EFFECTS OF VIBRATION STRENGTH TRAINING ON LOWER LIMB JOINTS IN LONG JUMPERS

EFEITOS DO TREINAMENTO DE FORÇA POR VIBRAÇÃO NAS ARTICULAÇÕES DOS MEMBROS INFERIORES DOS SALTADORES EM DISTÂNCIA

EFECTOS DEL ENTRENAMIENTO DE FUERZA POR VIBRACIÓN EN LAS ARTICULACIONES DE LOS MIEMBROS INFERIORES DE LOS SALTADORES DE LONGITUD

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ABSTRACT

Introduction: As a new training method, vibration strength training has been widely used in strength training and mass rehabilitation of foreign athletes. As an auxiliary method of strength training in China, vibration strength has also attracted the attention of professionals. Studies in this area are important to keep up with the latest international theories and techniques of vibration strength training. Objective: Study the effects of vibration strength training on the lower limb joints of long jump athletes. Methods: A search of recent medical literature was conducted to develop an experimental test method, and mathematical statistics were implemented to analyze this research study with volunteer long jumpers. Results: The relative increase in peak torque of the hip and knee joints was greater when compared to the ankle joint. Both showed considerable improvement after the experimental protocol. Conclusion: After comparing the vibration force of lower limb joints with the training effect of long jump athletes, some flexor strength training methods can be added, increasing the intensity and the amount of load appropriately so that the lower limb joint extensor and flexor strength level can be coordinated proportionally, aiming to improve the level of strength and motor coordination in athletes. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Resistance Training; Athletes; Vibration.

RESUMO

Introdução: Como um novo método de treinamento, o método de treinamento de força por vibração tem sido amplamente utilizado no treinamento de força e na reabilitação em massa de atletas estrangeiros. Como método auxiliar de treinamento de força na China, a força vibratória também tem atraído a atenção dos profissionais. Estudos nessa área são importantes para acompanhar as mais recentes teorias e técnicas internacionais de treinamento de força por vibração. Objetivo: Estudar os efeitos do treinamento de força por vibração nas articulações de membros inferiores de atletas de salto em distância. Métodos: Fez-se uma pesquisa na literatura médica recente para desenvolver um método de teste experimental e implementou-se a estatística matemática para analisar este estudo de pesquisa com saltadores em distância voluntários. Resultados: O aumento relativo do pico de torque das articulações do quadril e joelho foi maior quando comparado a articulação do tornozelo. Ambos demonstraram melhora considerável após o protocolo experimental. Conclusão: Após comparar a força de vibração das articulações dos membros inferiores com o efeito de treinamento de atletas de salto em distância, alguns métodos de treinamento de força de flexor podem ser adicionados, aumentando adequadamente a intensidade e a quantidade de carga, de modo que o extensor da articulação dos membros inferiores e o nível de força de flexor possam ser coordenados proporcionalmente, visando aprimorar o nível de força e de coordenação motora nos atletas. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores**:** *Treinamento de Força; Atletas; Vibração.*

RESUMEN

Introducción: Como nuevo método de entrenamiento, el método de entrenamiento de fuerza por vibración ha sido ampliamente utilizado en el entrenamiento de fuerza y la rehabilitación de masas de los atletas extranjeros. Como método auxiliar de entrenamiento de fuerza en China, la fuerza vibratoria también ha atraído la atención de los profesionales. Los estudios en este ámbito son importantes para mantenerse al día con las últimas teorías y técnicas internacionales de entrenamiento de fuerza por vibración. Objetivo: Estudiar los efectos del entrenamiento de fuerza por vibración en las articulaciones de las extremidades inferiores de los atletas de salto de longitud. Métodos: Se realizó una búsqueda en la literatura médica reciente para desarrollar un método de prueba experimental y se implementó la estadística matemática para analizar este estudio de investigación con saltadores de longitud voluntarios. Resultados: El aumento relativo del par máximo de las articulaciones de la cadera y la rodilla fue mayor en comparación con la articulación del tobillo. Ambos mostraron una mejora considerable tras el protocolo experimental. Conclusión: Después de comparar la fuerza de vibración de las articulaciones de los miembros inferiores con el efecto del entrenamiento de los atletas de salto de longitud, se pueden añadir algunos métodos de entrenamiento *de la fuerza de los flexores, aumentando adecuadamente la intensidad y la cantidad de carga, de modo que el nivel de fuerza de los extensores de la articulación de los miembros inferiores y el nivel de fuerza de los flexores puedan coordinarse proporcionalmente, con el objetivo de mejorar el nivel de fuerza y la coordinación motora de los atletas.* ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores**:** *Entrenamiento de Fuerza; Atletas; Vibración.*

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INTRODUCTION

The long jump is a fast power sport. It not only requires athletes to have super explosive ability and coordination ability, but also requires athletes to have efficient technical application ability. Therefore, the long jump has higher requirements on athletes' physical fitness and special skills. This high demand also increases the risk of injury to the knee and ankle joints of the take-off leg of long jumpers. Studies have shown that knee injuries account for 14% to 33% of all injuries in the human body; Increasing the reaction force of the vertical ground is likely to cause damage to the knee joint, and the reaction force of the vertical ground, the kinematics and dynamic parameters of the maximum instant will also change significantly. The take-off technique of the long jump makes the momentum of the center of gravity of the athlete's body change sharply, so as to obtain the necessary take-off speed and take-off angle, and at the same time, it will also cause sports injuries to the athlete's knee joint. Because the knee joint is the main point of force in the run-up and take-off movement, and the tendons and ligaments around the knee joint are relatively small and lack protection, it is easy to cause knee injury. Through experimental testing and mathematical statistics and other research methods, systematic research on the transformation, stress and angle of take-off technology of long jumpers is carried out, in order to explore the biomechanical factors that affect the risk of knee joint injury caused by long jump take-off technology, and the biomechanical mechanism of knee joint sports injury, it can provide theoretical reference for the prevention and rehabilitation of knee joint injury.

METHOD

Documentation method

Enter the keywords "long jump and take off", "knee joint injury", etc. through the electronic journal network, and check the relevant literature, it is clear that the long jump take-off action may cause the risk of sports injury to the athlete's knee joint, and has a deep understanding of the mechanism of sports injury, provide a theoretical basis for the research.[1] As a new strength training method, vibration strength training method has been widely used in strength training and mass rehabilitation of foreign athletes.[2] Then, as shown in Equation 1:

$$j\theta + k\theta = T(t) \tag{1}$$

Among them, j is the rotational inertia matrix, and T is the generalized moment vector.

Experimental test method

Using the Vicon motion capture system and Bertec three-dimensional force table test system produced by Oxford Metrics Cimited (OML) in the UK, for 5 male long jumpers of different levels during the take-off process, the technical aspects of the take-off leg and the form of muscle force were tested synchronously.[3] Figure 1: Athlete's take-off curve, real-time acquisition of parameters such as body center of gravity, knee joint and lower limb muscle force, torque and other parameters when the athlete completes the take-off action, and based on these parameters, further analyze the long-jump athlete's take-off leg knee joint injury during the take-off process influencing factors.[4] The selected subjects do not have any disease or injury, before the experiment, explain the intention of the experiment to the subjects, and make adequate preparations to ensure the successful completion of this test task. Subjects are required to complete the approach run with a good approach rhythm and maximum speed, step on the force platform for the last step, and successfully complete the follow-up technical movements of the long jump.[5]

Mathematical Statistics

Using Excel2010, SPSS25.0 and other software to analyze the obtained kinematics and dynamics parameters, statistical processing and correlation analysis were performed. The long jumper achieves the best speed by running a certain distance, be fully prepared for the upper board takeoff.[6] When taking off, make full use of the speed obtained from the run-up, and complete the speed conversion in a very short period of time, so as to obtain the maximum take-off speed and suitable take-off angle.[7] Figure 2. below shows the comparison curve of kinematics and dynamics.

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

RESULTS

The effect of vibration strength training on the maximum work of lower extremity joint extensor and flexor groups. Maximum work means that when a muscle group performs work during a certain number of repeated contractions, the maximum work value at one time, it represents the functional ability of the muscle, and also reflects the maximum muscle strength to a certain extent.[8] After 8 weeks of systematic training, the maximum work of the hip, knee and ankle extensor muscles of the two groups of subjects has been improved to varying degrees. According to general research and analysis, the take-off process is roughly divided into four phases and three stages: The instant of landing, the instant of maximum buffering, the instant of the body's center of gravity reaching the vertical plane, and the instant of taking off from the ground.[9] As shown in Figure 3 below. Among them,

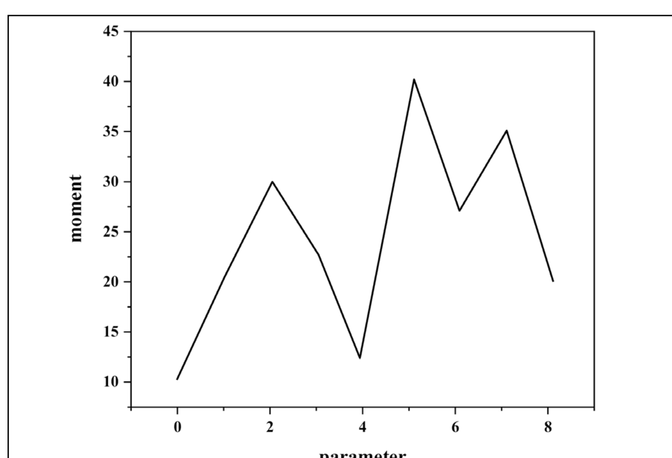

Figure 1. Changes in athletes' take-off muscles.

the buffering stage is from the moment of landing to the moment of maximum buffering; The moment of maximum buffering to the moment when the center of gravity of the body reaches the vertical plane is the transformation stage; The moment when the center of gravity of the body reaches the vertical plane and the moment when it leaves the ground is the kick-stretching stage. First, the knee joint has the largest increase in the relative peak torque of the lower extremity joint flexors, followed by the hip joint, and the third is the ankle joint.[10] Then the relative peak torque of the lower extremity flexors increased the most in the ankle joint, followed by the knee joint, and the third in the hip joint. As shown in Figure 4, the change curve of hip, knee, and ankle extensor and flexor muscles. The data also show that: The relative peak torque increment of hip and knee joints was larger than that of ankle joint. The study further revealed that, the increase of hip, knee, and ankle extensors and flexors shows that the relative peak torque increase of extensors is larger than that of flexors.[11]

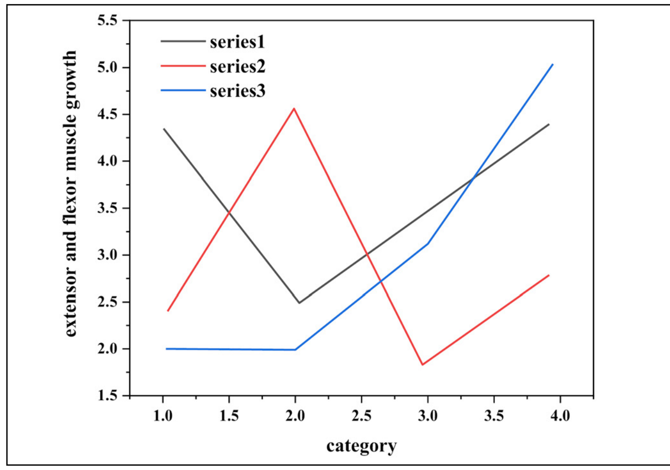

Figure 4. The change curve of the growth rate of hip, knee and ankle extensor and flexor muscles.

DISCUSSION

After further analysis of the study results, it was found that the hip extensors and flexors, knee and ankle flexors, the maximum work increment in group I was larger than that in group II.[12] Analyzing the reasons, it is believed that: Vibration strength training is the strength training carried out under the unstable vibration state of multiple particles, and the strength exercise is carried out in this unstable vibration state; On the one hand, target organs and more muscle groups can be mobilized to participate in exercise.[13] At the same time, more relevant synergistic muscles can be recruited to participate in the movement, so that more muscles can participate in the movement and generate greater force; On the other hand, when performing strength training under the unstable vibration state of multiple particles, the subject's attention is more concentrated, so that the nervous system is more actively involved in strength training.[14] The effects of strength training in a state of high concentration are remarkable, this is also an important reason why vibration strength training can be widely used in high-level sports training abroad. The difference is that the traditional non-vibration strength training is the strength training under the state of balance, and the motor units that the target organs and muscles can mobilize are relatively fixed and limited. Other synergists are not mobilized to actively participate in movement. In addition, because the control group was strength training with the body in a state of balance, the athletes also did not need to concentrate on strength training . Therefore, the effect of non-vibration strength training is relatively limited, and the increase is not as obvious as that of vibration strength training.

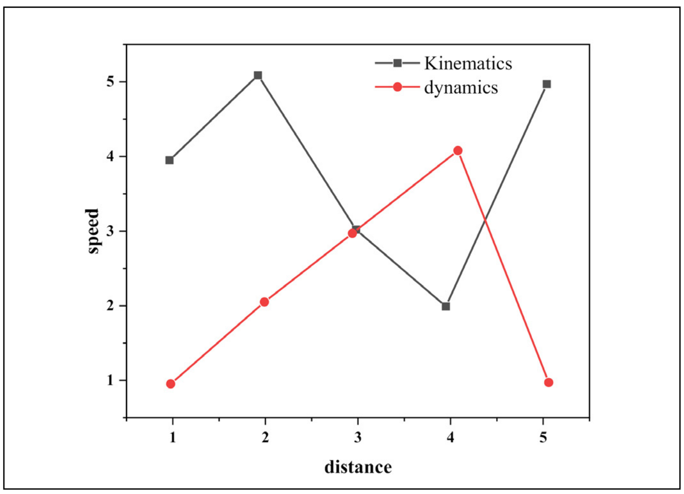

Figure 2. Comparison curve of kinematics and dynamics.

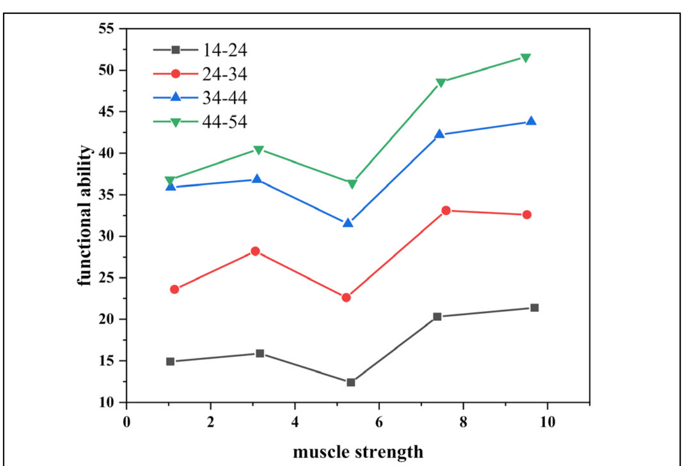

Figure 3. The four time phases change with age.

CONCLUSION

Hip flexors, knee flexors, and ankle extensors had larger relative peak torque increment ratios, while lower extremity flexors had relatively smaller relative peak torque increases. On the one hand, it may be related to the relatively weak flexor strength of athletes and the lack of corresponding flexor strength training; On the other hand, it may be related to the lack of flexor strength training methods in this experiment, and the load stimulation volume and intensity are not large enough, there is a certain relationship. In future experiments, some flexor strength training methods can be added, appropriately increase the load intensity and amount, so that the lower limb joint extensor and flexor strength level is proportionally coordinated, so as to better improve the coordination force level. The extensor and flexor strength of the hip, knee, and ankle joints all changed to varying degrees. Among them, the hip joint mainly showed a lower increase in the first 4 weeks, and a higher increase in the latter 4 weeks, showing an obvious change characteristic of "low first and then high"; The knee and ankle joints mainly showed a higher increase in the first 4 weeks, and a decrease in the latter 4 weeks, showing an obvious change characteristic of "high first and then low".

The author declare no potential conflict of interest related to this article

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