COMBINED EFFECTS OF MOVING FORWARD ON THE SADDLE AND POWER OUTPUT ON JOINT KINEMATICS AND MUSCLE ACTIVATIONS DURING CYCLING

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Introduction:
The cyclist's position changes depending on the power output (PO) and different conditions (wind, slope, event, etc). Thus, some cyclists exhibit forward positioning on the saddle during extended periods of time, especially when requiring high PO. However, moving from neutral to forward position involved an increase of joint forces (Bini et al., 2013) and discomfort (Verma et al., 2016). Discomfort due to improper seat position adjustment can in the long run lead to non-traumatic injuries. Few studies have analyzed the effects of forward positioning on the saddle on muscle activation and joint kinematics. The aim of this study was to quantify the impact of the forward position on muscle recruitment and in the 3D kinematics of the lower limb for various PO.

Protocols:
Seven elite cyclists took part in the study. Each participant performed a cycling protocol on an SRM indoor trainer. The test was composed of four parts alternating neutral and forward positions interrupted by active recovery phases (figure 1).

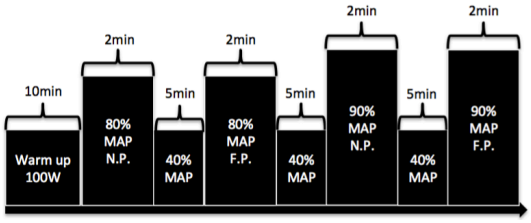

Figure 1: Experimental test, N.P.: Neutral Position, F.P.: Forward Position

Motion capture was performed using twelve optoelectronic Vicon cameras (Oxford Metrics, Inc., Oxford, UK) operating at a nominal frame rate of 100Hz. 3D hip, knee and ankle rotations were calculated according to ISB recommendations (Wu et al., 1995). The Range of Motion (ROM) has been computed and the Center of Mass (COM) position was calculated with the use of the anthopometrical data.
Surface electromyographic (EMG) activity of eight muscles was recorded using wireless Cometa Wave Plus system, at a sampling rate of 1000Hz: *Tibialis Anterior* (TA), *Biceps Femoris* (BF), *Rectus Femoris* (RF), *Medialis* and *Lateralis Gastrocnemius* (GasM, GasL), *Gluteus Maximus* (GM), *Vastus Lateralis* (VL), *Vastus Medialis* (VM). RMS of each EMG signal were calculated and normalized with the maximal RMS values obtained during maximal voluntary contractions prior to cycling test.

Statistical analysis:
A Kolmogorov-Smirnov test was used to verify normality and a Wilcoxon sign rank test to compare the nonparametric results for each position ($: $p<0.05$) and each PO (*: $p<0.05$).

Results:

Considering ROM data, joint kinematics was few impacted by cyclist's position on the saddle. Only two significant differences were exhibited in the neutral position caused by the increase of PO for knee internal/external rotation and ankle plantarflexion/dorsiflexion. Center of mass position changed in all directions with position modification. In the forward position, increasing PO from 80 to 90% of MAP significantly increased mean RMS values (figure 2) of BF (0.33 to 0.43), TA (0.31 to 0.40) and VL (0.33 to 0.37). In the neutral position, only mean RMS of VL significantly increased (0.31 to 0.36) when increasing PO. A significant decrease for mean RMS of BF (0.39 to 0.33) is observed when moving to forward position at 80% MAP as well as a significant decrease of GasM (0.37 to 0.32) is observed when moving to forward position at 90% MAP.

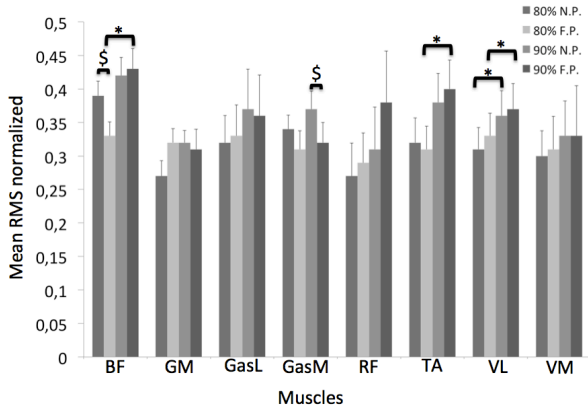

Figure 2: Mean RMS value for each position ($: p<0.05) and each PO (*: p<0.05)

Discussion:

This study presents the impact of both PO and forward position on the saddle, on the musculoskeletal parameters (joint kinematics and muscle activations). All muscles were not impacted in the same way. Indeed GasM, TA, VL and BF showed different behaviors depending either PO or position used by the cyclists on the saddle. Muscle activations results were similar to those found by Verma et al., 2016. The later was restricted to three muscles but who found a decrease in the GasM activation when moving forward but emphasized the interest of investigate EMG signal on more muscles to provide a better understanding the interactions of discomfort and change in seat position.

Conclusion:

Joint and muscle coordination during cycling seem to be more impacted by the increase of PO than position change on the saddle in the forward direction.

References:

Bini RR., Hume PA., Lanferdini FJ., Vaz MA. (2013). Effects of moving forward or backward on the saddle on knee joint forces during cycling. Physical Therapy in Sport, 14, 23-27.

Verma R., Hansen EA., de Zee, M., Madeleine P. (2016). Effect of seat positions on discomfort, muscle activation, pressure distribution and pedal force during cycling. Journal of Electromyography and Kinesiology (In Press)

Wu G. & Cavanagh P. (1995). ISB Recommendations for standardization in the reporting of kinematic data. *Journal of Biomechanics*, 28, 1257-61.