SplitCranks: concept and experimental development of a device for independent control of pedaling movements and forces

Kunzler, Marcos R.[1,2], Carpes, Felipe P.[1,2]
[1]Applied Neuromechanics Research Group, Federal University of Pampa, Uruguaiana, RS, Brazil
[2]Laboratory of Neuromechanics, Federal University of Pampa, Uruguaiana, RS, Brazil
Email: marcoskunzler@unipampa.edu.br

Summary

This study describes the concept and experimental development of the SplitCranks. SplitCranks is based in mechanisms commonly used in electrical cycle ergometers and built to allow independent control of mechanical loads between the lower limbs during pedaling. By showcasing our device to the biomechanics community, we are confident to expand the possibilities for research in biomechanics of cycling and receive valuable feedback from potential users.

Introduction

Knowledge of the lower limbs dynamics during cycling, including asymmetries and variability in the power output and pedal forces, is essential for sports training and rehabilitation. However, these parameters are difficult to assess and control. Unlike the observed in walking and running studies using split-belt treadmills [1], or equipment designed for cyclic movements particularly for individuals living with movement disorders [2], no cycle ergometer currently allows independent unilateral control of movement and workload between the legs during bilateral pedaling. In this study, we present for the first time the concept and experimental development of a device that enables independent unilateral control of workload during bilateral pedaling (SplitCranks, patent pending 23100.022275/2024-57).

Methods

SplitCrank was inspired by split-belt treadmills, which enable independent speed control between the legs during locomotion. We designed the SplitCranks system with independent cranks, each mechanically connected to its own electromagnetic resistance system, which is controlled separately by electronic microprocessors and software, all operated via computer. To achieve this configuration, we examined existing crank decoupling equipment [3] and developed a split and adapted bottom bracket to allow free and independent movement of each crank. In our first prototype, the mechanism's shape, position, and attachment were based on a traditional cycle ergometer used for cycling training. To regulate the workload intensity for each leg, we implemented electromagnetic resistance and commercial software. SplitCranks provides real-time control and visualization of mechanical load, power output, and cadence. Pilot testing confirmed that participants could comfortably adapt to the system while data were recorded.

Results and Discussion

SplitCranks allowed for the individualization of the mechanical load on each decoupled cranks during bilateral pedaling. Using our prototype (Fig. 1) in tests with volunteers wearing cycling shoes, we were able to properly adjust body positioning on the bike and record unilateral power output and pedaling cadence during bilateral cycling.

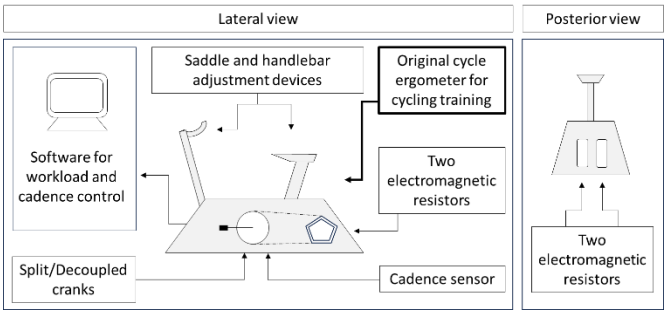

Figure 1: Schematic illustration of the SplitCranks.

Conclusions

SplitCranks enables unilateral control and workload manipulation during bilateral pedaling. This device has the potential to support research on novel cycling training and rehabilitation methods in biomechanics, kinesiology, motor control, and related fields.
As a technological innovation, we are currently in the process of patenting it with the National Institute of Industrial Property (INPI) [4] in Brazil.

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