

Journal of Science and Cycling

Breakthroughs in Cycling and Triathlon Sciences



Special number: World Congress of Cycling Science 2015, 1/2 July 2015, Utrecht

Editors: Mikel Zabala (PhD)
Greg Atkinson (PhD)



Science & Cycling
1 & 2 July 2015, Utrecht



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Internal Mechanical Power During Cycling Using Non-Circular Versus Circular Chainrings

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Abstract

Introduction: Non-circular Rotor Q-Rings have been shown to increase tangential force during the pedalling downstroke compared to conventional circular chainrings¹, and due to this advantage, have been proposed as a potential aid in improving short-term cycling performance such as in BMX and sprint cycling races². Some evidence exists that suggests this effect on pedal force may manifest in a change in metabolic cost over repeated revolutions during submaximal, steady-state cycling bouts using Rotor Q-Rings³. One mechanism by which a change in total metabolic cost may occur is via a change in the power required to move the limbs segments against gravitational and inertial forces through the pedal stroke (internal mechanical power, or IP) when compared to using circular chainrings (at the same external mechanical power, EP). Strutzenberger et al.¹ reported an increase in joint muscle power of the hip when Q-Rings were used compared to circular chainrings at 70 and 90 rev · min⁻¹, which could cause an increased IP and result in a greater total metabolic cost. The aim of this study was to further investigate the mechanical and metabolic energetics of using Q-Rings during cycling. Their effect on IP, compared to a conventional circular chainring, was assessed using a recently-proposed, multidisciplinary model for calculating IP in cycling⁴, which accounts for the strengths and limitations of previous biomechanical and physiological approaches. Total metabolic cost was also compared between the two chainrings for cycling over a range of workloads.

Method: Ten elite male road cyclists completed 5-min cycling bouts at 80 rev · min⁻¹ at 100, 200 and 300 W using a standard circular chainring and 52-tooth Q-Ring set in two positions: '#1' and '#5'. Oxygen consumption was converted to metabolic power. Tangential and radial crank forces and crank position were measured using Axis Cranks (SPE, Carole Park, Australia). The x-intercept of the EP-metabolic power relationship, multiplied by the slope (delta efficiency), was equal to the physiological estimate of IP. The biomechanical estimate of IP was taken as the summed muscle joint power, determined from digitised video footage and inverse dynamics analysis, in excess of that required to apply power to the pedals (Giorgi et al. 2014).

Results: Preliminary analysis of data is presented in Table 1. Data are presented as mean ± SD. No significant differences were found between the chainrings for total metabolic power or the physiological estimate of IP.

Discussion: Further analysis will allow the description of changes in potential and rotational kinetic energies and muscle and joint powers throughout the pedal revolution. This information will permit the calculation of the biomechanical estimate of IP and comparisons to be made between chainrings and Q-Ring positions.

References:

1. Strutzenberger et al. (2014). Effect of chainring ovality on joint power during cycling at different workloads and cadences. *Sports Biomech.* 13(2): 97-108.
2. Mateo-March et al. (2014). Does a Non-Circular Chainring Improve Performance in the Bicycle Motocross Cycling Start Sprint? *J Sports Sci Med.* 13(1): 97-104.
3. O'Hara et al. (2012). Effects of Chainring Type (Circular vs. Rotor Q-Ring) on 1km Time Trial Performance Over Six Weeks in Competitive Cyclists and Triathletes. *Int J Sports Sci Eng.* 6(1): 25-40.
4. Giorgi et al. (2014, July). A Range for the "Real" Value of Internal Mechanical Power in Cycling. In A. De Haan, C.J. De Ruiter & E. Tsolakidis. *ECSS Amsterdam 2014 Book of Abstracts*. Paper presented at 19th Annual Congress of the European College of Sport Science, Amsterdam, The Netherlands (pp. 343-344).

Table 1: Mean \pm SD Total Metabolic Power and Physiological Estimate of Internal Mechanical Power (IP) in Elite Cyclists Using Circular and Non-Circular (Q-Ring) Chainrings.

| | Total Metabolic Power (W) | | | Physiological Estimate of IP (W) |
|---------------------------|---------------------------|--------------|---------------|----------------------------------|
| | 100 W | 200 W | 300 W | |
| Circular Chainring | 551 \pm 19 | 947 \pm 34 | 1403 \pm 72 | 105 \pm 44 |
| Q-Ring Position 1 | 558 \pm 33 | 962 \pm 60 | 1423 \pm 59 | 94 \pm 34 |
| Q-Ring Position 5 | 559 \pm 29 | 955 \pm 42 | 1427 \pm 61 | 114 \pm 35 |

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