

ELECTROMYOGRAPHIC COMPARISON OF UPHILL WHEELCHAIR PROPULSION BETWEEN YOUNG MALES AND FEMALES

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INTRODUCTION

Wheelchair users may encounter a great variety of ramp slopes in everyday activities, necessitating the need to study the demands imposed on the body by various ramp angles. Very few studies have been conducted to examine muscle function during uphill wheelchair propulsion. Also, no attempt has been made to compare the electromyographic (EMG) characteristics of uphill stroking between males and females. To fill the void, the purpose of this study was to compare the EMG levels during wheelchair propulsion over ramps of different slopes exhibited by young males and females.

METHODS

Subjects. Nine male (age 21.1 ± 3.8 yrs) and five female (21.4 ± 3.3 yrs) wheelchair users of different functional levels with no history of persistent joint disorder or musculoskeletal trauma in their upper extremities served as the subjects.

Ramp. A wooden ramp [7.3 m (24') long and 1.1 m (3.5') wide] of adjustable slopes – 0° to 10° at intervals of 2° – was constructed (Figure 1). Because of the crank and pulley systems, the slope of the ramp can be adjusted in a very short time with minimum

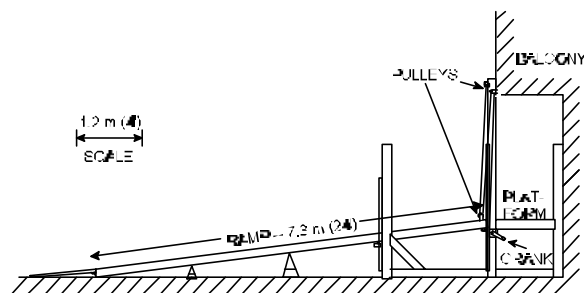


Figure 1. Side view of a wooden ramp.

effort.

Trials. Using his/her own wheelchair, each subject pushed up the ramp two times for each slope condition at a self-selected normal speed. The sagittal view (right-hand side) of the stroking movement was recorded by a S-VHS camcorder (60Hz).

EMG. Six pairs of surface electrodes with on-site preamplification circuitry (Liberty Technology MYO115) were attached to the right side of the body to monitor the extensor carpi radialis (EC), triceps brachii (TB), antero-middle (AMD) and postero-middle deltoids (PMD), pectoralis major (PM), and latissimus dorsi (LD). To obtain maximum EMG levels of the selected muscles/muscle groups, maximum effort isometric wrist flexion extension, elbow extension, shoulder flexion, extension, horizontal adduction, and elevation was performed before the experimental trials.

The EMG signals were stored in a small battery operated data logger (Tattletale Mode 8) attached to the chair and downloaded to a computer hard disk at the end of each trial. The sampling rate and duration were set at 1,000 Hz and 5s, respectively. In order to synchronize the EMG and corresponding video recordings, a large light-emitting diode (LED) was attached to the floor and was visible to the camera view. The LED became active automatically at the beginning of the 5-s EMG data recording period.

Data Reduction. The video recordings were used to identify the instants of initial contact, release, and second contact. For the purpose of this study a stroke cycle starts at the instant of hand contact (the beginning of the push phase) and ends at the instant immediately before the next hand contact. A stroke cycle

consists of two phases – *push* and *recovery phases*. The push phase starts at the instant of hand contact and ends at the instant the hand loses contact with the rim. The recovery phase is the period from the end of contact phase to the instant of initial contact.

The raw EMG signals were band pass filtered at a cutoff frequency range of 10 - 1,000 Hz and full-wave rectified. The processed signals were normalized to the maximum EMG levels observed during the isometric trials. One stroke cycle when the subject was in the mid-section of the ramp was selected from each trial for analysis. The average profile over two stroke cycles (one from each trial) was obtained. For each subject, the peak EMG value (expressed as % maximum) and the average EMG over the two phases of the stroke cycle, was determined for each muscle/muscle group.

Statistical Analysis. For each average/peak EMG measure, means and standard deviations were computed for the males and females for each slope condition. A one-way ANOVA was conducted to test for significant difference between the two genders for each EMG measure ($p < 0.05$).

RESULTS AND DISCUSSION

As expected, the EMG levels increased with increasing slope. In general, the TB, AMD, and PM were more active during the push phase while the PMD was more active during the recovery phase. Both EC and LD were equally active in both the push and recovery.

Significant differences in mean EMG activity between males and females were found in the LD during the push phase (Fig. 2) and PM during recovery phase (Fig. 3), as well the peak activity during the push phase in the AMD and LD (Fig. 5) and the recovery phase in the PM (Fig. 6). The female subjects in general had greater levels of muscle activation for each muscle group.

The results indicate that while there is little difference in the muscle activation pattern between men and women during uphill stroking, women in general use a greater

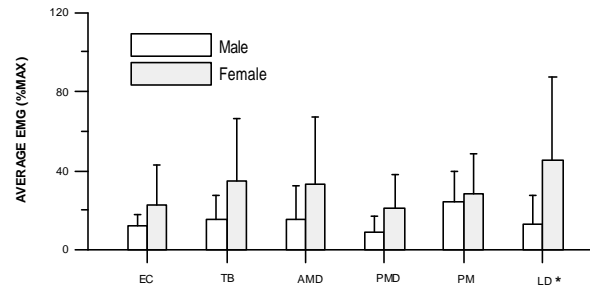


Figure 2. Average Muscle Activity during the Push Phase

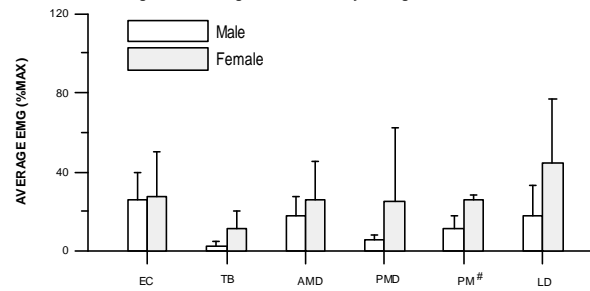


Figure 3. Average Muscle Activity during the Recovery Phase

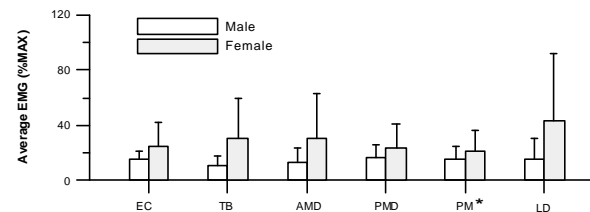


Figure 4. Average Muscle Activity during the Stroke Phase

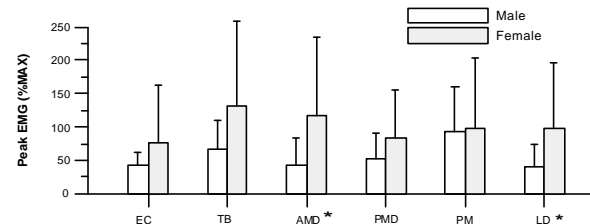


Figure 5. Peak Muscle Activity during the Push Phase

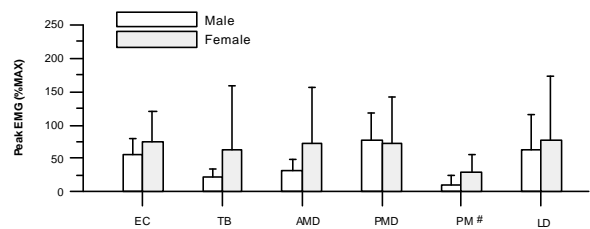


Figure 6. Peak Muscle Activity during the Recovery Phase

percentage of their maximum strength to accomplish the same task as compared to the male subjects.

ACKNOWLEDGMENT

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