CHANGES IN THE FLEXOR AND EXTENSOR MUSCLES AT DIFFERENT SPEEDS

MUDANÇAS NOS MÚSCULOS FLEXOR E EXTENSOR A DIFERENTES VELOCIDADES

CAMBIOS EN LOS MÚSCULOS FLEXOR Y EXTENSOR A DIFERENTES VELOCIDADES

Original Article
Artigo Original
Artículo Original

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ABSTRACT

Introduction: Centrifugal strength is an important element for strength quality. Developing muscle centrifugal strength can effectively increase the stability of lower limbs and reduce the risk of injury. Objective: To explore the characteristics of contractile force of flexor ahods in strength training and rehabilitation training, and the extensor muscles of the knee joint in athletes with different speeds of centripetal force. Methods: The knee joint muscle group of 8 first-level male high jumpers and 8 second-level male high jumpers were tested by isokinetic centrifugal contraction; the angular test velocity was 60 °/s, 120 °/s, 240 °/s, and the indexes included peak torque, relative peak torque (peak torque/body weight), and the peak torque flexural extension ratio. Results: With the centrifugal contraction of the knee joint muscle group ($P < 0.05$), the second-level high jumpers should increase the ability of the knee flexor muscle group of the take-off leg. In the case of constant velocity centrifugal contraction ($P < 0.01$), taking off time must be reduced, that is, taking off speed must be accelerated. Conclusions: The difference in the knee joint muscle isokinetic test results is one of the reasons for the difference in knee joint flexor and extensor muscle contractility under the different speed forces of high jumpers. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Muscle rigidity; Flexural strength; Muscle strength.

RESUMO

Introdução: A força centrífuga é um elemento importante na qualidade de força. O desenvolvimento da força centrífuga muscular pode, efetivamente, aumentar a estabilidade dos membros inferiores e reduzir o risco de lesões. Objetivo: Explorar as características da força contrátil do músculo flexor no treinamento de força e de reabilitação, e os músculos extensores da junta do joelho em atletas com diferentes velocidades de força centrípeta. Métodos: O grupo muscular da articulação do joelho de oito saltadores de primeiro escalão do sexo masculino, e oito saltadores de segundo escalão do sexo masculino foi testado por contração centrífuga isocinética. A velocidade de teste angular foi de 60 °/s, 120 °/s, 240 °/s, e os índices incluíram torque de pico, torque de pico relativo (torque de pico/peso corporal) e a razão extensão-flexão de torque de pico. Resultados: Na contração centrífuga do grupo muscular da articulação do joelho ($P < 0,05$), os saltadores de segundo escalão devem aumentar a habilidade do grupo muscular flexor do joelho da perna de arranque. No caso da contração centrífuga de velocidade constante ($P < 0,01$), o tempo de arranque deve ser reduzido, ou seja, a velocidade de arranque deve ser acelerada. Conclusões: A diferença nos resultados dos testes isocinéticos do músculo da junta do joelho é uma das razões para a diferença na contratilidade muscular flexor e extensor da junta do joelho sob forças de velocidade diferentes em saltadores. ***Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.***

Descritores: *Rigidez muscular; Resistência à flexão; Força muscular.*

RESUMEN

Introducción: La fuerza centrífuga es un elemento importante en la calidad de fuerza. El desarrollo de la fuerza centrífuga muscular puede efectivamente aumentar la estabilidad de los miembros inferiores y reducir el riesgo de lesiones. Objetivo: Explorar las características de la fuerza contráctil del músculo flexor en el entrenamiento de fuerza y de rehabilitación, y los músculos extensores de la articulación de la rodilla en atletas con diferentes velocidades de fuerza centrípeta. Métodos: Se testó el grupo muscular de la articulación de la rodilla de 8 saltadores de primer escalafón del sexo masculino, y 8 saltadores de segundo escalafón del sexo masculino por contracción centrífuga isocinética. La velocidad de prueba angular fue de 60 °/s, 120 °/s, 240 °/s, y los índices incluyeron torque de pico, torque de pico relativo (torque de pico/peso corporal) y la razón extensión-flexión de torque de pico. Resultados: En la contracción centrífuga del grupo muscular de la articulación de la rodilla ($P<0,05$), los saltadores de segundo escalafón deben aumentar la habilidad del grupo muscular flexor de la rodilla de la pierna de arrancada. En el caso de la contracción centrífuga de velocidad constante ($P<0,01$), el tiempo de arrancada debe reducirse, o sea, la velocidad de arrancada debe acelerar. Conclusiones: La diferencia en los resultados de las pruebas isocinéticas del músculo de la articulación de la rodilla es una de las razones para la diferencia en la contractilidad muscular flexor y extensor de la articulación de la rodilla bajo fuerzas de velocidad diferentes en saltadores. ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

Descriptores: Rigidez muscular; Resistencia flexional; Fuerza muscular.

DOI: http://dx.doi.org/10.1590/1517-8692202127072021_0375 Article received on 07/29/2021 accepted on 08/18/2021

INTRODUCTION

Strength is the ability of the human neuromuscular system to overcome or resist resistance when working. Strength quality is one of the important signs of the development level of physical training of athletes, and is also the basis of all physical qualities, and to a certain extent determines the development of other physical qualities.[1] Centrifuge strength, as an important part of strength quality, has significant significance in developing rapid strength, improving sports performance and sports injury rehabilitation. Centrifugal contraction is the main working form of muscles in the braking buffer stage. Improving the centrifugal force of lower limbs is of great significance for the prevention of injury, and developing the centrifugal force of muscles can effectively increase the stability of lower limbs and reduce the risk of injury.[2]

In recent years, with the in-depth research on the mechanism of centrifugal training and the working principle of muscles, centrifugal training has become one of the important methods of strength training and rehabilitation training due to its lower energy consumption, higher load and better training effect compared with centripetal training . At present, there are few studies on the influence of centripetal combined with centrifugal training on muscle fast force and the relationship between centripetal combined with centrifugal training of different loads and speed factors.[3,4]

The knee joint muscle groups of 8 first-level male high jumpers and 8 second-level male high jumpers were tested by isokinetic centrifugal contraction, the test angular velocity is 60 °/s, 120 °/s, 240 °/s, and the indexes include peak torque, relative peak torque (peak torque/body weight), and peak torque flexural extension ratio. To prove that the difference in the test results of knee joint isokinetic muscle group is one of the reasons for the difference in the contractile force of knee joint flexor and extensor muscle group under different speed force of high jumpers.[5,6]

METHOD

Subjects

There are 16 high jumpers from Beijing Sport University and Capital Institute of Physical Education, including 8 jumpers from the first level and 8 jumpers from the second level. The take-off leg is all left leg. The basic information is shown in Table 1.

Experimental method

Experimental place: Biomechanics Laboratory, Capital University of Physical Education. Test time: April 2008. The equipment is German ISOMED2000 constant velocity tester. The biomechanical characteristics of knee joint muscle group during isokinetic centrifugal contraction (restrained working) were tested in strict accordance with the provisions of ISOMED2000 isokinetic tester operation manual. Test experimental parameters: angular velocity 60°/s, 120°/s, 240°/s, joint starting Angle +10°~+90°, test indexes are peak torque, relative peak torque (peak torque/body weight), peak torque flexural extension ratio. The tests were conducted in two half-day batches over the course of a week. The test process is as follows: first do preparation activities (it is appropriate to have a fever and not feel tired, and the heart rate should be controlled at 120-130 times /min), then the posture was fixed and the laser head was calibrated and positioned. Finally, the test was conducted. The subjects repeated 6 tests with the maximum strength according to the design requirements, and tested 3 groups with 120s interval in each group.[7,8]

Table 1. Basic information of subjects (n=8).

Level	Age	Height	Weight	Performance	The training of year
Level 1	21	1.88	70.89	2.05	5.8
Level 2	20	1.8.0	66.25	1.86	3.8

RESULTS

Analysis and discussion on the test results of isokinetic centrifugal contraction peak moment, relative peak moment and flexion/extension ratio of knee flexor and extension muscle groups of the first and second level high jumpers.[9]

It can be seen from Table 2 that, when the knee joint muscle group is centrifugally contracting, the peak torque of knee extensor in the take-off leg and swing leg of the first-level high jumpers is significantly different from that of the second-level high jumpers ($P < 0.05$). Combined with the analysis of the characteristics of the project, it is concluded that the centrifugal contraction of extensor group has three functions: First, the centrifugal contractility of the knee extensor group is an important factor to maintain the height of the center of gravity. The anti-centrifugal contractility of the knee extensor group can prevent the center of gravity from dropping excessively and sitting down at the hip. Secondly, the transformation of the knee extensor group from centrifugal contraction to centripetal contraction is an important link to maintain the approach speed. The rapid centripetal contraction of the knee extensor group can effectively prevent the support weakness of the swinging leg and the rapid forward shift of the center of gravity. Third, the extensor group does concessional work, that is, passive elongation, which increases the initial contraction length of the extensor group and the working distance, which is of the same significance as the transcendental apparatus in throwing events.[10]

DISCUSSION

Test data and analysis of the total and relative total work of the flexor and extensor muscles of the knee joint of the first and second level high jumpers

As can be seen from the data in Table 3, during centrifugal contraction, the knee joint muscle groups of high jumpers at different given speeds are shown as follows: The total power of flexor and extensor of knee joint of swing leg was significantly different in first-level athletes

Table 2. Peak moment, relative peak moment and peak moment flexion and extension ratio of the first and second level high jumpers' taking off legs.

The angular velocity/((°)·s-1)	60	120	240
Primary flexor peak moment	134	140	140
Secondary flexor peak moment	127	132	135
Primary flexor relative peak moment	2.5	3	2.6
Relative peak moment of flexor II	1.9	2	1.99
Peak moment of primary extensor	214.6	227.9	211.8
Secondary extensor peak moment	208	216	220
The relative peak moment of the primary extensor	3.6	4	3.6
The relative peak moment of the secondary extensor	3.5	3.8	3.5
First order peak torque flexion	0.56	0.5	0.65
Second order peak torque flexion	0.7	0.46	0.6

Table 3. Total and relative total work of the flexor and extensor muscles of the take-off leg of the first and second level high jumpers by isokinetic centrifugal contraction.

The angular velocity/((°)·s-1)	60	120	240
Flexor total energy/J	114	110	114
Flexor total energy/J	105	111	113
Flexor relative total work (J·kg-1)	1.7	1.56	1.60
Flexor relative total work/ (J·kg-1)	1.6	1.70	1.69
Extensor total energy/J	194	194	1.92
Extensor total energy/J	185	187	189.4
Extensor relative to total work/ (J·kg-1)	2.8	2.73	2.81
Extensor relative to total work/ (J·kg-1)	2.79	2.83	2.85

than in second-level athletes (P < 0.05). It indicates that the centrifugal contraction ability of knee muscle group of first-level athletes is stronger than that of second-level athletes.[11] Analyzes believed that in the penultimate step knee flexor and extensor groups in landing buffering and stretching process, the eccentric contraction of kinetic energy gained by the ability to work to keep the run-up to jump, to ensure the subsequent takeoff effect, has very important significance, and higher rolled shrinking ability can meet the technical requirements of the high. There was no significant difference between the eponymous muscle of the first and second class athletes (P BBB 0 0.05).[12]

Test results and analysis of average power and relative average power of knee flexor and extensor muscle groups in high jumpers

As can be seen from Table 4, the average flexor and extensor power of the knee of the high jumper increases with the increase of the given movement speed (P < 0.01), and the average flexor and extensor power of the take-off leg is greater than that of the swing leg, and the average power of the extensor is greater than that of the flexor. The average power increases with the increase of the angular velocity of a given motion. For power, it depends on the ratio of work to time, as can be seen from the data in the table, the moment and total work of the ipsilateral muscle group at the same level have no significant difference at different angular velocities, while the exercise time decreases rapidly with the acceleration of the angular velocity of the knee joint, as shown by the increase of the average power, therefore, in order to improve the power of the take-off, it is necessary to reduce the take-off time, that is, to accelerate the take-off speed.

Table 4. Average power and relative average power of the flexor and extensor muscle group of the take-off leg of the first and second level high jumpers.

The angular velocity/((°)·s-1)	60	120	240
Flexor muscle power/J	64	133	208
Flexor muscle power/J	51	79	148
Flexor relative power (J·kg-1)	0.91	1.88	2.99
Flexor relative power/ (J·kg-1)	0.85	1.3	2.5
Extensor power/J	90	181	265
Extensor power/J	80.1	121	217.8
Extensor relative power/ (J·kg-1)	1.26	2.66	3.88
Extensor relative power/ (J·kg-1)	1.35	1.99	3.56

CONCLUSION

The knee joint muscle groups of 8 first-level male high jumpers and 8 second-level male high jumpers were tested by isokine centrifugal contraction, and the angular velocity of 60°/s, 120°/s and 240°/s were tested. The indexes included peak torque, relative peak torque (peak torque/body weight) and flexion/extension ratio of peak torque. The results show that the knee flexor and extensor peak moments of the first-level high jumpers are significantly different from those of the second-level high jumpers (P < 0.05), so the second-level high jumpers should increase the ability of flexor knee flexor contraction of the take-off leg. In the case of constant velocity centrifugal contraction, the average power increases with the increase of the given angular velocity (P < 0.01). Therefore, in order to improve the power of taking off, the time of taking off must be reduced, that is, the speed of taking off must be accelerated. The difference in the test results of knee joint isokinetic muscle group is one of the reasons for the difference in the contractile force of knee joint flexor and extensor muscle group of the first and second level high jumpers under different velocity force.

All authors declare no potential conflict of interest related to this articl

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. Rui Ma: writing and methodology; Wenyan Li: data analysis, article review and intellectual concept of the article.

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