MUSCULAR ENDURANCE IN MOUNTAINEERS UNDER DIFFERENT LOAD TRAINING OBSERVATION

OBSERVAÇÃO DA RESISTÊNCIA MUSCULAR EM MONTANHISTAS SOB DIFERENTES TREINAMENTOS DE CARGA

OBSERVACIÓN DE LA RESISTENCIA MUSCULAR EN MONTAÑISTAS BAJO DIFERENTES ENTRENAMIENTOS DE CARGA

Original Article
Artigo Original
Artículo Original

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ABSTRACT

Introduction: Mountaineering is a very healthy reasoning sport event that focuses on intelligence and physical strength, climbing rock walls with the hands. Objective: Observe the specific indicators of upper limb strength in mountaineering. Methods: Athletes from a rock-climbing training team were selected as the research subjects (N=12, M=6). Before the formal experimental test, the subjects performed 30-minute warm-up exercises, including stretching and jogging. Results: The negative correlation between sports performance and maximum heart rate after a 15-meter speed climb indicates that the higher the heart rate mobilized in sport, the better the exercise performance. Similarly, was observed the positive correlation between athletic performance and blood lactate at 3 minutes after a 15-meter climb, i.e., the higher the blood lactate during exercise, the worse the athletic performance. Conclusions: The higher the climbing speed and the lower the blood lactate, the better the athletic performance. Thus, athletes with high training levels and solid athletic ability can achieve a higher maximum heart rate level during exercise. ***Evidence Level II; Therapeutic Studies - Investigating the result.***

Keywords: Training; Mountaineering; Muscles.

RESUMO

Introdução: O montanhismo é um evento esportivo de raciocínio muito saudável que se concentra tanto na inteligência quanto na força física, consistindo em escalar paredes de rocha com as mãos. Objetivo: Observar os indicadores específicos de força dos membros superiores do montanhismo. Métodos: Os atletas de uma equipe de treinamento em escalada em rocha foram selecionados como os sujeitos de pesquisa (N=12, M=6). Antes do teste experimental formal, os sujeitos fizeram exercícios de aquecimento de 30 minutos, incluindo essencialmente exercícios de alongamento e manobras de montanhismo. Resultados: A correlação negativa entre o desempenho esportivo e a frequência cardíaca máxima após uma escalada de 15 metros de velocidade indica que quanto maior a frequência cardíaca mobilizada no esporte, melhor o desempenho do exercício. Da mesma forma, houve a correlação positiva entre o desempenho atlético e o lactato de sangue aos 3 minutos após uma escalada de 15 metros, ou seja, quanto maior o lactato sanguíneo durante o exercício, pior o desempenho atlético. Conclusão: Quanto mais alta a velocidade de escalada e mais baixo o lactato sanguíneo, melhor o desempenho atlético. Assim, atletas com alto nível de treinamento e forte capacidade atlética podem alcançar um nível máximo de frequência cardíaca maior durante o exercício. ***Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.***

Descritores: *Treinamento; Montanhismo; Músculos.*

RESUMEN

Introducción: El alpinismo es una prueba deportiva de razonamiento muy saludable que se centra tanto en la inteligencia como en la fuerza física, consistiendo en escalar paredes de roca con las manos. Objetivo: Observar los indicadores específicos de la fuerza de los miembros superiores en el alpinismo. Métodos: Se seleccionaron atletas de un equipo de entrenamiento de escalada en roca como sujetos de la investigación (N=12, M=6). Antes de la prueba experimental formal, los sujetos realizaron ejercicios de calentamiento de 30 minutos, que incluían esencialmente ejercicios de estiramiento y maniobras de montañismo. Resultados: La correlación negativa entre el rendimiento deportivo y la frecuencia cardíaca máxima tras una subida de velocidad de 15 metros indica que cuanto mayor sea la frecuencia cardíaca movilizada en el deporte, mejor será el rendimiento del ejercicio. Asimismo, se observa la correlación positiva entre el rendimiento atlético y el lactato en sangre a los 3 minutos después de una subida de 15 metros, es decir, cuanto más alto sea el lactato en sangre durante el ejercicio, peor será el rendimiento atlético. Conclusión: Cuanto mayor sea la velocidad de ascenso y menor el lactato en sangre, mejor será el rendimiento deportivo. Así, los atletas con un alto nivel de entrenamiento y una fuerte capacidad atlética pueden alcanzar un nivel de frecuencia cardíaca más alto durante el ejercicio. **Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.**

Descriptores: *Entrenamiento; Montañismo; Músculos.*

DOI: http://dx.doi.org/10.1590/1517-8692202228062022_0013 Article received on 01/06/2022 accepted on 02/18/2022

INTRODUCTION

Rock climbing is a very healthy mental sports event that focuses on both intelligence and physical strength, that is, climbing rock walls by hand. This refers to not relying on any external auxiliary force, only relying on the climber's own strength to complete the climbing process.[1] It is generally believed that during exercise, the upper limb muscles of rock climbers, compared with other sports muscles, often support the weight of the entire body, and the exercise load will be correspondingly larger than other sports muscles.[2] Based on the current research, this article proposes the analysis of the surface EMG of the upper limb muscles of rock climbers under different load training. From the relationship between heart rate, sports performance and blood lactate, we can judge that the higher the training level of speed climbers, the higher their blood lactate level. The lower the sports performance, the better.[3] The electrical activity of the muscles of the left limb of the athlete increases compensatory during the climbing process. These changes in overall motor behavior may be caused by the movement of the activation source of the sensory motor area of the higher central cerebral cortex during the exercise.[4]

METHOD

Research object

Taking the speed climbing athletes of the rock climbing training team as the research object, there are a total of 12 outstanding athletes. Among them, there are 6 male athletes with a height of (171.2±2.1) cm, a weight of (65.2±4.8) kg, an age of (23.1±1.1) years, and a training period of (6.2±1.2) years; 6 female athletes with a height of (162.1) ±3.4) cm, weight (54.2 ± 4.1) kg, age (21.3 ± 1.3) years, training years (5.6 ± 0.9) a. Before the start of the test, the experimental process was explained to the subjects. Each subject voluntarily participated in the study and filled out an informed consent form.[5]

Design of the experiment

Taking the climbing process of the rock climbing speed competition athlete as the observation object, the heart rate of the subject during the exercise is collected, and the blood lactic acid of the subject is tested 3 minutes after the completion of the 15m climb. At the same time, the surface EMG signal and video signal of the upper and lower limb muscles of the subject were collected during the entire climbing process of the subject.

Procedure of the experiment

Before the formal experimental test, the subjects performed a 30-minute warm-up exercise, which mainly included stretching exercises and jogging. During the warm-up process, the wireless telemetry heart rate belt is worn on each athlete to observe the athlete's exercise intensity during the warm-up process. After the warm-up exercise, surface EMG electrodes are attached to the athlete's upper and lower limbs related muscles, and then the surface electrode wires are bound with an elastic bandage so that the movement of the electrode wires affects the athlete's technical movements and surface EMG signals. In the formal experiment, before the athlete starts to exercise, the tester uses the remote control to send a synchronization signal, which is sent to the electromyography collector and the camera respectively. After the synchronization signal is received, the tester sends an instruction to start the exercise. After the athletes completed the 15m climbing distance, they immediately recorded the subjects' exercise time.[6] After the athlete rested for 3 minutes, the subjects' ear blood was taken for blood lactic acid test.

RESULTS

Heart rate, blood lactate and sports performance

In order to comprehensively evaluate the energy metabolism characteristics of the speed rock climbing event, the author observed the relationship between the maximum heart rate, blood lactate and sports performance of all male and female athletes during the 15m climbing process. The linear correlation analysis between these indicators is shown in Figure 1 and 2. The results found that there was a negative correlation between sports performance and the athlete's maximum heart rate after climbing at 15m, indicating that the greater the heart rate mobilized during the exercise, the better the performance of the speed climber. At the same time, the athlete's sports performance is also positively correlated with the athlete's blood lactic acid 3min after 15m climbing, that is, the higher the blood lactic acid produced by the athlete during the exercise, the worse the sports performance.[7]

EMG characteristics

It can be seen from Figures 3 and 4 that the surface EMG amplitudes of the upper limb-related muscles (biceps, triceps, flexors, and extensors) of the upper limbs gradually during the cyclical climbing process. Increase. Among them, the electromyographic amplitude of the biceps brachii and finger flexor muscles of the right upper limb increased significantly compared with the initial exercise, and for the left side, the electromyographic amplitude of these muscles increased even more. However, the amplitude of the surface EMG signal of the lower limb muscles did not change much during the speed climbing, and there was no significant increase in the change.[8] In this study, it was found that although the surface EMG signal amplitude of the left and right upper limb muscles increased during the climbing process, the increase

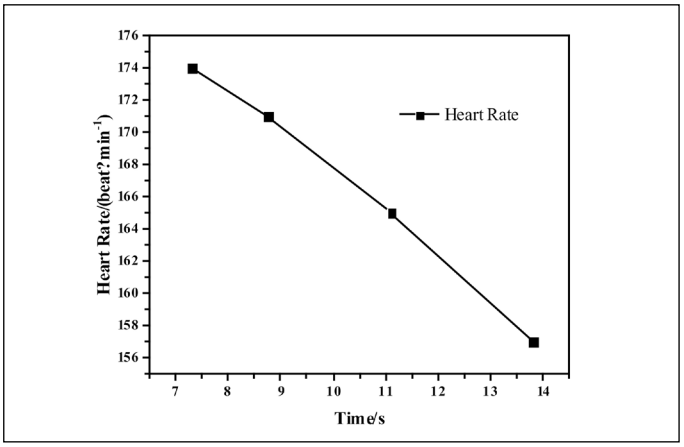

Figure 1. Correlation between maximum heart rate and sports performance during exercise.

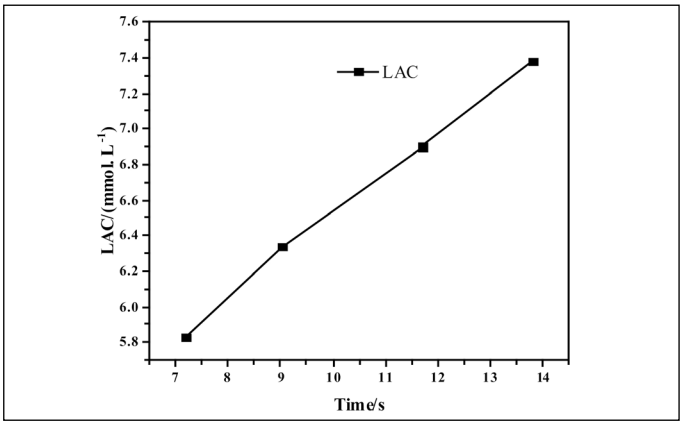

Figure 2. Correlation between blood lactic acid and sports performance during exercise.

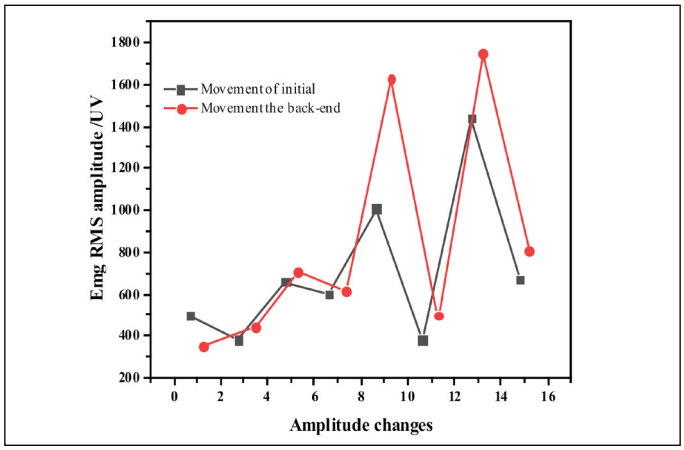

Figure 3. The RMS amplitude changes of sEMG of the right upper and lower limb muscles of all subjects at the beginning and after the exercise.

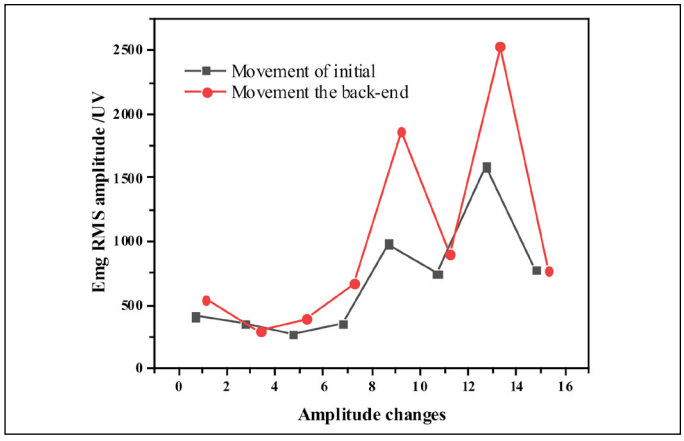

Figure 4. The RMS amplitude changes of the left upper and lower limb muscles sEMG of all subjects in the initial and post-exercise segments.

was more obvious on the left side. For this reason, the total amount of electrical activity of the surface EMG signals of the left and right limbs was compared at the beginning of the exercise and the later period of the exercise, and it was found that the total discharge of the muscles of the left limb after the exercise was significantly higher than that of the right.[9]

DISCUSSION

Neuromuscular fatigue characteristics of rock climbers during the 15m special climbing

From the original electromyogram, we can see that the muscles of the upper and lower limbs of the subjects are involved in the work during the entire climbing process of the athlete. This muscle activity is carried out periodically and alternately. Compared with the surface EMG signal of the muscles of the lower limbs, the discharge duration of the finger flexors and extensor muscles of the upper limbs is longer, with an average duration of 0.9 s, but the potential amplitude is very high. It shows that the finger flexor of the forearm is very important in the process of completing the technical action, and the discharge pattern of the finger extensor is the same as that of the finger flexor. This may be the activation of the finger extensor through the form of muscle co-activation. Through the synchronous analysis of electromyography and video, it can be seen that the finger flexors and finger extensors contract almost in the same pattern at the same time. The main purpose is to fix the body posture by grasping the climbing point and play the role of fixing the muscles. Therefore, the discharge time of the finger flexors and the finger extensors is relatively long, which is an isometric contraction. The simultaneous contraction of the finger flexors and the finger extensors is mainly accomplished by the co-activation of the central nervous system. The co-activation of the antagonist muscles, or the simultaneous contraction of the active muscles and the antagonist muscles, can increase the stiffness of the joint and improve the stability of the joint.[10]

The total amount of electrical activity of the left and right limbs of the athletes at the beginning of the exercise is similar, but when compared with the beginning of the exercise, the level of electrical activity of the muscles of the left and right limbs increases in the latter part of the exercise. Among them, the electrical activity level of the left limb muscles increased more obviously. The increase in electrical activity is a manifestation of body fatigue. In view of the occurrence of muscle fatigue, the body needs to recruit more motor units to maintain the current state of motion. As the exercise continues, the energy consumption in the muscles cannot be replenished in time, coupled with the accumulation of metabolites, muscle fatigue will occur. However, in order for athletes to reach the target force level with each contraction, their brains need to continuously activate more motor neurons in the spinal cord in order to recruit more muscle fibers to compensate for the fatigued muscle fibers, and to ensure that the level of strength output remains unchanged. Therefore, the amplitude of the muscle surface EMG signal increases during the athlete's muscle fatigue, which is a manifestation of the brain center's regulation during the peripheral muscle fatigue of the body. At the same time, the changes in the frequency domain of the surface EMG signal also proved that the athlete's muscle fatigue occurred during the climbing process, especially the small muscle groups of the biceps brachii and finger flexor muscles. Through further analysis, it is found that the increase in electrical activity of the right limb during exercise is mainly due to the biceps brachii, while the discharge of almost all muscles on the left is higher than the previous level. Among them, the finger flexors, biceps, latissimus dorsi and triceps are more obvious. This shows that in the latter part of the exercise, athletes use the left limb muscles to complete the final exercise task, which may be the result of the "rotation work" of the body's motor unit.

CONCLUSION

This article proposes the observation of upper limb muscle endurance of rock climbers under different load training, from the relationship between heart rate, sports performance and blood lactic acid. From this, it can be judged that the higher the training level of speed climbers, the lower their blood lactic acid levels, and the better their sports performance. At the same time, athletes with a high level of training and strong athletic ability can reach a higher maximum heart rate level during exercise. The electrical activity of the muscles of the left limb of the athlete increases compensatoryly during the climbing process. These changes in overall motor behavior may be caused by the movement of the activation source of the sensory motor area of the higher central cerebral cortex during the exercise. In addition, another reason may be that the muscle strength of the left upper limb of speed climbers is generally weak, so the small muscles of the left upper limb are more prone to fatigue. Due to the limitation of experimental conditions, it is impossible to conduct research on all muscle groups in the flexion dangling movement, such as latissimus dorsi, pectoralis major, etc. This type of research will continue in the future. There are many training subjects for fingerboards, such as different fulcrum grips, different grip distances, different loads, etc., which require further research.

ACKNOWLEDGMENT

Scientific Research Foundation of Chongqing University of Technology: A Research on Talent Cultivation of Rock Climbing on Universities, Grant Number:2021ZDR024.

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

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. JL: writing; WD: data analysis; YH: article review.

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