CHANGES IN HAND RIM WHEELCHAIR PROPULSION TECHNIQUE AND MECHANICAL EFFICIENCY AFTER A 3-WEEK PRACTICE PERIOD

S. de Groot[1], L.H.V. van der Woude[1], H.E.J. Veeger[1,2]

[1] The Institute of Fundamental and Clinical Human Movement Sciences (IFKB), Vrije Universiteit, Amsterdam, Netherlands
[2] Man-Machine Systems and Control Group, Delft University of Technology, Delft, Netherlands
E-mail: s.de.groot@fbw.vu.nl Web: www.ifkb.nl

INTRODUCTION

In rehabilitation, recently injured individuals have to learn a new motor task, e.g. propelling a wheelchair. According to Sparrow (1983), motor performance of novices is relatively inefficient even though they may perform at a rate optimal to their stage of learning. With practice, the movement pattern will be refined to approximate more closely that which is biomechanically and physiologically optimal within the constraints of the task. It is hypothesized that improved mechanical efficiency (ME) as a consequence of task proficiency is closely linked with improved propulsion technique. Therefore, the purpose of this experiment was to study changes in propulsion technique and gross ME during a 3-week wheelchair-practice period.

METHODS

Twenty able-bodied subjects were randomly divided over one experimental group (EXP, n = 10) and one control group (C, n = 10). EXP received a 3-week wheelchair-practice period ($3 \cdot wk^{-1}$, i.e. 9 trials) on a computer-controlled wheelchair ergometer, while C only participated in trial 1 and 9. Every trial comprised of two four-minute exercise blocks at two different levels of external power output (block 1: $0.15\ W \cdot kg^{-1}$ and block 2: $0.25\ W \cdot kg^{-1}$) at a velocity of $1.11\ m \cdot s^{-1}$, with two minutes of rest before each exercise block. Force application, bilateral symmetry, inter-cycle variability, timing and gross ME were determined on all 9 trials during the last minute of an exercise block.

RESULTS AND DISCUSSION

Gross ME increased over the trials in EXP compared to C (Table 1). This increase could theoretically *not* be due to a training effect because the exercise blocks were at a too low intensity and of a too short duration. Increased efficiency and thus task proficiency was only expressed in a limited set of propulsion technique parameters. No significant differences between the groups over time were found for the effective force application (FEF) (Table 1), bilateral symmetry and inter-cycle variability. It may be suggested that these variables change more rapidly – i.e. in the first minutes - or on a much longer time span than 3 weeks. The push frequency (f) and the negative deflection in the power output curve at the start of the push phase (PnegS; Fig.1) diminished significantly while the work per cycle (Wcycle), push time (PT) and cycle time (CT) increased significantly over time in EXP in contrast to C (Table 1). This was also found in a previous training study (Woude et al., 1999). Changes in the timing variables (f, PT, CT and subsequently Wcycle) indicate a change in segment excursions and velocities, next to changes in muscle contraction characteristics. This may have led to the increase in gross ME.

SUMMARY

A 3-week wheelchair-practice period had a

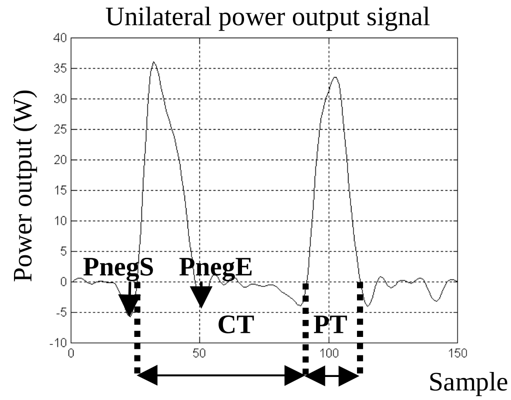

Figure 1. Definition of variables.

favorable effect on timing parameters, work per push and gross ME, indicating a possible effect of the timing parameters on ME.

Although no changes in force application parameters, bilateral symmetry and inter-cycle variability occurred during the wheelchair-practice period, these variables may optimize in the initial minutes of practice or on a (much) longer time scale than 3 weeks.

REFERENCES

Sparrow, W.A. (1983). *J. Motor Behavior*, **15(3)**, 237-61.

Woude, L.H.V. van der, et al. (1999). *Med.Sc.Sp.Exerc.*, **31(2)**, 331-41

Table 1. Change over time of the measured variables (mean). * significant at $p < 0.05$

	Trial	**PnegS (W) ***	**PnegE (W)**	**FEFmax (%)**	**f (pushes / min) ***	**PT (s) ***	**CT (s) ***	**Wcycle (J) ***	**ME (%) ***
EXP	1	-5.64	-1.95	80.03	62.83	0.37	0.99	0.38	7.45
	9	-2.93	-1.26	83.93	46.35	0.45	1.40	0.54	8.11
C	1	-4.41	-2.56	80.84	63.52	0.35	1.00	0.39	7.37
	9	-4.01	-2.08	82.64	60.20	0.36	1.08	0.41	7.23