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ANALYSIS OF ASYMMETRY DURING A SUPRAMAXIMAL CYCLING TEST PERFORMED IN DIFFERENT SADDLE POSITIONS

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SUMMARY

The aim of this study was to analyze pedaling asymmetry during a supramaximal test performed in different saddle positions. Twelve competitive cyclists were volunteers in this study. The experiment was performed on four different days, with an interval of 48 hours between them. On the first day, cyclists were submitted to an incremental maximal test to determine the aerobic variables and also to perform a familiarization with the supramaximal test. On subsequent days, cyclists performed, randomly, a 30-second Wingate test in three different saddle heights (upward, downward and reference position). The results show that preferred lower limb presented significantly higher peak torque values ($p<0.05$) compare to the non-preferred limb in the three saddle heights investigated. The data suggest that during supramaximal test preferred lower limb produced greater peak torque than non-preferred lower limb regardless of the saddle height.

INTRODUCTION

Preference and performance are associated, which means that performance of preferred limb is usually more successful than that observed for the non-preferred limb [1]. It was suggested [2] that asymmetries in bilateral power output in cycling can vary from 5% to 20%. Significant pedaling asymmetry (characterized by differences higher than 10%) was found for crank peak torque during a simulated cycling 40 km time trial [3]. Furthermore, an increase of exercise intensity elicited reduction of pedaling asymmetry [3]. However, asymmetries during high intensity cycling have not been investigated in previous studies. Changes in the cycling position can affect not only the mechanical parameters of the pedaling, but also the asymmetry. One of the important external factors studied in cycling is the saddle position [4]. Thus, the aim of this study was to analyze pedaling asymmetry during a supramaximal test performed at different saddle heights.

METHODS

Subjects: Twelve competitive cyclists with a mean age of 31.7 ± 5.9 years, body mass of 73.8 ± 6.6 kg, maximal oxygen uptake of 56.8 ± 3.8 ml·kg^{-1}·min^{-1}, and maximum power output of 316.4 ± 35.6 W, participants of regional and national championships were volunteers. During the two months preceding the study, they completed 217.5 ± 103.2 km of cycling training/week on average. The athletes were classified as competitive level athletes because they showed maximal oxygen uptake between 50 and 60 ml·kg^{-1}·min^{-1} and maximum power output between 275 and 375 W [5]. They were fully informed of the risks and discomforts associated with the experimental procedures. All participants signed an Informed Consent Form in agreement with the Committee of Ethics in Research of the local institution.

Protocol: Tests were performed in four different days, with an interval of 48 hours between them. On first day cyclists performed an incremental maximal cycling test to determine the aerobic variables and a familiarization with the supramaximal test. On subsequent days, randomly, cyclists performed a 30-second Wingate test [6] in three different saddle heights. The saddle height was individually shifted upward and downward [seeing 2.5% of the distance from the pubic symphysis to ground (DPSG)] and the reference position was that saddle height used by cyclists in training and competition (Figure 1).

Figure 1. Saddle height measured from the distance from the pubic symphysis to the ground and the three positions during the Wingate tests: upward (+2.5% DPSG), reference position, and downward (-2.5% DPSG).

Data collection: The incremental test and Wingate tests were performed on an electronically braked cycle ergometer (Excalibur Sport, Lode, Netherlands). The incremental test began at 100 W, followed by increments of 30 W every 3 min, until the voluntary exhaustion. During Wingate test cyclists were instructed to remain seated and do the maximum effort throughout the test. During the test athletes were verbally encouraged to make every effort possible.

Data analyses: Torque was measured every two degrees of the pedaling cycle (0-360°) using a pair of instrumented cranks. Positive peak torque, defined as the largest torque value generated during the propulsive phase of the pedaling cycle (0-180°), for both lower limbs [preferred (P) and non-preferred (NP)] were calculated. Preferred limb was identified for each participant by means of the revised Waterloo Inventory. An asymmetry index (AI%) describing the relative strength difference between the preferred and non-preferred limb, was calculated using equation 1:

$$AI\% = \left(\frac{P-NP}{P}\right) X\ 100. \qquad \text{Equation 1}$$

This equation provided the magnitude and direction of bilateral asymmetry and considered the lateral preference. ***Statistics procedures***: Data normality, sphericity and homogeneity of variances were verified by Shapiro-Wilk, Levene, and Mauchly tests, respectively. Peak torque was compared between limbs and the saddle heights by analysis of variance (ANOVA) for a linear mixed model (2 limbs x 3 saddle heights) using Bonferroni corrections for multiple comparisons. The level of significance was set at $p<0.05$. Data were analyzed in SPSS version 15.0 for Windows (SPSS Inc., Chicago IL, USA).

RESULTS AND DISCUSSION

Results of positive peak torque of preferred and non-preferred limbs in the three saddle heights are depicted in Figure 2. Torque was statistically higher ($p<0.05$) for preferred limb compare to non-preferred limb in the three saddle positions evaluated. Asymmetry in favor of the preferred leg was reported before [2]. Studies have demonstrated that when the pedaling workload is increased there is an improvement of pedaling symmetry [2,3]. However, here we show that preferred limb produces greater torque in supramaximal efforts. During submaximal effort, the literature suggests that symmetry emerges from factors such as increase of bilateral input and release of inhibitory vias [7]. It is possible that for supramaximal efforts, central nervous system is not able to sustain a symmetric performance and the higher performance of preferred limb could results from peripheral adaptation or more likely the influence of inhibitory pathways. However, this issue requires further investigation.

The symmetry index was similar between the three saddle positions tested (Figure 3). The present study showed that regardless of the saddle position, the asymmetries index occurred. It reinforces the hypothesis of central factors contributing to the asymmetry in supramaximal efforts. If a peripheral adaptation determined the asymmetry observed, it would be expected lower asymmetries for the reference position (position that the cyclists is used during the training and competition). However, we found that asymmetry was not dependent on the "adaptation" of the cyclists for a given position. Interestingly, asymmetry was the same regardless of the saddle position. Therefore, a neural mechanism could be contributing to the behavior observed.

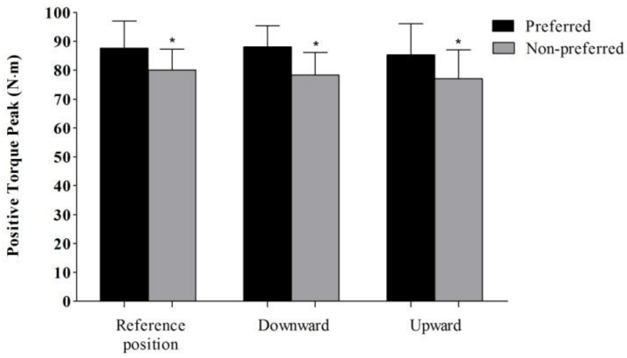

Figure 2. Mean and standard-deviation peak torque for lower preferred and non-preferred limb considering saddle in the preferred, upward and downward position in the Wingate test. *Difference between limbs ($p<0.05$).

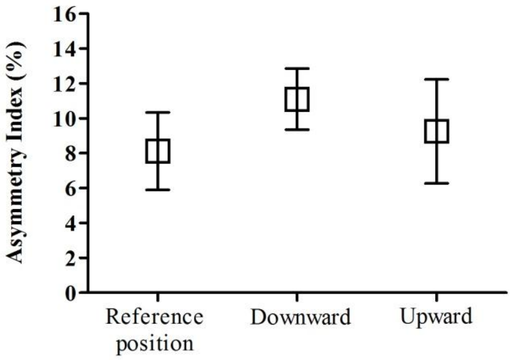

Figure 3. Asymmetry index during the Wingate test in the three saddle positions (reference position, downward, and upward).

CONCLUSIONS

Preferred limb produces higher peak torque during supramaximal exercise regardless of the saddle position assumed. This result seems to rely on neural mechanism rather than peripheral muscle adaption. Further studies are required to test this hypothesis.

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