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Abstract

Optimization of hand spacing in submaximal hand cycling: a case study

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1. Background

As the medio-lateral distance between the feet in cycling, the distance between the hands in hand cycling has received little attention in scientific literature. However, Krämer et al. (2009) recommend a crank width (i.e. distance from the centres of both handles) equivalent to 85% of the inter-acromion distance (IAD) for sprint performance. Our objective was to determine optimal crank width in submaximal condition in a high-level paraplegic cyclist (44 years old, 1.75 m, 74 kg), victim of a paralysis following a compression of the D4-D5 vertebrae.

2. Methods

During a first visit in the laboratory, the participant performed an incremental test to measure the maximal aerobic power (MAP) with his usual crank width (90% of the IAD). This cyclist previously used a crank width equal to 72% of the IAD but he had recently chosen to modify this parameter due to muscle pain. One week after the incremental test, he performed 3 tests of 8 min at 50% of MAP and at the same freely chosen pedalling cadence with three different crank widths: (1) 80% [narrow], (2) 85% [medium] and (3) 90% [wide] of the IAD. These experimental tests were separated by 18 min: 4 min of recovery at 30% of MAP, 10 min of break to change crank width and 4 min of restart at 30% of MAP (free pedalling cadence). The tests were performed on the participant's personal handbike positioned on a standard ergometer (Elite, Fontaniva, Italy). Crank power output (PO) was measured with a valid power meter (SRM, Jülich, Welldorf, Germany). During each test, Gross efficiency (GE; Cortex Biophysik GmbH, Leipzig, Germany), muscle activity of Trapezius Superior, Triceps Brachii, Biceps Brachii, Deltoideus Anterior, Deltoideus Posterior and Pectoralis Major of both upper limbs, which are particularly recruited in hand cycling (Arnet et al. 2012), (Delsys Trigno™ Wireless EMG, Delsys Inc., Boston, USA) and rating of perceived comfort (Millour et al. 2019) and RPE (Borg, 1982) were measured. Muscle activity was averaged for the 2 sides of the body, quantified by the root-mean-square (RMS) of the EMG signal and expressed as a percentage of the average RMS values measured during the test performed with the narrow crank width.

3. Results

Results showed constant PO and cadence for all tests (78.3 ± 0.2 W and 73.3 ± 0.7 rpm). However, GE was better with the medium crank width compared to the narrow and the wide crank widths (18.5% vs. 17.8% and 17.4%, respectively). Despite these physiological changes, RPE was equal to 10/20 for all tests and was therefore not altered by the change in crank width. On the other hand, the wider crank width led to comfort improvement (7/10, 8/10, 9/10 with the narrow, medium and wide crank widths, respectively). In addition, muscle activity (table 1) decreased for all muscles (except the Pectoralis Major) when the crank width increased.

4. Conclusions

Results showed an improvement in biomechanical and subjective variables when the participant pedaled with a crank width equivalent to 90% of the IAD. Nevertheless, GE was better with the medium crank width. Krämer et al. (2009) reported that a crank width equal to 85% of the IAD would be optimal for supra-maximal performance. Our results suggest that this crank width would also be suitable for sub-maximal performance. However, the increased recruitment of the majority of the upper limb muscles with the narrower crank widths could explain the muscular fatigue previously reported by the participant when he used a crank width equal to 72% of the IAD. We can therefore advise this cyclist to use the medium crank width (85% of the IAD) to improve performance or a slightly larger crank width if he feels discomfort or muscle pain.

5. Acknowledgements

Morphologics Company.

Keywords: Paraplegia; Gross efficiency; Muscle activity; Perceived comfort; Perceived exertion.

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Table 1. Activity of 6 muscles recruited in hand cycling (average of the right and left body side) expressed as a percentage of the average RMS values measured during the test with the narrow crank width.

	Trapezius (%)	**Triceps (%)**	**Biceps (%)**	**Deltoideus Anterior (%)**	**Deltoideus Posterior (%)**	**Pectoralis Major (%)**
Narrow	100	100	100	100	100	100
Medium	93	94	94	93	94	99
Wide	83	89	90	91	89	101