A COMPARISON OF LOWER EXTREMITY MUSCLE ACTIVITY DURING EXERCISE ON A CYCLE ERGOMETER AND RECUMBENT STEPPER

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INTRODUCTION

Adults are encouraged to participate in aerobic activities that involve large muscle groups and are rhythmic in nature. Cycling and stair climbing are both activities that fit this recommendation and have been shown to enhance overall fitness and health. Further, cycling and stepping are currently prescribed during lower extremity orthopedic rehabilitation. These activities also help to reduce the risk of secondary injury because they reduce anterior shear forces in the knee due to their closed kinetic chain nature. Closed kinetic chain exercises are regularly used after ACL reconstruction surgery because they result in less strain on the ACL than open kinetic chain exercises like traditional knee extensions (Morrissey et al., 2000). Thus, bicycle ergometers are commonly used for rehabilitation after knee joint surgery. A recumbent stepper may provide the same exercise and safety benefits because it permits the user to perform a rhythmic closed kinetic chain exercise in a seated position.

Muscle activation is an important aspect of exercise and rehabilitation and can be quantified using electromyography (EMG). Following knee surgery proper lower extremity function is dependent on sufficient muscular activity and recruitment. Ergometer cycling has been shown to be an effective exercise for rehabilitating the thigh musculature. The high muscular activation and low knee joint loading associated with cycling exercise makes it an effective modality for successful rehabilitation. Since recumbent stepping has been shown to improve aerobic capacity and upper and lower body strength (Hass et al., 2001), one could hypothesize that it is also well suited for rehabilitation of the lower extremities. Apparently, the stepping activity requires a significant amount of muscle activation in the legs, but the extent of this activation has not been studied. The purpose of this study was to evaluate the muscular effort of a recumbent stepper compared to a traditional stationary cycle, using EMG. In addition, the influence of seat position was examined.

PROCEDURES

Ten male volunteers (age: 21.6 ± 1.9 y; height: 1.76 ± 0.05 m; mass: 74.1 ± 12.4 kg) with no history of lower extremity disorder or musculoskeletal trauma participated. To assess the myoelectric activity of selected lower extremity muscles, six pairs of surface electrodes were attached to the right side of the body over the following muscles: vastus lateralis (VL), vastus medialis (VM), rectus femoris (RF), biceps femoris (BF), medial gastrocnemius (MG), and soleus (SL). To obtain knee flexion angle (KFA), two 60 Hz video cameras were used to determine the 3D locations of the hip, knee, and ankle joints. Seat position was defined by the maximum knee flexion angle during exercise. Four seat positions (KFA = 0°, 15°, 30°, and 45°) were used and two trials were conducted at a stepping rate of 80
steps/min for each seat position and each exercise device. A metronome was used to control the stepping rate. Each subject was asked to exercise with a load that was perceived as "moderately heavy" for 30 s in each trial with a 1-min rest between trials. The order for the seat locations and exercise device was assigned randomly. A Peak Motus system and MESPEC 4000 8-channel radio telemetry EMG unit sampling at 900 Hz were used to collect EMG data during each trial.

Normalized average EMG data (expressed as %MVIC) were analyzed using separate two-way ANOVAs (2:device x 4:KFA) with repeated measures for each muscle during both the knee extension phase and the knee flexion phase ($\alpha=0.05$).

RESULTS AND DISCUSSION

Several significant differences were detected during the extension phase. Increased muscle activation was observed in the thigh muscles (VL, VM, RF, BF) for the stationary bike compared to the recumbent stepper ($P<0.05$) (Figure 1). Muscle activation also varied with seat position for the VL and VM ($P<0.05$). More specifically, muscle activity increased with greater KFA.

For similar workloads, as measured with self-reported ratings of perceived exertion, stationary cycling requires greater muscular effort than recumbent stepping. In order to achieve comparable fitness improvements during rehabilitation, higher workloads should be used while recumbent stepping.

SUMMARY

Stationary cycles are commonly used during lower extremity rehabilitation. Recumbent steppers may be another effective device for rehabilitation although increased workloads may be necessary to achieve improvements in muscular fitness.

REFERENCES

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Figure 1. Average EMG values during the knee extension phase (VL=vastus lateralis, VM=vastus medialis, RF=rectus femoris, MG=medial gastrocnemius, SL=soleus). Significant differences (*$P<0.05$) exist between the cycle and stepper for the thigh muscles.