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Measurement of surface electromyography characteristics of Wushu athletes in the technical movement based on telemetry EMG

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Abstract. The development of the martial arts movement is essentially the development of human potential. In order to improve the athletic level and to find out the shortage of athletes' martial arts, this paper intends to use the telemetry electrometer to measure the surface electromyography characteristics of Wushu athletes during the martial arts movement. Compared with the commonly used analysis method of surface electromyogram (EMG) signals, we choose the time-frequency analysis method as the index of fatigue of muscle. Then, this paper takes the Sanda movement as an example, designs the comparative experiment of the excellent athletes (group A) and the general level athletes (group B), and analyzes the EMG signals during the movement of the athletes.

Key words. Telemetry EMG, surface electromyography, martial arts movement.

1. Introduction

After the exclusion of other factors, the essence of the competitive sports development is to explore human potential. It is very difficult to achieve constant development on a high level of achievement [1]. Therefore, on the basis of respecting the laws of nature, people need to use new technology to find out the subtle problems in sports technology, and to correct them, so as to improve the level of competitive sports [2].

Based on a large number of relevant literature, this study uses surface electromyography to observe the activities of the athletes during the martial arts movement, analyzes its surface EMG characteristics, so as to improve the technology of athletes in the subtle aspects and promote the development of technology and performance [3]. Compare the main difference between the excellent athlete and the general level athlete, find out the nature of the difference, and provide the theoretical basis for

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the Sanda athletes in order to cultivate the fast and accurate response ability under the complex game conditions, as well as providing a direct application method for the coach to carry out the scientific, targeted and effective training. It is vitally significant to elevate level of movement training and promote health of entire people.

2. 2. Methods applied to muscle fatigue assessment using surface myoelectric signals

The surface electromyogram (SEMG) is a one-dimensional time series signal that records the morphological changes of neuromuscular system [4]. There are different degrees of correlation between time-frequency characteristics and muscle activity state and functional state [5]. Surface electromyography spectrum analysis and time-frequency analysis are used to study the muscle fatigue index of athletes.

2.1. Time domain analysis

The time domain refers to the evaluation index that can reflect the change characteristics of the EMG curve in the time dimension [6]. The main indexes are integral electromyography (IEMG), mean amplitude (MA), root mean square amplitude (RMS), duration (DUR) and so on. Electromyography (EMG) is an electrodiagnostic medicine technique for evaluating and recording the electrical activity produced by skeletal muscles [7]. EMG is performed using an instrument called an electromyograph to produce a record called an electromyogram. IEMG refers to all the EMG signal rectified by the filter. The specific formula is as follows:

$$\mathrm{IMEG} = \int_{t}^{t+T} |\mathrm{EMG}(t)| \, \mathrm{d}t \,. \tag{1}$$

Here, t is the lower limit of the integral, $t+T$ is the integral line, $\mathrm{EMG}(t)$ is the time variation function of the EMG curve. Symbol MA reflects the intensity of the EMG signal and the number of units involved in the movement and the frequency of the same degree of change.

2.2. Frequency domain analysis

The frequency domain analysis refers to the evaluation of EMG signal in frequency. The main method is to pass the fast Fourier transform (FFT) of the time domain signal to obtain the spectral or power spectrum of the surface area electrical signal, which can reflect the change of the surface EMG signal at different frequency components, so it can be better to reflect the distribution characteristics of surface area of the signal in the frequency dimension [8]. The parameters commonly used for electromyography are the average power frequency (MPF) and the median frequency

(MF). The quantity MPF is given by the formula

$$\mathrm{MPF} = \frac{\int_0^\infty fP(f)\,\mathrm{d}f}{\int_0^\infty P(f)\,\mathrm{d}f}\,. \tag{2}$$

In formula (2), $P(f)$ represents the electromyogram, and f represents the frequency. Quantity MF is the intermediate value of the discharge frequency of muscle fiber in the process of skeletal muscle contraction.

3. Measurement of surface electromyography characteristics of athletes during technical exercise

In this study, we need to select the athlete's fist and leg movements in the Sanda Competition and training process to measure the surface EMG characteristics, in order to collect the EMG signals of the athletes in the fist and leg movements. All the subjects in this study are 12 boys aged about 20 years old, and they are in good health. The subjects are divided into group A and group B. The group A is 6 martial arts athletes selected from the Wushu Sanda Team of Xi'an sports institute, and the group B is the same level of 6 athletes selected from the school Wushu Sanda team.

The surface EMG test uses the German MEGA company's ME6000 16-guided telemetry EMG instrument, the instrument used to collect experimental EMG signal, and the acquisition frequency is 1500 Hz. We use Myo Research-XP software to standardize the original EMG signal to obtain the corresponding data. In this experiment, we compare the athletes of group A and group B, mainly to analyze the changes of surface electromyography of muscle during the movement of athletes, and use a variety of methods to carry out real-time synchronous monitoring of the EMG in the technical action of athletes during the whole process. The specific experimental process is shown in Fig. 1.

4. 4. Analysis of surface electromyography characteristics of athletes during technical movement

4.1. Analysis of muscle discharge duration in action

The duration of muscle activity is the time between the beginning and the end of the muscle activity, which is the duration of the muscle's discharge. During the course of the action, the coordination between the muscles is very important. If the coordination degree between muscles is high, then the muscle discharge time is neat and regular, so it can save more energy consumption in the work under the same situation, and also can be used to determine the level of training athletes. The discharge duration of straight punch muscle of group A and group B is as shown in Fig. 2.

As can be seen from Fig. 2, the discharge duration of the triceps and brachioradialis is the longest in the straight punch movement, and the discharge duration of

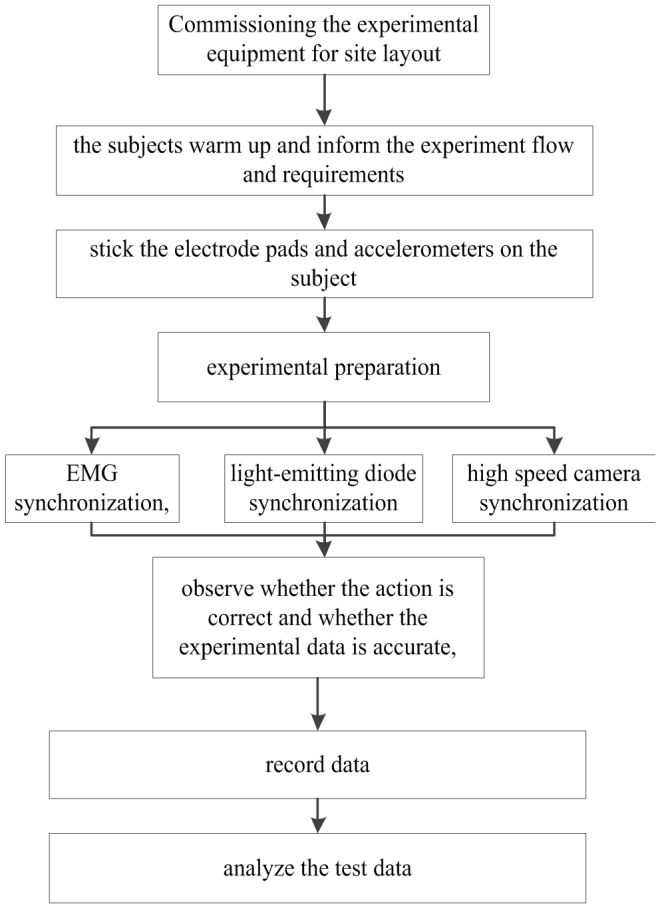

Fig. 1. Experimental process

the deltoid is the shortest. On the whole, compared with group A, the duration of the straight punch muscle of group B is relatively early, and the discharge duration is longer. The duration of the round kick muscle of the different level athletes is as shown in Fig. 3.

As can be seen from Fig. 3, the duration of the round kick muscle in group A is the longest, followed by the order of gluteus maximus, abdominal oblique and biceps femoris. The duration of the gluteus maximus muscle in group B is the longest, followed by the order of musculus obliquus externus abdominis, rectus femoris and biceps femoris. From the discharge duration, there is no difference between different levels of athletes.

For the long discharge muscles, in the usual training, we should not only pay attention to the strength of muscle exercises, but also pay attention to the duration of long muscle endurance exercises, which can give full play to the main force of muscle muscle strength, while increase the level of endurance of muscles that are

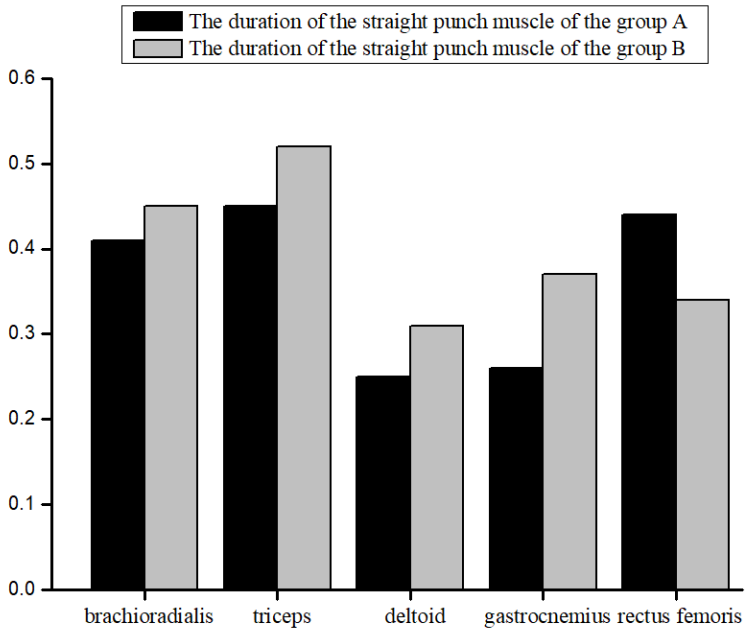

Fig. 2. Duration of the straight punch muscle of the two groups

involved in the entire movement for a long time, that is, in the usual training, we should not only pay attention to strengthen the reaction force, the greatest strength and fast strength, but also to strengthen the strength of endurance training.

4.2. Analysis of mean square amplitude in action

The mean square root values of the block muscles in the group are significantly higher than those in the group B. In the side kick leg technical action, the mean square root value of the medial muscle, gluteal muscle and femoral component muscle of group B is significantly higher than that of group A. In the group B, the medial femoral muscle discharge is larger, the root mean square value is the highest, and the discharge volume is the smallest. From the results of the root mean square amplitude data can be found that, when the athletes complete the action, the muscles should pay attention to coordination. In the case of saving energy to play greater muscle strength, and the coordination between the muscles is also very important.

5. Conclusion

Based on the important role of the reaction ability in the technical movement, this study takes the Sanda movement as an example. The results show that the duration of discharge in group A is relatively short, and has better elasticity and contractility. From the different levels of athletes' straight movements of the EMG

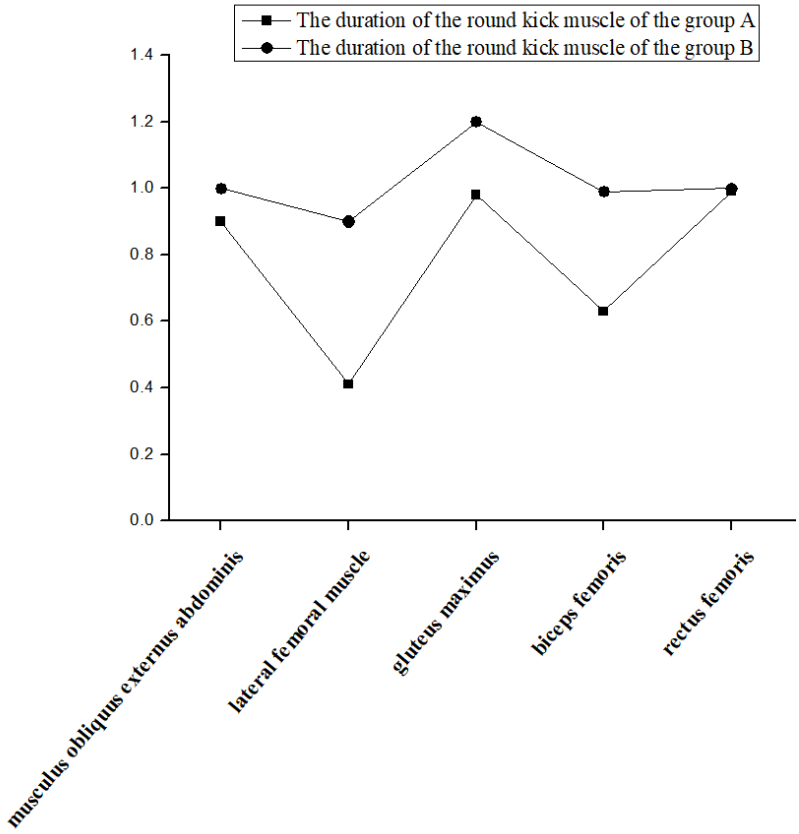

Fig. 3. Duration of the round kick muscle of the different level athletes

characteristics, which indicates that the upper limb muscle discharge is higher, and the lower limb muscle discharge is smaller, this is consistent with the principle of right straight action force. At the same time, the muscle force of the group A athletes in the side kick action is reasonable. In addition to gastrocnemius, the duration of muscle discharge in group A is shorter than that in group B, and the duration of muscle discharge in group A is shorter than that in group B in the whip legs action, which is reasonable for saving energy and a good contraction force. According to the results of the study, we understand the muscle force situation of the whip legs action, so we should carry out the specialized training to the main muscle.

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