Study the Effects of EMG, HR, RPE and Low Back Pain in Different Exercise Bikes Riding Positions

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ABSTRACT

The effects of EMG, HR, RPE and low back pain to legs in different exercise bikes riding positions were studied. In the condition of sixty RPM (revolutions per minute), the subjects are sixteen healthy graduates riding exercise bikes three minutes in five different seat positions (Standard, Forward, Backward, Up, Down), and use BioPacMP150, POLAR watch and VAS to record the changes of legs EMG, HR, RPE and Low back pain. When riding, turning the seat position upward, EMG signals is larger, HR, RPE and low back pain are also higher. In different riding seat positions really can bring out different muscular contraction, HR, RPE, and low back pain. The differences will provide references to exercise bike riders.

Keywords：Exercise Bikes, Electromygraphy (EMG), Heart Rate (HR), Ratings of Perceived Exertion (RPE).

1. INTRODUCTION

There are many styles of exercise bikes, but the main purpose is to enjoy exercise pleasure indoors. Although this kind of fix machines cannot increase and strengthen riding skills, they can continue to exercise indoors and also can increase physical strength. The largest difference of these training equipments is price, comfortable and amusement effects (Ballantine and Grant, 1992). Review the research of exercise bikes is almost in seat cushion research and finding a close relationship among seat, holder and pedal when riding, especially in the seats research, finding the pressure of male perineum will increase when riding and further will increase sports injury (Eadric Bressel, et al, 2007). The research also found the effect of seat inclination angle to low back pain. The findings are when the seat forward can decrease the muscle tension from the back to sacrum, and also can decrease the pressure of perineum and genital. Further, it can decrease the happening of low back pain and increase the comfort of riding (Moshe Salai et al, 1999). However, to the motion of pelvic cavity the finding is the largest angle occurs when tread pedal pelvis internal and external rotation induce (Julie L. Sauer, James J. Potter, Christine L. Weisshaar, Heidi-Lynn Ploeg, ＆ Darryl G. Thelen, 2007). At this time, if the seat is too high or to low, it probably may cause the effect of pelvic stability. However, the past research found when comparing the low handle position and the high handle position, the subjects present 77％ larger pelvic anterior tilt angle and 11％ larger trunk flexion angle(Eadric Bressel ＆ Bradj, Larson, 2003). Therefore, if fixing the handle position and changing the seat positions, maybe we can find out perfect riding positions. However, in the aspect of exercise injury, it finds out that over riding exercise bikes will result in knee and hip injury and it also has the closely relationship among the size of bikes, seat positions and the handle distance (Tony Wanich, et al, 2007).

The research of riding excise bikes to EMG and HR areas, in 2007, Hu-Han Wang, Chun-Chung Chou and Hsin-Fu Lin test the largest VO2 and lower extremity EMG by using exercise bike with different upper extremity handle and different riding positions, they found that using upright position can get the higher VO2 value. However, because of only measuring vastus lateralis(VL) EMG cannot totally explain when under road handlebar riding, the activated situation of other legs. In 2002, Edmund R.Burke pointed out that the period of riding exercise bikes major muscle group of legs,such as vastus lateralis (VL), gastrocnemius (GS), biceps femoris (BF) and tibialis anterior (TA) are the easiest muscle of occurring in EMG measurement. Perry et al. (2001) used EMG, HR and RPE to the relative research of exercise bike. The finding showed that when the values of EMG, HR and RPE are being standard, the increase of work load has the liner relationship to EMG signal estimate, HR and RPE. However, this experiment did not discuss the different seat positions but focused on the output changes of power. Further the previous research almost used no inertia system fix exercise bikes to do outdoor riding experiment analysis, but this is not often seen in the relative research of indoor inertia system exercise bikes.

This research will discuss the difference of legs EMG signals, HR, RPE and low back pain responses when changing the seat height of exercise bikes. There are three purpose of this research. First of all, to analyze the differences of EMG total estimate and individual activated to legs VL, GS, BF and TA under different riding model and different seat position change. Next, to analyze the differences of HR and RPE under different riding model and different seat position change. Finally, to analyze the differences of low back pain responses under different riding model and different seat position change.

2. RESEARCH METHOD

2-1. Research Design

This research collect data of lower extremity EMG signals, HR, RPE and low back pain responses by random sampling five different positions riding exercise bike.

2-2. Research Subjects

Sixteen healthy male gradates (average age 22.73±2.84, average weight 67±8.68kg and average height 171.43±5.74cm)。

2-3. Research Equipments

This research uses the Giant Tempoe exercise bike and the standard seat for experiment equipments. This research tests five different seat positions in order by 60RPM riding three minutes. Seat positions are 1. Standard seat position, 2. Seat forward three cm, 3. Seat backward three cm, 4. Seat downward five cm, 5. Seat upward five cm (Fig. 1).

Because the structure of the exercise bike, it results the limit of seat position in moving distance. Therefore, the moving forward and backward distance of seat is two cm less than the moving up and down distance of seat. The exercise data choosing and analyzing styles record left VL, BF, TA, GS use EMG, HR and VAS when subjects ride the exercise bike. In the aspect of the EMG choosing area, we use BioPac MP150 and ACQ KnowledgeVersion3.8.1. Its setting amplification factor is 1000 times, choosing frequency is 1000Hz and it is through band pass 10-500HZ miscellaneous signal process to analyze EMG signal by integral handle style. In the area of HR, we use POLAR S725X watch to record the HR changes when riding and resting. POLAR S725X HR chart is HR measurement equipment specialized to the exercise bike.

Its main function can record the HR changes and mileage when riding and also can do analyses by using infrared rays transmits data to the computer. Because the HR will increase when the exercise time increases and the HR changes of exercise and the recovery of HR after exercise have a close relationship, trainers can use HR controlling method to monitor the physical reaction when doing exercise and is not affected by exercise participating styles and the equipment choosing.(Wang, S.C, 2008). In the area of RPE, using 0-10 Borg (Rating of Perceived Exertion) scale (Gunnar A. V. Borg, 1982) to analyze when subjects finish each riding, recording the differences of subjects RPE feeling. Low back pain index analysis is to use 0-10 VAS score (Visual Analogue Scale for low back pain feeling) to record low back pain of subjects after each riding.

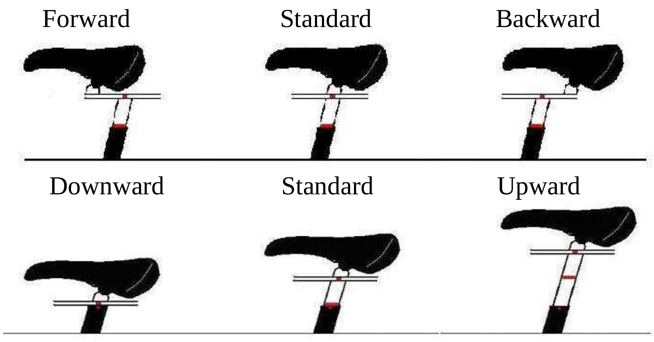

Fig. 1. Five different seat positions.

3. PROTOCAL DESIGN

Before starting the experiment, all subjects must fill in the letters of consent. Measuring individual standard seat height and seat distance by using The Greg LeMond Method. Next, fasten POLAR HR sensor belt to the breast of subjects and let them to rest three minutes to measure resting HR. Then paste EMG sensor to legs and collect MVC data of left lower extremity VL, BF, TA, GS. After that, let subjects warm up by riding the exercise bike three minutes without resistance. After warming up, let subjects start to stamp three minutes and 60RPM on five different seat positions. On the design of riding rotational speed, it follows the suggestion of Wu, Y.D.(2008). In the exercising model of exercise bikes, 50-60RPM can provide effective exercise speed. This experiment also consider the long time in five different riding seat positions easily resulting in the tiredness problem, so removing the resistance and using lower exercise strength to do the considering factor of riding rotational speed in this experiment. Over the process, using EMG to monitor lower extremity muscle activity of subjects and using POLAR watch to measure HR variability of subjects. Besides, in the process of riding, using RPE to let examiners understand whether RPE and HR are consistent. The test is five times. Collecting one subject data can be finished about one hour.

4. DATA ANALYSIS

In the aspect of EMG analysis using ACQ Knowledge Version 3.8.1 setting amplification factor is 1000 times and selecting the more stable EMG signal when riding between the first minute to the second minute. At the same time, setting sampling frequency is 1000Hz, and after band pass 10-500HZ processing EMG signal uses integral process to analyze EMG signal estimate. In the aspect of HR and RPE, select the more stable HR and RPR data to analyze when riding between the first minute to the second minute. In the aspect to VAS, recording subjects back pain feeling to analyze after each riding.

5. RESULTS AND DISCUSSION

The data of experiment shows that the total legs MEMG of EMG totals estimate when the seat turns up lower extremity is larger (Fig. 2.). Stamping position will be uncomfortable when the seat is upward. The reason is when the seat is upward, in the posture of tread pedal in order to maintain the stability of trunk and pelvis must do bigger internal and external rotation motion. These also make lower extremity anterior and posterior muscle must bear the body weight and have the relationship with motion control when doing exercise. Take individual activated estimate lower extremity four muscle VL, BF ,TA ,GS in five different seat riding positions(Fig. 3.) for example. GS activated estimate is the largest under five different seat position changes, especially when the seat turns upward GS is apparently larger than other three muscles. This has relationship with inertia effect because under no resistance circumstance, riding inertia will drive the pedal rotating. However, because subjects want to control the riding speed in 60rpm, this induces GS contraction to control the pedal rotation speed when stamping. When the seat position is higher, in order to maintain the body stability, subjects contraction GS induce stand on tiptoe to complement the need of stability when riding.

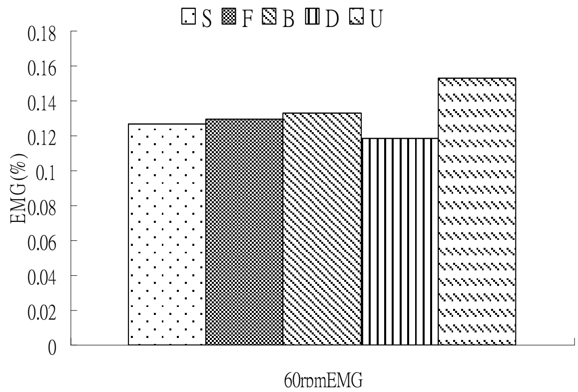

Fig. 2. Different riding positions lower extremity EMG perform (S-Standard seat position, F-forward, B-backward, D-downward, U-upward).

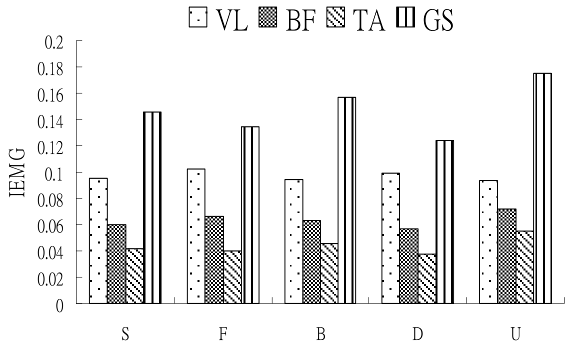

Fig.3. Four muscle group in different riding positionsEMG performs (VL-vastus lateralis, BF-bicepsfemoris, TA-tibialis anterior, GS-gastrocnemius).

Table.1. Different riding positions HR, RPE and VAS results

Positions	**S**	**F**	**B**	**D**	**U**
HR(dpm)	92.355	92.68	92.91	91.30	96.44
RPE	1	0.75	0.812	0.875	1.093
VAS	0.375	0.1875	0.3125	0.375	0.4375

Table 1 shows the difference of HR, RPE and VAS in different riding seat positions. When the seat position is upward, HR and RPE is higher. It should have the relationship with increasing strength of grasp handlebar to maintain body stability when the riding center of gravity position is higher. Besides, legs also use more strength to control the stamping motion in order to maintain trunk stability. These make cardiovascular loading increase and further induce higher HR and RPE and this is consistent with previous research results of Eadric Bressel, et. al.(2008) about the effect of riding position stability and handlebar pressure. In the aspect of VAS shows that when the seat position is upward, induce of low back pain is higher than other seat positions. This probably has the relationship with the ache resulting from low back muscle over stretch when the seat position is upward; it results in the changes of low back flexion angle.

6. CONCLUSION AND SUGGESTION

In the point of sports injury prevention, when the riding seat position is upward, the legs muscles use is bigger. If riding in a long time or not warning up well, it will result in Achilles tendon tendinitis and muscle ache. At the same time, when the seat position is higher, it also will result in higher HR and higher low back pain responses. It probably result from back flexion increase and riding instability, so it has apparent effects on induce lower extremity muscle strength, HR and low back pain when the riding seat positions change. If under longer riding time or more resistance loading it will result in sports injury. In the point of sports training, this research fins that legs EMG signal estimate will become bigger when the riding seat position is upward. If we want to get particular muscle group stretch and reach better strength when the seat position is upward, it can induce more EMG signal estimate。Besides, in the aspect of HR different changes of positions have different HR. In the future, it also can use in the cardiopulmonary endurance advancement to elders and cardiovascular diseases patient.

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