Effects of cycling shoe cleat position in performance and physiological variables during cycling and subsequent running in simulated Olympic distance triathlon

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Background: A proper intervention at the foot-shoe-pedal interface in cycling could optimize lower limb kinematics, improving health and performance.[1] It has been established that the 1st metatarsal head must be positioned directly above the pedal spindle.[1] But the triathlon, which combines swimming, cycling and running, has specific characteristics in terms of biomechanical and physiological responses and a backward cleat position could be more appropriate on subsequent running in a triathlon at constant load.[2] However, the legal drafting in Olympic distance triathlon leads to a great variability in crank power output production (PO).[3] Another study which has simulated draft-legal triathlon did not observe any benefits with an aft cleat position, whether for cardiovascular cycling or running performance. However, the authors have reported a change of running pacing and particularly a faster running speed during the 1st kilometer with the traditional 1st metatarsal cleat placement.[4] The purpose of this study was to determine the impact of the antero-posterior shoe cleat position in performance and physiological parameters during the cycling and running phases of a simulated Olympic distance triathlon.

Methods: Eight well-trained triathletes (6 males and 2 females) volunteered for this experiment (Mean ± SD: 22 ± 11 years old, 1.73 ± 0.09 m, 60.8 ± 7.7 kg). The participants performed three experimental tests within two weeks. Firstly, they completed an incremental cycling test until exhaustion to determine the maximal aerobic crank power output production (MAP) and the maximal oxygen consumption (VO_{2max}). Then, they did a cycle-run protocol simulating the intensity of a draft-legal triathlon with two cleat positions in a random order (Table 1). The forward cleat position (FCP) positioned the center of the cleat 5 mm in front of the 1st metatarsal and the backward cleat position (BCP) placed the center of the cleat 5 mm behind the 1st metatarsal. The cycling tests were performed on a Wattbike® cycle ergometer (Wattbike Pro, Nottingham, UK) allowing to control the break resistance and the running tests were made on a standard treadmill® (Tunturi T90, Tunturi New Fitness BV, Almere, Netherlands). The VO_2 was collected during cycling and running with an Oxycon-Pro® system (Oxycon-Pro, Erich Jaeger, Germany) and the energy cost (C) was calculated for the running tests.[5] The cycling PO was measured with the Wattbike® and the running distance with the treadmill. Pairwise Wilcoxon tests were used to establish statistical differences between means. Statistical significance was set at $p < 0.05$.

Table 1: *Cycle-run protocol*

	Cycling		Transition	Running
FCP	32 minutes divided into 8 sections of 4 minutes		1 minute	Maximum distance over 20 minutes
	3'30 at 50-75% of MAP and 80 rpm	*30" at 100-200% of MAP with free pedalling cadence*		
BCP	32 minutes divided into 8 sections of 4 minutes		1 minute	Maximum distance over 20 minutes
	3'30 at 50-75% of MAP and 80 rpm	*30" at 100-200% of MAP with free pedalling cadence*		

Results:

Table 2: *Mean of performance and physiological parameters during cycling and subsequent running according to the cycling cleat position*

	Cycling			**Running**					
	Total			*1st section of 5'*			*Total*		
	FCP	**BCP**	***p***	**FCP**	**BCP**	***p***	**FCP**	**BCP**	***P***
% of MAP	70.4 ± 8.6	66.8 ± 5.9	> 0.05						
Distance (meters)				1190 ± 150	1150 ± 100	> 0.05	4960 ± 540	4910 ± 480	> 0.05
% of VO_{2max}	**65 ± 3.9**	**59.7 ± 6.7**	**< 0.05**	68.8 ± 11.0	60.9 ± 10.9	> 0.05	75.6 ± 8.8	65.2 ± 15.6	> 0.05
C ($mlO_2.km^{-1}.kg^{-1}$)							**147.5 ± 22.8**	**127 ± 34.7**	**< 0.05**

Table 2 shows a significant decrease of oxygen consumption with the BCP during the cycling part of the test. However, we can notice a slight increase of PO with the BCP but no significant. During the subsequent running, the performance was better while the FCP condition, and particularly during the 1st section (40 m) but no-significant. This improvement was coupled with a no-significant increase of VO_2, which could explain the gain of performance. However, the C was significantly higher during the FCP condition compared to the BCP condition.

Discussion: For cycling, our results suggest that the BCP is more economical despite a no significant decrease of performance. It has been reported that a forward 1st metatarsal cleat position could lead to overuse injuries.[1] Thereby, a 1st metatarsal or a slightly aft cleat placement could be more suitable for performance and injury prevention in cycling. Despite a performance improvement with the FCP during the subsequent running, the BCP was significantly more economical, which could be caused by a muscular economy.[2] Moreover, the pacing was different with a faster 1st running section with the FCP, which is in agreement with previous study.[4] In conclusion, our results suggest that a 1st metatarsal or a slightly further backward cleat placement would be more appropriate for cycling and subsequent running economy in Olympic distance triathlon despite a better performance (but no significant) with the FCP.

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