor muscle increased from 161.88 ± 39.16 Nm to 186.19 ± 40.29 Nm. In the balance ability test, the left lateral test increased from 68.78 ± 4.65 cm to 74.35 ± 3.29 cm, the left increased from 109.33 ± 7.22 cm to 114.65 ± 7.54 cm. The increase in the control group was small. Conclusion: Cyclic resistance training demonstrated a beneficial effect on both lower limb strength and balance in basketball athletes, and was effective in improving the physical capacity of basketball players. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Training, Endurance; Basketball; Athletes; Postural Balance; Lower Extremity.

RESUMO

Introdução: O treinamento cíclico de resistência permite que ao fim de cada ciclo de movimento, todas as partes do corpo do atleta voltem para a posição de início, permitindo a repetibilidade constante do exercício. Acredita-se que essa atividade possa influenciar significativamente a capacidade física dos membros inferiores dos atletas de basquetebol. Objetivo: Estudar os efeitos do treinamento cíclico de resistência sobre a força dos membros inferiores e a capacidade de equilíbrio dos jogadores de basquetebol. Métodos: Foram selecionados 36 jogadores de basquetebol, divididos aleatoriamente em grupos experimental e controle. O grupo experimental recebeu um treinamento durante 8 semanas combinando o treino de rotina com o treinamento cíclico de resistência, enquanto o grupo controle permaneceu apenas com o treino de rotina. Os dados relevantes de desempenho, força e equilíbrio foram analisados antes e após o procedimento, passando por uma análise estatística e confronto com a literatura atual. Resultados: O momento de pico do flexor no grupo experimental aumentou de 94,42 ± 28,20 Nm para 101,85 ± 23,30 Nm; o torque de pico do músculo extensor aumentou de 161,88 ± 39,16 Nm para 186,19 ± 40,29 Nm. No teste de capacidade de equilíbrio, o teste lateral esquerdo aumentou de 68.78 ± 4.65 cm para 74.35 ± 3.29 cm, o esquerdo aumentou de 109,33 ± 7,22 cm para 114,65 ± 7,54 cm. O aumento no grupo de controle foi reduzido. Conclusão: O treinamento cíclico de resistência demonstrou um efeito benéfico tanto na força quanto no equilíbrio dos membros inferiores dos atletas de basquetebol, sendo eficaz para melhorar a capacidade física dos jogadores de basquete. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** Treino de Resistência Física; Basquetebol; Atletas; Equilíbrio Postural; Extremidade Inferior.

RESUMEN

Introducción: El entrenamiento de resistencia cíclica permite que al final de cada ciclo de movimiento, todas las partes del cuerpo del atleta vuelvan a la posición inicial, permitiendo la repetibilidad constante del ejercicio. Se cree que esta actividad puede influir significativamente en la capacidad física de los miembros inferiores de los atletas de baloncesto. Objetivo: Estudiar los efectos del entrenamiento de resistencia cíclica sobre la fuerza de los miembros inferiores y la capacidad de equilibrio de los jugadores de baloncesto. Métodos: Se seleccionaron 36 jugadores de baloncesto y se dividieron aleatoriamente en grupos experimental y de control. El grupo experimental recibió entrenamiento durante 8 semanas combinando entrenamiento rutinario con entrenamiento de resistencia cíclica, mientras que el grupo control permaneció sólo con entrenamiento rutinario. Se analizaron datos relevantes de rendimiento, fuerza y equilibrio antes y después del procedimiento, sometiéndolos a análisis estadísticos y confrontándolos con

la literatura actual. Resultados: El momento flexor máximo en el grupo experimental aumentó de 94,42 ± 28,20 Nm a 101,85 ± 23,30 Nm; el momento máximo del músculo extensor aumentó de 161,88 ± 39,16 Nm a 186,19 ± 40,29 Nm. En la prueba de capacidad de equilibrio, la prueba lateral izquierda aumentó de 68,78 ± 4,65 cm a 74,35 ± 3,29 cm, la prueba lateral izquierda aumentó de 109,33 ± 7,22 cm a 114,65 ± 7,54 cm. El aumento en el grupo de control fue reducido. Conclusión: El entrenamiento de resistencia cíclica demostró un efecto beneficioso tanto en la fuerza de las extremidades inferiores como en el equilibrio de los atletas de baloncesto, y fue eficaz para mejorar la capacidad física de los jugadores de baloncesto. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Entrenamiento de Resistencia; Baloncesto; Atletas; Equilibrio Postural; Extremidad Inferior.*

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INTRODUCTION

Basketball is based on a number of techniques, such as dribbling, passing, receiving and shooting. At the same time, it also trains people's strength and speed, develops flexible body, and achieves the purpose of strengthening physique.[1] In addition, basketball is a team sport, which can promote cooperation between players and also has the function of making friends. In the high-intensity competitive competition, athletes need not only excellent technical and tactical ability, but also excellent physical ability to play their due level.[2] At the same time, it is also necessary to maintain the stability of the body and movement in order to make better use of multiple basketball techniques and successfully complete the connection of a series of movements.[3] The ability of human body to maintain balance is the result of acquired development, and is an advanced evolutionary response controlled by the cerebral cortex. Modern research has proved that the physiological mechanism of maintaining human balance is very complex.[4] It is generally believed in kinematics-related studies that body balance depends on the coordination of various parts of the body and the control of the central system on the motion effectors, and the strength of the lower limbs also plays an important role.[5] The explosive quality of lower limbs, such as starting, acceleration and rebound, is very important for athletes. How to use fast and effective training methods to improve the explosive force of lower limbs is the purpose of this paper.[6] The research in this paper mainly compares the effects of circular training and traditional strength training to find more effective training methods for basketball players.

METHOD

Experimental object

First of all, before the experiment, a questionnaire survey about personal information and basketball related experience was conducted on the basketball special class players in the sophomore year of a sports college. The study and all the participants were reviewed and approved by Ethics Committee of Hunan University of Science and Engineering (NO.HNUSE20F05). According to the results of the questionnaire, 36 students who have not been injured recently and have enough time to participate in training were selected as the research object of this paper. Before the experiment, it was confirmed that the students' basic physical condition was healthy, and the selected subjects had a certain understanding of the purpose and training methods of the experiment. Before the experiment officially started, they signed a letter of knowledge and voluntarily agreed to participate in the experiment training, and tried to ensure that there was no absence, late and early leave during the experiment that would affect the overall training effect. Before training, 36 basketball players were randomly divided into experimental group and control group. The basic information of the height, weight and training years of the two groups are shown in Table 1.

From the data in Table 1, it can be seen that there is no significant difference between the experimental group and the control group in height, weight and training years ($p>0.05$), and the results of randomization meet the basic requirements of the control experiment.

Table 1. Basic information of experimental group and control group.

Project/Group	Control group (n=18)	Experimental group (n=18)	P
Height (cm)	183.232±3.6165	184.343±3.5304	0.6593
Body weight (cm)	82.366±6.9692	78.644±5.6126	0.6676
Years of training (yr)	3.229±1.4496	3.053±1.1735	1.0003

Experimental arrangement

The whole experiment lasted for 8 weeks, during which two groups of basketball players were trained according to the same training frequency, three times a week, Monday, Wednesday and Friday. Each training time is 60 minutes. The training process consists of three parts: warm-up for 10 minutes at the beginning of the training; The formal training time is 40 minutes; 10 minutes of relaxation after training. The difference between the control group and the experimental group During the formal training, the control group did not change according to the previous routine training, and the experimental group carried out the combination of routine training and circulating resistance training. Cyclic resistance training in the experimental group mainly includes squatting, lunge resistance, dumbbell and resistance band exercise with medium load. During the whole training process, the heart rate of the athletes in the experimental group should be maintained between 140 and 160. The two groups had no other heavy load exercise except experimental training, and kept their living habits healthy and consistent.

Test method

Before, during and after the experiment, it is necessary to measure and record the relevant indicators of the tested athletes.

The lower limb strength test of basketball players mainly includes four indicators: flexor peak torque, flexor relative peak torque, extensor peak torque, and extensor relative peak torque. The measuring instrument uses the Kinitech isokinetic muscle strength test system made in Australia.

The balance test of basketball players mainly adopts the YBT balance measurement method, which mainly includes four directions: front, back, left and right. This reflects the stability of the lower limbs and the balance of the left and right sides of the subjects. The measuring instrument mainly uses the Y-Balance balance test kit made in China. Before the test, the subjects need to take off their shoes and socks and stand barefoot on the measuring instrument. The test begins with the measurement of the index of the right hind leg. The subject stands on the test platform with one side of his foot, his hands on his waist, and the thumb of his standing foot is aligned with the red mark. Push the test board in different directions as far as possible with the other foot according to the instructions. The indicators in each direction are tested three times. In case of special circumstances, an additional test can be carried out.

The measuring equipment used in this paper mainly includes isokinetic muscle strength test system and Y-Balance balance test suite, as

well as the list and score book used for recording. The training equipment mainly includes yoga mat, dumbbell, elastic band, elastic ball and other equipment used by the experimental group for resistance training, as well as basketball training equipment such as large basketball, wrist guard and finger guard.

RESULTS

Effect of cyclic resistance training on lower limb strength of basketball players

In order to study the effect of cyclic resistance training on the lower limb strength of basketball players, the knee strength changes of the two groups of basketball players before and after the training were analyzed. The data results are shown in Table 2 and Table 3.

It can be seen from Table 2 that there is only a slight difference ($p<0.05$) between the two groups in the relative peak torque of the extensor muscles before the cyclic resistance training. The relative peak torque of the extensor muscles in the control group and the experimental group are 2.603 ± 0.3463Nm/kg and 2.398 ± 0.3271Nm/kg, respectively. There was no significant difference in the other three indexes as a whole ($p>0.05$). The peak torque of the flexor in the control group and the experimental group were 107.463 ± 34.2956 Nm and 94.425 ± 28.2035 Nm, the relative peak torque of the flexor was 1.649 ± 0.3371 Nm/kg and 1.371 ± 0.2547 Nm/kg, and the peak torque of the extensor was 176.526 ± 33.0060 Nm and 161.888 ± 39.1697 Nm, respectively. It basically meets the requirements for experimental comparison.

Then the two groups of knee joint strength indicators after training were compared and analyzed, and the results are shown in Table 3.

It can be seen from the data in Table 3 that the relative peak torque index of flexors in the control group and the experimental group began to show significant changes ($p<0.01$) compared with that before training, which were 1.791 ± 0.2776 Nm/kg and 1.548 ± 0.1630 Nm/kg, respectively. There was no significant difference in the index of relative peak torque of extensor muscle ($p>0.05$), which was 2.978 ± 0.3361 Nm/kg and 2.913 ± 0.3569 Nm/kg, respectively. Although the other two indicators were not significantly different between the two groups, they showed significant changes compared with those before training. After the cyclic resistance training, the values of the flexor peak torque, the relative peak torque of the muscle, the extensor peak torque and the relative peak torque of the extensor muscle of the athletes in the experimental group all increased to different degrees. The peak torque of flexor increased from 94.425 ± 28.2035 Nm before training to 101.851 ± 23.3024 Nm after training; The relative peak torque of flexor changed from 1.371 ± 0.2547 Nm/kg before test to 1.548 ± 0.1630 Nm/kg after training; The peak torque of extensor muscle increased from 161.888 ± 39.1697Nm before test to 186.196 ± 40.2926Nm after training; The relative peak torque of extensor muscle also increased by about 0.5 Nm/kg. In addition to a small decrease in the peak moment of flexor muscle in the control group, the other three indicators also increased in varying degrees.

Table 2. Basic situation of knee joint strength of two groups of basketball players before training.

Project/Group	Control group (n=18)	Experimental group (n=18)	P
Flexor peak torque (Nm)	107.463±34.2956	94.425±28.2035	0.8022
Relative peak moment of flexor (Nm/kg)	1.649±0.3371	1.371±0.2547	0.0789
Peak torque of extensor muscle (Nm)	176.526±33.0060	161.888±39.1697	0.5399
Relative peak torque of extensor muscle (Nm/kg)	2.603±0.3463	2.398±0.3271	0.0460

Table 3. The Effect of Cyclic Resistance Training on the Knee Strength of Basketball Players.

Project/Group	Control group (n=18)	Experimental group (n=18)	P
Flexor peak torque (Nm)	99.532±29.4020	101.851±23.3024	0.7870
Relative peak moment of flexor (Nm/kg)	1.791±0.2776	1.548±0.1630	0.0089
Peak torque of extensor muscle (Nm)	201.563±12.1393	186.196±40.2926	0.5225
Relative peak torque of extensor muscle (Nm/kg)	2.978±0.3361	2.913±0.3569	0.0501

Effect of cyclic resistance training on basketball players' balance ability

The statistical analysis of the changes in the balance ability of the two groups of basketball players before and after the training shows that the data results are shown in Table 4 and Table 5.

From the data in Table 4, it can be seen that before the cyclic resistance training, the test results of the four indexes of the balance ability of the two groups, namely, the left front, the left rear, the right front and the right rear, are not significantly different ($p>0.05$), which are within the normal range, and meet the basic requirements of the following experimental comparison in this paper.

The results of comparative analysis of the two groups of balance ability related indicators after training are shown in Table 5.

It can be seen from the data in Table 5 that after training, the four indexes of the control group and the experimental group began to show significant differences ($p<0.05$), and the balance ability of the left front side and the right front side showed very significant differences ($p<0.01$). The left front balance index of the control group and the experimental group after training was 69.464 ± 3.9230 cm and 74.359 ± 3.2937 cm, respectively, and the right front balance index after training was 69.541 ± 3.4219 cm and 72.567 ± 3.1765 cm, respectively. This is a big change from before training. At the same time, the difference between the left rear and the right rear also gradually expanded. The left rear balance ability index of the control group and the experimental group after training was 114.039 ± 7.7227cm and 114.658 ± 7.5479cm, respectively, and the right rear balance ability index after training was 107.489 ± 4.2171cm and 116.943 ± 4.3620cm, respectively. However, there was no significant difference in the four indicators of the two groups before training.

DISCUSSION

The balance ability and coordination ability of athletes are the comprehensive embodiment of various sports tasks. The balance and

Table 4. Basic situation of balance test of two groups of basketball players before training (YBT-LQ test).

Project/Group	Control group (n=18)	Experimental group (n=18)	P
Left front (cm)	66.748±5.2511	68.787±4.6546	0.0516
Left rear (cm)	111.682±6.9692	109.333±7.2220	0.2071
Right front (cm)	68.247±4.2996	66.817±3.8947	0.0764
Right rear (cm)	106.177±6.0506	112.016±5.6606	0.3606

Table 5. The Effect of Cyclic Resistance Training on the Balance Test of Basketball Players (YBT-LQ Test).

Project/Group	Control group (n=18)	Experimental group (n=18)	P
Left front (cm)	69.464±3.9230	74.359±3.2937	0.0000
Left rear (cm)	114.039±7.7227	114.658±7.5479	0.0207
Right front (cm)	69.541±3.4219	72.567±3.1765	0.0000
Right rear (cm)	107.489±4.2171	116.943±4.3620	0.0184

coordination ability will directly affect the athletes' sports ability, which has a vital impact on the athletes' comprehensive sports. And this has also become one of the important factors of special technical evaluation. For basketball players, balance training is very important, because it can ensure the stability of the players' body center of gravity in the sports competition, and can give full play to the best technical level of players. From the content of this study and the analysis of the experimental results, the cyclic resistance training has a very good effect on the promotion and improvement of the dynamic balance and coordination ability of young basketball players. Through the experimental training in this paper, the lower limb strength and balance ability of the experimental group has made a very significant progress compared with the previous one, and compared with the control group, the progress is more obvious, and the gap between the experimental group and the control group also has a significant expansion trend compared with the previous one. This shows that it is possible to improve the dynamic balance and coordination ability of basketball players by using cyclic resistance training as warm-up training, and the training results are very significant.

CONCLUSION

In order to improve the balance ability of basketball players and improve their basketball performance, different experts have made various attempts in the field of basketball training. Relevant research shows that in addition to special training, a certain proportion of resistance training can be added to further improve the strength of players' lower limbs. This paper studies the influence of cyclic resistance training on the lower limb strength and balance ability of basketball players, and compares and analyzes the differences between the two training methods in improving the balance ability of basketball players compared with the general routine training, providing a basis for the reasonable organization of balance training of basketball players. The experimental results showed that the lower limb strength and balance ability of the control group and the experimental group members were improved to a certain extent, but the improvement of the circulatory resistance training group was greater. Therefore, circulating resistance training is helpful to improve the strength and balance ability of basketball players' lower limbs, and can be reasonably applied in daily training as a supplement to general routine training.

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