APPLICATION OF NEUROMUSCULAR ELECTRICAL STIMULATION IN DEVELOPING ROWERS' MUSCLES

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INTRODUCTION

Rowing technique can be divided into three categories by the characteristics of Force-time curves. Different kinds of rowing styles are the result of different habits and training, but they also reflect the conditions of specific muscle groups of each individual. Neuromuscular electrical stimulation (NMES) is developed from clinical electrical stimulation. Many researchers are interested in its application in sports training. Pan Huiju et al. (1991) found out that NMES has many advantages compared with direct muscle electrical stimulation, so we applied NMES to the rowers as a supplemental training method,

METHOD

20 elite male rowers in Zhejiang rowing team volunteered to take part in this study. The subjects were divided into two groups. Group A received NMES from NMES-168 Stimulators every night plus normal training everyday for two weeks, and the muscle groups that received NMES were decided by the features of their F-t curves measured with a strain gauge set in a Concept rowing ergometer. Group B was trained normally. Heart rates were monitored during the stimulations. Before the stimulation, two tests were done. Test 1 is to measure the blood lactate acid concentration (BLAC) with a YSI-1500 lactate analyser 2 minutes after 20 minutes rowing with intensity of 1 min. 50 s/500m (1'50s/500m) and rowing frequency of 18 on a Concept rowing ergometer. 10 minutes after Test 1, Test 2 measured the time the rowers take to finish 2500m on a Concept rowing ergometer. After 2 weeks of stimulation, the F-t curves, Test 1 and Test 2 were done again.

RESULTS AND DISCUSSION

The first purpose of this study was to detect the characteristics of each rower's technique and correct the incorrect rowing styles by measuring F-t curves. Three categories of rowing techniques are shown in Fig 1 according to the characteristics of F-t curves.

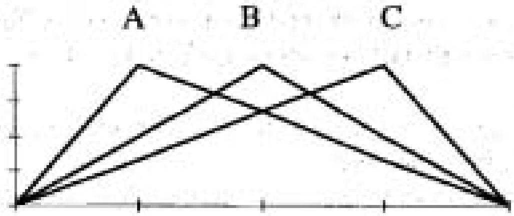

Figure 1. Three types of rowing techniques

Category A emphasizes the synchronized explosive effects of legs, body and arms at the beginning.

Category B pays more attention to the action of the muscles in the midway of the rowing cycle.

Category C emphasizes the synchronized action of body and arms.

Different features of the F-t curves are the result of different habits and training, but they also reflect the conditions of specific muscle groups of each individual. For example, rowers of Category A generally have strong legs and weak bodies and arms, which make the F-t curves go up quickly and come down very soon. This is the most common situation. When coaching these kinds of rowers, we should not only tell them to start the rowing cycle with legs and then aid body and arms consequently, but also find effective ways to increase the strength of body and arms. It would be useless if we only tell them to pay attention to the action of bodies and arms and did not solve the problem of weak muscles of bodies and arms.

Then what kind of F-t curve is good? In what way can we achieve the greatest efficiency? According to the principles of sports biomechanics, the best technique should make the boat go smoothly and with least speed changes. So a good F-t curve should rise quickly to the top point and then keep the height for as long as possible, then the curve goes down for the next cycle.

The smoothness of the curve is very important. Steady force makes the boat go steadily. The ending of the cycle should not be over-emphasized, because it makes the boat vibrate up and down and create greater waves, and the muscles of the body and arms are relatively weaker compared with those of legs.

The smoothness of the curve can reflect the training level of the rowers. Excellent rowers can always control the action of muscles; their curves are always smoother than the others, because the whole cycle of rowing needs the action of legs, body and arms. Good coordinating ability makes smooth transition from the action of a muscle group to the next.

The measurement of F-t curves of the subjects showed that most of the rowers had weak body muscles. Two rowers showed problems of slow action of legs, and another two rowers showed obvious decrement of arm strength after some time of rowing even though everything was okay at the beginning.

The decrease of F-t curve is probably caused by poor coordinating ability. However, we believed the basic reason was the weakness of specific muscle group. Neuromuscular electrical stimulator NMES-168 is the result of years' research of the scientists in our institute. Experiments had shown that it is very effective in increasing explosive powers, prolonging maximum force duration and relieving sports injuries as well.

The second purpose of this study was to decide whether NMES-168 can also be used in developing rowers' muscles effectively. In the previous studies, sports scientists usually gave out the results to the coaches and the coaches revise their training plan according to the results and suggestions. In this research, we ndt only found problems but also tried to solve them. We designed an experiment described earlier in the method. We applied NMES -168 as a supplemental measure to the training of Group A, the muscle groups that received NMES were rowers' weak muscle groups. ,

During stimulations, the correct position of the electrode is very important. NMES, which is different from direct electrical stimulation, stimulates the nerve segments that control the contraction of muscle fibers, so the accessory electrode is always on the spine where nerves controlling specific muscle groups extend, the main electrode on the position where nerves enervate muscle fibers. Fig 2 shows the position of the electrodes when doing NMES to the dorsi -lumbar muscles.

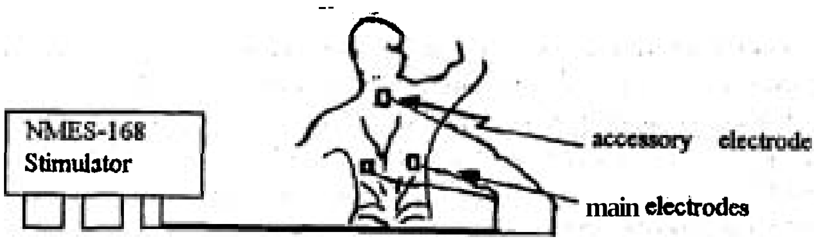

Figure 2. The position of the electrodes when doing NMES to the dorsi-lumbar muscles.

The results of the two tests are in Table 1 and Table 2.

Table 1.
Results of Test 1.

	before experiment average	SD	after experiment average	SD
Group A	5.38	0.58 mmol/l	4.27	0.43 mmol/l
Group B	5.32	0.63 mmol/l	4.89	0.59 mmol/l

Table 2.
Results of Test 2.

	before experiment average	SD	after experiment average	SD
Group A	8'20	0'21 sec	8'03	0'19 sec
Group B	8'21	0'22 sec	8'11	0'17 sec

, After two weeks of experimental training, the F-t curves of both Group A and Group B were generally in better form. In Test 1, the average BLAC of Group A decreased from 5.38mmol/l to 4.27mmol/l, and the average BLAC of Group B decreased from 5.32 mmol/l to 4.89mmol/l after the experiment. T tests showed that both Group A and B had significant difference in BLAC before and after the experiment ($p<0.01$). Before the experiment, Group A and Group B had no significant difference ($p>0.05$). After the experiment, significant difference existed ($p<0.01$).

When doing Test 1, we select the rowing frequency of 18, intensity of 1'50s/500m and working time of 20 minutes in a Concept rowing ergometer. This kind of intensity, frequency and duration is often arranged in daily training classes. The rowers are familiar with it, so the psychological factors didn't affect the results of the experiment. Two minutes after the rowing, finger tip blood was taken to measure BLAC. In Concept , the intensity is expressed by the time for rowing 500m in the water. 1'50s/500m means the rower keeps the boat going at a speed of 4.55m/s.

Test 2 was also one of the tests often practiced in daily training. Each individual had experiences in doing such a test, so the test results can well reflect the general increment of their ability. Test 2 showed that the average time for rowing 2500m of Group A decreased from 8'20 to 8'03, and that the average time for rowing 2500m of Group B decreased from 8'21 to 8'11. T tests showed that the performances of Group A were significantly improved($p< 0.01$) after the experiment, and that there were also some improvements in Group B ($p< 0.05$).

Both Test 1 and Test 2 indicated that most rowers had significant progress after two weeks of conscious training, and that Group A had greater improvement. After measuring the Force-time curves, the rowers learned the weakness of their technique, and then trained with a definite aim to reach the best medal. The improved technique of the rowers caused the decrement of BLAC after the same amount of training. Rowers of Group A not only know their features of their techniques through F-t measurement, but also adopt NMES to the weak parts of their muscle groups besides normal training. That is why they got better results after 2 weeks of experimental training.

During the stimulations, the heart rates of the subjects increased a little. The average heart rates of the subjects were 65.18.0 and 73.29.1 before and during the stimulations respectively, the increment was about 12%.

CONCLUSIONS

We concluded that by measuring Force-time curves we can train rowers according to the characteristics of each rower, and that NMES-168 played a positive role in the development of muscles of elite rowers.

REFERENCES

Pan, H. et al. (1991). A biomechanical research of neuromuscular electrical stimulation, J. Zhejiang Sports Sci., 3:50-54.