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Bicycle Device Innovation: A Process for Instrumenting a Stationary Cycle Ergometer for the Purpose of Backward Pedaling

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Abstract- Interest in backward pedaling (BP) on a stationary seated cycle is gaining interest for the purpose of mode of travel, exercise, rehabilitation, and aerobic/anaerobic testing. A method and process are described for the conversion of a forward pedaling (FP) stationary cycle ergometer to that which permits loaded stationary BP exercise. The method for deconstructing the FP stationary exercise cycle is described. Likewise, the method for installing the loading instruments allowing BP loaded stationary cycling are described. This non-complex and straightforward set of instructions can be carried out with limited tools and mechanical experience. Given that previously owned stationary cycles can be readily acquired at affordable prices, the methods and process described in this paper may provide a low-cost solution for those looking to implement BP cycling for the purpose of exercise, rehabilitation, and aerobic/anaerobic testing.

Keywords- *Reverse, Stationary Cycling, Rehabilitation, Exercise*

I. Introduction

People engage in cycling for the purposes of commuting, as an exercise modality, for recreation, and as a form of athletic competition [1, 2]. Others perform stationary cycling as a form of exercise [2], as a rehabilitative modality [3, 4, 5], and as means for assessing aerobic/anaerobic fitness [6, 7]. The aforementioned applications of kinetic and stationary cycling are traditionally performed with a forward pedaling (FP) motion of the feet engaged with the cycle pedals (and does not include recumbent cycling).

Other forms of stationary cycling are now gathering interest with regards to rehabilitation of the cardiovascular system [8] as well as musculoskeletal conditions of the lower limbs [3]. Chasland et al. [8] postulated evidence supporting the use of eccentric cycling (EC) as a promising modality for patients with chronic heart failure. Neptune & Kautz [3] provide evidence that reverse or backward pedaling (BP) may have benefits with regards to rehabilitation of the lower limbs. Others have also examined the potential benefits of BP with regards to joint loading, muscle activation, and metabolism [3, 9, 10]. While oxygen consumption was similar between FP and BP, muscle activation patterns and knee joint loading was found to be different between FP and BP [3, 9, 10]. With regards to knee joint loading Neptune & Kautz [3] observed increased patellofemoral compressive loads and decreased tibiofemoral compressive loads while BP in a mathematical simulation of knee joint loading comparing FP to BP.

A number of inventors have filed patents that provide designs for BP kinetic and stationary cycles [11-14]. However, for most individuals, assembling a device (a BP cycle in this case) based upon a schematic drawing/design to becoming a physical functioning device is rather impractical. As such, it appears as though a cost effective means of acquiring a cycle for the purpose of BP merits consideration.

Hence, the purpose of this paper was to describe a non-complex, cost effective method and process for the conversion of a FP stationary bike to that which permits BP loaded stationary exercise.

II. Methods And Materials

The FP stationary cycle that was modified to allow BP is the Monark cycle ergometer model 817E (Monark Exercise AB, Vansbro, Sweden) (Fig. 1). The tools needed for the cycle retrofit included standard crescent wrenches, hacksaw, and a file (Fig. 2).

The pedaling load is controlled by turning a tension knob that changes the length of a tension spring. The tension spring is interfaced to a friction belt that is seated on the perimeter of the flywheel. As the spring is lengthened, tension increases as does friction on the flywheel (i.e. pedaling load is increases).

Figure 1. Monark model 817E (Monark Exercise AB, Vansbro, Sweden)

Figure 2. Retrofitting tools: hacksaw, file and crescent wrench

Figure 3. Close-up of the pendulum assembly

Figure 4. Front view of pendulum stop removal by hacksaw

Figure 5. Front view of pendulum stop removed

During FP the pendulum swings back towards the rider and the load can be determined by viewing the pendulum reader. In order to allow the pendulum to swing forwards during BP, the pendulum stop was cutoff with a hacksaw and filed to remove any metal burs (Fig. 4-5). Once the pendulum stop was removed the pendulum reader was repositioned by loosening the bolt that secured the pendulum reader (Fig. 6). Once the bolt was loosened, the pendulum reader was rotated to a forward position as shown in Fig. 7 and the bolt was then re-tightened, securing the pendulum reader in the forward position. This allows the device to be calibrated for assessing power output during BP which is advantageous for exercise and research purposes.

When the bike was pedaled in reverse (BP), the pendulum would then swing in the reverse direction (away from the rider) and the pendulum reader is then be used to measure the resistance (load).

Figure 6. Loosen bolt to shift pendulum reader

Figure 7. Pendulum positioned to allow backward pedaling

Figure 8. Pedaling backwards will cause the pendulum to swing forward where by the load can be assessed by viewing the pendulum reader

III. Results

The modified Monarch stationary cycle for the purpose of BP provides the following:

- A non-complex method and process for converting a FP load bearing stationary cycle to that of a BP load bearing stationary cycle,
- An economical solution for those looking to implement BP cycling for the purpose of exercise, rehabilitation and aerobic/anaerobic assessment, and
- A method and process that allows for the conversion of a load bearing stationary cycle that requires only common household tools with negligible mechanical aptitude/skills.

IV. Discussion

The goal of this article was to provide a non-complex, cost effective method and process for the conversion of a FP stationary bike to that which allows BP loaded stationary exercise and we believe all aspects of this goal were achieved.

The stationary cycle used for this demonstration was previously owned and acquired for a fraction of the cost of a new “state-of-the-science” model. A potential reader of this manuscript could certainly find equivalent models on E-commerce sites like eBay.com or Amazon.com. The tools required to modify the stationary cycle are commonly owned and are easily acquired at very affordable rates.

The step by step instructions (including images) provided in the Methods section demonstrate a straightforward replicable process by which virtually any individual with minimal mechanical skills could carry out. Further, should an individual choose not to engage in the retrofit process themselves, it is likely any “handy man” could be employed to complete the retrofit process that would likely take a maximum of 1-2 hours.

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