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Effect of shoes cleat position on physiological and biomechanical variables of cycling performance

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Introduction: The cleat under the cycling shoe is generally positioned below the first metatarsal head, directly over the pedal axis (Silberman et al., 2005, Clinical Journal of Sport Medicine, 15, 271-276). Previous studies did not found significant change of oxygen consumption (VO2) with moving forward or backward the cleat position (Van Sickle & Hull, 2007, Journal of Biomechanics, 40, 1262-1267; Paton, 2009, International Journal of Sports Physiology and Performance, 4, 517-523) although small changes in electromyography (EMG) activity in leg and thigh muscles have been observed (Ericson et al., 1985, Scandinavian Journal of Rehabilitation Medicine, 17, 53-61; Litzenberger et al., 2008, The Engineering of Sport 7, 1, 215-222). However, these changes have been observed with non cyclist subjects for larger shoe cleat displacements (+ 50 mm).

Purpose: The aim of this study was to investigate the acute effects of small variation of cleat position on the energy cost and pedalling technique (kinetics, kinematics and electromyography) during submaximal cycling. The second purpose was to analyze their effects on supramaximal cycling performance.

Methods: Twelve cyclists participated (25 ± 6 years; 69 ± 7 kg; 1.78 ± 0.05 m; Maximal Aerobic Power: 406 ± 40 W), being amateur and elite cyclists, according to previous conventions (Ansley and Cangley, 2009, European Journal of Sport Science, 9(2), 61-85). They performed three 5-min submaximal pedalling exercises (35, 50 and 65% MAP) and one 10-s supramaximal test (sprint) on Lode Excalibur electromagnetically braked cycle ergometer (Lode B. V., Groningen, The Netherlands). Three different cleat positions were studied in a randomized order: under the first metatarsal head, 15 mm forward and 15 mm backward. Power output, oxygen consumption, kinematics of lower limb joints and surface EMG activity (EMG) of six lower limb muscles (rectus femoris: RF, vastus lateralis: VL, biceps femoris: BF, tibialis anterior: TA, gastrocnemius lateralis: GL, soleus: SOL) were recorded during all the pedalling exercises, at 1, breath-by-breath, 200 and 1000 Hz, respectively. The kinematics and RMS over whole crank cycle of EMG activity were computed during 30 consecutives pedalling cycles. One-way ANOVA for repeated measures was performed to analyse the effect of cleat position on biomechanical and physiological variables.

Results and Discussion: Hip ROM was lower in forward position and ankle ROM was lower in backward position compared to the metatarsal position (Figure 1). None significant differences between the three cleat positions were found for knee ROM and RMS despite trends can be observed in backward position for SOL and GL activity to decrease and for RF and TA activity to increase. These tendencies are consistent with previous studies (Ericson et al., 1985; Litzenberger et al., 2008).

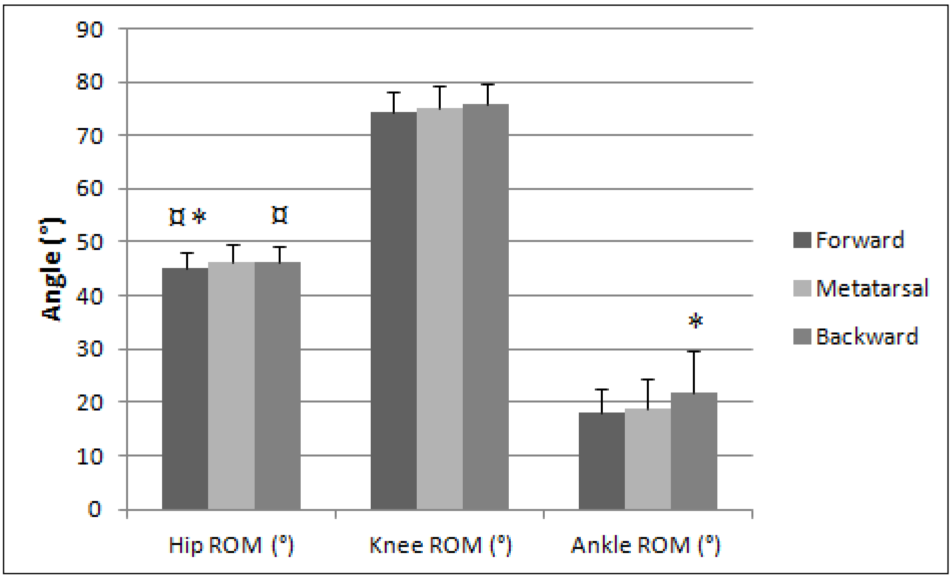

*Figure 1: Hip, Knee and Ankle Range Of Motion with the three different cleat position at 65%MAP. * Significant differences with respect to the metatarsal position; ¤ Significant differences between backward and forward positions*

Like in previous studies (Van Sickle & Hull, 2007; Paton, 2009), small changes of cleat position had no significant effects on VO_2, nor on gross efficiency (19.9 ± 1.9 % ; 19.5 ± 2.1 % ;19.4 ± 2.0 % respectively for forward, metatarsal and backward cleat positions). No significant differences in peak power output were found during the supramaximal test between forward (18.9 ± 3.2 $W.kg^{-1}$), metatarsal (19.0 ± 3.4 $W.kg^{-1}$) and backward (19.0 ± 2.9 $W.kg^{-1}$) cleat positions.

To conclude, the main finding of this study is that small changes of cleat position (± 15 mm) involve slight changes of kinematic of the hip and ankle joints without altering cycling efficiency and maximal power output during supramaximal sprints. Although muscular activity level remains unchanged by variation ± 15 mm of cleat position, these results should be completed by the analysis of the muscle timing activation.

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