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LETTER TO THE EDITOR

# Surface Electromyography and Isokinetic Muscle Test for Aerobics Athletes with Exercise-Induced Rotator Cuff Injury based on Ecological Science Theory

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Objective: To observe and analyze the surface electromyography and isokinetic muscle test for aerobics athletes with exercise-induced rotator cuff injury. Methods: A total of 180 aerobics athletes with exercise-induced rotator cuff injury treated at our hospital were enrolled (research group). Meanwhile, 180 healthy athletes were selected as control group. Surface electromyography and isokinetic muscle test were performed on members in both groups. And the results were compared. Results: Results showed that the EMG value of supraspinatus and infraspinatus of the research group were significantly lowered than those of the control group, when the shoulder was abduced at an angular velocity of 60 °/s and 90 °/s. ($P < 0.05$); meanwhile, the EMG value of infraspinatus of the research group were significantly lowered than those of the control group, when the angular velocity was 90 °/s and 120 °/s ($P < 0.05$); moreover, the peak torques of the research group at shoulder external/internal rotation as well as at shoulder abduction and adduction with an angular velocity of 60 °/s, 90 °/s and 120 °/s were significantly lowered than those of the control group ($P < 0.05$).Conclusion: When an athlete suffered from rotator cuff injury, it will be difficult to involve the supraspinatus and the infraspinatus muscles at shoulder abduction. And the combined force of the middle bundle of deltoid muscle and supra spinatus would be impaired due to rotator cuff injury, thus weakening the shoulder joint abduction ability.

## I Introduction

Hongmei Zhao, Qin Xie, Buslaev published "Correlation Study on Women Aerobics Athletes' Physical Quality and Skilled Movement Level" on Issue 107, Pages: 3927-3932, Article No: e107436, Year: 2019, in the article, Aerobics are popular in youth. Analysis and study have gone deeper into aerobics athletes' physical quality and skilled movement level to improve its comprehensive performance in competition. Just on the basis of the thought, the paper established evaluation model regarding skilled level, selected several women aerobics athletes as study objects and tested them, input the results into relative software and analyzed, then standardized the original data by T type distribution and checked it by applying Pearson correlation analytic method. Study results show that chest circumference has the largest significance impacts on women aerobics athletes' skill performance and so does sit-and-reach on women aerobics athletes' body shape performance. This study provides references for improving

aerobics athletes' performance.

**II Data and Methods**

A total of 180 aerobics athletes with exercise-induced rotator cuff injury (as shown in Figure 1) treated at our hospital from January 2015 to August 2018 were enrolled as research group. Meanwhile, 180 healthy athletes were selected as control group. All patients in the research group had previous injury history of upper extremities when doing overhead movements. And the injured shoulder joint was dominant shoulder. Of those, there were 120 male patients and 60 female patients in the research group, with an average age of (25.9±3.2) years. Moreover, there were 108 male patients and 72 female patients in the control group, with an average age (24.8±3.5) years. All patients enjoyed the right to know, and formal consent forms were obtained. This study was approved by the ethic committee of our hospital.


**Fig 1. The image examination of a patient**

During isokinetic muscle test, the torque and the surface electromyo graphic signal of anterior, middle, posterior bundle of deltoid muscle, supraspinatus, infraspinatus and teres minor muscle were monitored simultaneously (Gao et al. 2017, Hong 2015).

**III Results**

Comparison of the iEMGvalue of the rotator cuff muscle and muscles around the shoulder joint at shoulder abduction between both groups

As shown in Table 1, the iEMG value of the rotator cuff muscle and muscles around the shoulder joint were measured when the shoulder was abduced at an angular velocity of 60 °/s, 90 °/s and 120 °/s. And results showed that the iEMG value of supraspinatus and infraspinatus of the research group were significantly lowered than those of the control group ($P < 0.05$).

**Table 1. Comparison of the iEMG value of the rotator cuff muscle and muscles around the shoulder joint at shoulder abduction between both groups ($\bar{x} \pm s$)**

| Groups | Indicators | 60 °/s | 90 °/s | 120 °/s |
|---|---|---|---|---|
| Research group (n=180) | Anterior bundle of deltoid muscle | 0.41±0.08 | 0.36±0.05 | 0.39±0.07 |
| | Middle bundle of deltoid muscle | 0.69±0.20 | 0.88±0.28 | 0.86±0.25 |

| | | | | |
|---|---|---|---|---|
| | Posterior bundle of deltoid muscle | 0.45±0.56 | 0.41±0.09 | 0.42±0.13 |
| | Supraspinatus | 0.45±0.05 | 0.41±0.02 | 0.58±0.22 |
| | Infraspinatus | 0.28±0.09 | 0.27±0.08 | 0.25±0.06 |
| | Teres minor muscle | 0.15±0.05 | 0.12±0.01 | 0.12±0.05 |
| Control group (n=180) | Anterior bundle of deltoid muscle | 0.58±0.07 | 0.45±0.13 | 0.49±0.04 |
| | Middle bundle of deltoid muscle | 0.79±0.04 | 0.66±0.26 | 0.71±0.17 |
| | Posterior bundle of deltoid muscle | 0.53±0.39 | 0.51±0.39 | 0.45±0.32 |
| | Supraspinatus | 0.95±0.16 | 0.87±0.39 | 0.98±0.07 |
| | Infraspinatus | 0.95±0.19 | 0.87±0.27 | 0.86±0.30 |
| | Teres minor muscle | 0.14±0.02 | 0.13±0.08 | 0.14±0.05 |

Comparison of the iEMG value of the rotator cuff muscle and muscles around the shoulder joint at shoulder extorsion between both groups

As shown in Table 2, the iEMG value of the rotator cuff muscle and muscles around the shoulder joint were measured when the shoulder was external rotated at an angular velocity of 60 °/s, 90 °/s and 120°/s. And results showed that the iEMG value of infraspinatus of the research group were significantly lowered than those of the control group, when the angular velocity was 90 °/s and 120 °/s ($P < 0.05$).

**Table 2. Comparison of the iEMG value ofthe rotator cuff muscle and muscles around the shoulder joint at shoulder extorsion between both groups ($\bar{x} \pm s$)**

| Groups | Indicators | 60 °/s | 90 °/s | 120 °/s |
|---|---|---|---|---|
| Research group (n=180) | Anterior bundle of deltoid muscle | 0.19±0.06 | 0.18±0.05 | 0.15±0.07 |
| | Middle bundle of deltoid muscle | 0.47±0.12 | 0.42±0.16 | 0.42±0.20 |
| | Posterior bundle of deltoid muscle | 0.52±0.13 | 0.32±0.10 | 0.31±0.09 |
| | Supraspinatus | 0.59±0.09 | 0.57±0.03 | 0.52±0.06 |
| | Infraspinatus | 0.40±0.06 | 0.29±0.06 | 0.29±0.11 |
| | Teres minor muscle | 0.16±0.05 | 0.19±0.06 | 0.18±0.06 |
| Control group (n=180) | Anterior bundle of deltoid muscle | 0.21±0.12 | 0.19±0.10 | 0.19±0.07 |
| | Middle bundle of deltoid muscle | 0.47±0.29 | 0.42±0.22 | 0.41±0.19 |
| | Posterior bundle of deltoid muscle | 0.56±0.16 | 0.41±0.15 | 0.38±0.35 |
| | Supraspinatus | 0.57±0.13 | 0.56±0.28 | 0.61±0.05 |
| | Infraspinatus | 0.53±0.16 | 0.62±0.29 | 0.60±0.03 |
| | Teres minor muscle | 0.17±0.02 | 0.15±0.08 | 0.17±0.09 |

Comparison of the peak torques at shoulder external/internal rotation as well as at shoulder abduction and adduction between both groups

As shown in Table 3, the peak torques of the research group at shoulder external/internal rotation as well as at shoulder abduction and adduction were significantly lowered than those of the control group ($P < 0.05$).

**Table 3. Comparison of the peak torques at shoulder external/internal rotation as well as at shoulder**

**abduction and adduction between both groups ($\bar{x}$ ±s)**

| Groups | Indicators | 60 °/s | 90 °/s | 120 °/s |
|---|---|---|---|---|
| Research group (n=180) | The peak torques at shoulder external/internal rotation | 75.60±5.62 | 72.39±10.42 | 66.79±6.35 |
| | The peak torques at shoulder abduction and adduction | 91.25±12.16 | 89.77±9.84 | 77.98±15.36 |
| Control group (n=180) | The peak torques at shoulder external/internal rotation | 53.29±3.40 | 55.09±4.38 | 53.28±4.52 |
| | The peak torques at shoulder abduction and adduction | 64.55±4.68 | 61.52±4.92 | 65.63±5.68 |

## IV Discussion

As a non-invasive method with good specificity for evaluating muscle function, surface electromyography can ideally assess skeletal muscle contraction activity (Kuti and Oyelami 2015). Meanwhile, because the movement speed is constant during exercise and the exercise muscle can produce maximum strength at any time during the whole movement, the surface electromyography signal could present the active state of skeletal muscle (Wu and Liu 2015).

The skin (surface) electrode is placed on the surface of the target muscle, and collective myoelectric activity of single muscle, one or multiple groups of muscles are recorded. The EMG signal was collected during muscle activity/action (isotonic, isometric, isokinetic.) to quantitatively and qualitatively analyze the neuromuscular function (Xiao et al. 2018). The integral electromyogram is the total amount of discharge in the muscles participating in the activity in a certain period of time, which could be used to analyze the contraction characteristics of the muscle in a unit time. The isokinetic muscle strength test adopts the superiority of isokinetic contraction, and records the transient variation of torque during exercise with the help of special attachments and computer processing. Then the torque curve and numerous data reflecting the muscle function would be obtained, including peak-to-peak torque ratio at flexion and extension, torque and power, which can be used as an important indicator for evaluating muscle motor function (Yalcin et al. 2019).

Results from this research showed that the muscle strength of each group of muscle of shoulder joint was significantly reduced in the research group. When the shoulder joint was abduced at different angular velocity, the iEMG value of supraspinatus and infraspinatus of the research group were significantly lowered than those of the control group, while there was no significant difference in other indicators. The above findings prove the poor involvement of supraspinatus and infraspinatus at abduction when there is rotator cuff injury. The iEMG value of infraspinatus of the research group were significantly lowered than those of the control group when the shoulder was external rotated at varied angular velocity, demonstrating poor involvement of infraspinatus at external rotation when there is rotator cuff injury and no changes in the supraspinatus, deltoid muscle and teres minor muscle. Moreover, the peak torques of the research group at shoulder external/internal rotation as well as at shoulder abduction and adduction were significantly lowered than those of the control group, indicating weakened abduction caused by decreased combined force of the middle bundle of deltoid muscle and supraspinatus.

## V Conclusion

To sum up, as a common type of rotator cuff injury, exercise-induced rotator cuff injury is usually caused by

doing the same movement repeatedly, which would result in fatigue of the anatomical structure of a certain part. When the changes of certain anatomical structure could not be repaired physiologically, the normal physiological anatomical structure would be altered, resulting in shoulder joint disease. Exercise-induced rotator cuff injury seriously affects the normal movement and training of aerobics athletes, which may even cause them to leave during competition. In order to reduce the chance of rotator cuff injury in excellent athletes, the surface electromyography and isokinetic muscle strength testing techniques can be fully applied to evaluate the shoulder joint motor function objectively before training. Based on the results, scientific training program could be advanced. Meanwhile, the surface electromyography and isokinetic muscle strength test can provide a valuable theoretical basis for the rehabilitation treatment strategy after exercise-induced rotator cuff injury, which has enormous application value. In the future, study with large sample should be conducted.

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