BOOK OF ABSTRACTS **Open Access**

Connection between Heel Motion and Torque in crank revolution

Fukuda, M.[1]✉, Kitawaki, T[2].

Purpose:
In cycling, Torque is made from pedaling. Recently some power meters measure torque in pedaling. Especially Pioneer Power Meter (Pedaling Monitor System - Pioneer Corporation, Tokyo Japan) can measure torque and power in 12 zones in each crank revolution. Using this system, we can easily learn every torque pattern of cyclists are different. Furthermore, we already know ever pedaling of cyclists are different, some of these cyclists have different pedal motion in Left and Right, their L/R balance are different. While in pedaling, forefoot is fixed with cleat, vertical heel motion relative to the pedal angle. From these observations, we can make an assumption that heel motion affects torque. So, this research is carried out in order to find out which heel motion increase torque in a crank revolution.

Methods:
We measured variations of torque and heel motion. Torque variation was measured by Pioneer Power Meter and download data from their data analysis web service “Cyclo-Sphere”. Heel motion is almost equal as foot angle which can be measured with pedal axle to heel angle. Also crank angle can be obtained from the center of crank arm and pedal axle, as shown in Figure 1. These are recorded in 240 fps high speed movie and separated into still pictures. The markers position can be obtained by simple 2D analyses from them.
Since the purpose of this study is to measure torque not power in order to make the measurement of torque easier, we tried to lower the cadence by limiting the rotate crank of cyclists to under 70 rpm on a home trainer.
We divided the crank revolution into 12 zones of 30 degrees. First zone is “0” and last is “11”. We only measure in down stroke which are zone 0 to 6, as shows in Figure 2.

Results & Discussion:
Heel motion of cyclists were analyzed and categorized into three types. Type 1 cyclists go down his heel over the pedal axle while in down stroke, Type 2 cyclists keeps foot angle, Type 3 cyclists move heel up, down and up. Especially torque of zone 1 to 2 in type1 is lower torque than type 2. Type 3 is almost same as type 1. In zone 4 to 6, torque of type 1 and 3 is better than type 2. Pedal motions are confirmed to affect torque variation in a crank revolution. Interestingly, during the measurement, we could see type 1 cyclists locked his foot joint as dorsal flexion like dead lift. Type 2 cyclists use foot joint with natural flexion like deep squat. At top dead center his foot joint is in dorsal flexion and plantar flexion at bottom dead center. In fact, type 2 cyclists can do deep squat on the floor, but type 1 cyclists cannot. Foot angle affects toque variation, but foot angle is related to their particular movement type of whole body.
In the next few month, we’ll increase the number of cyclists we test, and measure extra variation of pedal motion.

Conclusion:
In order to reveal connection between torque and heel motion in crank revolution, torque and foot angle were measured in each divided crank revolution. We found that the following became clear: (1) Heel motions affect torque variation in crank revolution. (2) Particular movement type of each cyclist’s whole body seems to affect heel motion.

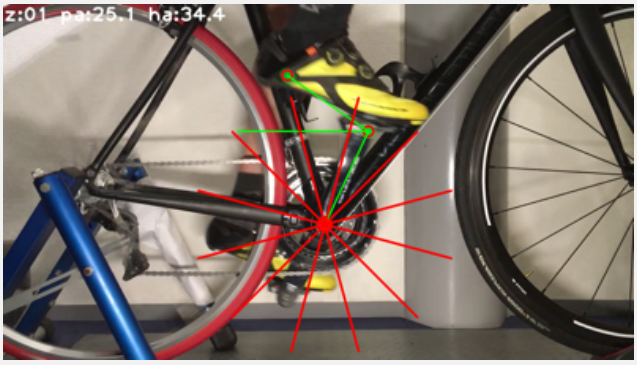

Figure 1. Marker of pedal axle and heel.

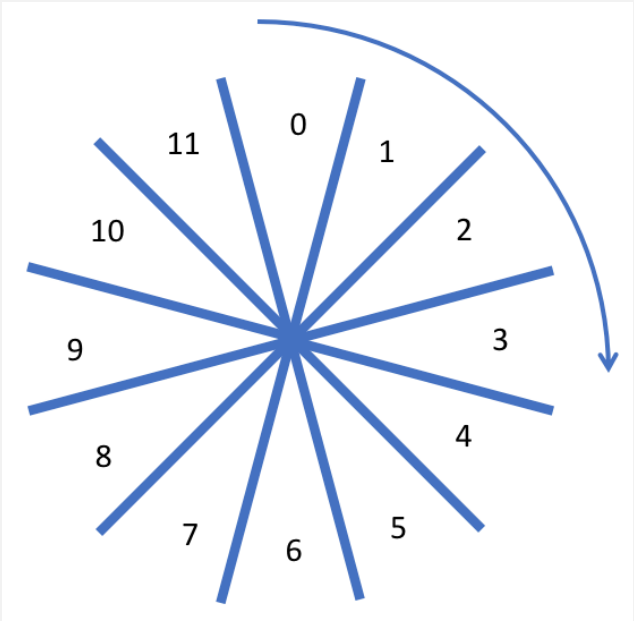

Figure 2. Zones of crank revolution.

Key words: Power Output, Exercise intensity control mechanisms, Performance monitoring, Professional cyclists, Record Power Profile.

✉**Contact email:** info@hamsterspin.com (M Fukuda)

[1] *Hamster Spin Cycling, Tokyo, Japan.*

[2] *Department of Mathematics, Kansai Medical University, Osaka, Japan*