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Conference Abstract

To shuffle or not to shuffle

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1. Introduction

The impact of a rider shuffling on their saddle is an issue that is often debated within the cycling fraternity. However, there are limited experimental results that support or refute the commonly held belief that shuffling might adversely affect a rider's aerodynamic drag or power output. Indeed, when shuffling is investigated the primary focus of the research is often optimising rider position from a comfort perspective (Brooke & Broadbent, 2020). From a biomechanical perspective, when a rider moves forward on the saddle their affective saddle height decreases impacting on lower limb kinematics and ultimately reducing cycling efficiency (Ferrer-Roca et al., 2014), pedalling resultant force and force effectiveness (Bini et al., 2011). Therefore, it is hypothesised that cycling power output will be reduced in instances where riders have a high rate of shuffle.

2. Methods

Following institutional ethical approval, we recruited five experienced track riders who were asked to complete a four kilometre cycling time trial on an indoor cycling velodome. Using a novel piece of technology (Body Rocket Ltd, West Sussex, UK) that takes a direct drag force measurement (DFDM), the aerodynamic drag of a rider alone can be measured. The ability to take a DFDM is via the use to 4 sensors on the handlebar saddle and pedals, these sensors isolate the rider from the bike and measure the force on the rider. As a by-product of the DFDM system the weight of the rider and moments on the saddle can be measured, thus leading to the ability to determine the position of a rider on the saddle. The ability to determine the position of the rider on the saddle is simply made by dividing the measured weight by the measured moment and an x offset. In order to validate the rider movement on the saddle and investigate the impact of shuffling, a saddle mounted camera was developed, termed ShuffleCam. The ShuffleCam (see Figure 1) was an inferred camera and motion capture system to act as a visual method to monitor the position of the rider on the saddle and verify the saddle movements of the rider measured by the Body Rocket system. Figure 2 provides an example of data captured from the Body Rocket system and ShuffleCam across a 4km pursuit.

Figure 1. Image of the ShuffleCam as set-up.

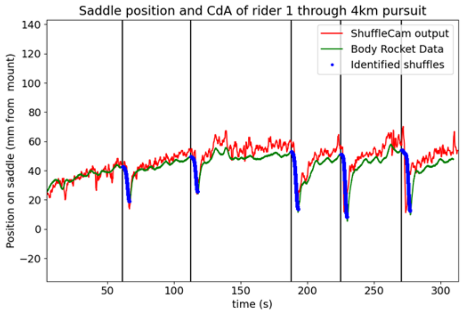

Figure 2. Rider position on the saddle during a 4km pursuit effort illustrating both the Body Rocket loadcell data (green trace) and the ShuffleCam output (red trace) with identified shuffles marked in blue measured as distance moved from the saddle mount.

3.Results

Figure 3. Rider saddle position vs cycling power output from two example riders (plots A & B) during a 4 kilometer cycling time trial. Cycling power output (black), saddle position (red) are plotted against time with identified saddle shuffles illustrated in blue with the period of the shuffle shown by the grey shading.

Our results demonstrate that shuffling occurs during a 4 km time trial effort in trained cyclists who riding in their preferred cycling positions. Figure 3 illustrates data from two example riders.

As can be seen in Figure 3, both riders have different rates of shuffle. Over the course of the time trial, Rider A shuffled a total of 19 times at a rate of 4.8 shuffles per minute. During each of the shuffles the rider's power output decreases with the range being 159.13W. By comparison Rider B has a lower shuffle rate but still experiences a reduction of power output during each shuffle of 0.87W. Interestingly data from Rider C demonstrates only one shuffle during the time trial effort, with, conversely, an increase in power of 5W. Figure 4, shows the level of agreement between the data obtained from the Body Rocket system vs the ShuffleCam over the course of a shuffle. The mean bias between systems was 5.18mm with a lower limit of agreement -2.85mm and upper limit of agreement of 13.21mm.

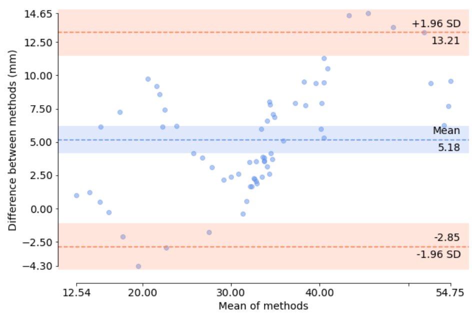

Figure 4. Bland-Altman plot demonstrating limits of agreement in shuffle measurement between ShuffleCam and Body Rocket system.

4.Discussion

The results from this study demonstrate good agreement between data recorded on the ShuffleCam and the Body Rocket system. Our data demonstrated that all participants exhibited saddle shuffles during the 4 kilometre time trial effort, although there were clear between-rider differences in both frequency and magnitude. Moreover, the impact of shuffling on cycling power output appears to be rider dependent, with some riders experiencing larger reductions in power output for the same shuffle magnitude compared to others.

The simultaneous data collected during the 4 kilometre time trial efforts suggest that the Body Rocket System under-estimates saddle movements measured by the ShuffleCam by approximately 5mm. Interestingly the difference between Body Rocket and ShuffleCam measurements tends to increase as the duration of the shuffle increase, so larger magnitude shuffles lead to slightly greater discrepancy between the two systems. The observed differences in recorded shuffle duration between the two systems could be due to the way that they measure saddle movement. The ShuffleCam records the position of spherical markers on the back of the rider whereas the Body Rocket system measures the forces and moments on the saddle it is possible that a slight pelvic tilt changes the centre of mass of the rider on the saddle, and in-turn the recorded position on the saddle.

Our data demonstrate that there were considerably between-rider differences in how their cycling power output was affected by shuffling. Some riders experienced a drop in power by as much as 8.8W over the course of 8 second windows, while others did experience any reduction in power when shuffling. We did not measure kinematic data in order to be able to identify specific mechanisms for this but can speculate on why this might be such as aspects of the bike set-up. Saddle set-back and crank length are factors impact the functional range of the hip flexion, and ultimately influence rider comfort. Discomfort in the time trial position is common because of the constraints that the need to maintain an aerodynamic position has on the rider, and the small contact points between rider and bicycle (i.e. handle bars, saddle and pedals), with the trunk bent forwards to allow the rider to contact each point simultaneously. This tucked position, combined with riding for a prolonged period of time at high power outputs leads to frequent discomfort (Polanco et al., 2017), and likely increases the desire to change posture on the bicycle. Therefore, even though riders in this study utilised their preferred cycling position, discomfort from maintaining the position for a period of time under high levels of physiological stress. Indeed, results from previous studies have suggested that even though more aggressive aerodynamic positions might provide an aerodynamic advantage, it does not necessarily lead to an improvement in cycling performance due to reduced cycling efficiency and power output production capability (Fintelman et al., 2015), as well as leading to adverse effects on the comfort of the rider.

5.References

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