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Underlying skeletal muscle determinants of the force-velocity-endurance profile of elite endurance athletes

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INTRODUCTION:
Athlete's force-velocity-endurance (FVE) profile is an important factor of rowing performance (1, 2), but its underlying skeletal muscle determinants remains unknown in this population. In endurance-trained athletes, the critical power (CP), a major component of the FVE profile, is strongly related to muscle O2 supply (i.e. capillarization) (3) but could also in theory be influenced by changes in O2 consumption capacities (4). Interestingly, elite rowers display high maximal oxygen uptake and elevated CP (2). Therefore, it can be hypothesized that elite rowers display exceptional both O2 supply and consumption which are determinant of their elevated CP. CP can result from different combinations of critical force (F0c) and velocity (V0c). Although different physiological and muscle characteristics determinants can intervene on the dimensions of force and velocity of CP, they have never been investigated. Therefore, the aim of the present study was to investigate the relationship between skeletal muscle features and parameters of the FVE profile in elite rowers.
METHODS:
Eleven elite rowers performed i) a 3-min all-out test (3AO), ii) a 2000 m trial, both on a rowing ergometer, and iii) a muscle biopsy (vastus lateralis). Before the 3AO, six strokes in different velocity conditions were performed and these force/velocity data were analysed to assess maximal power (Pmax), maximal force at null velocity (F0i) and maximal velocity at null force (V0i). The same procedure was replicated at the end of the 3AO to obtain F0c, V0c and CP. Biopsy cryosections were used for immunofluorescent staining to obtain fibre-type specific capillary-to-fibre ratio (C/Fi), fibre cross-sectional area (CSA) as well as fibre typology. Histo-enzymatic staining of the sections was used to quantify relative activity of cytochrome C oxidase into the fibres (COx).
RESULTS:
Pmax and CP were positively related to the 2000m trial performance ($r=0.86$; $p<0.001$ and $r=0.74$; $p<0.01$). CSA was positively correlated to Pmax and F0i ($r=0.70$; $p<0.02$ and $r=0.71$; $p<0.01$) but not V0i ($r=0.44$; $p=0.15$). C/Fi and CSA ($r=0.72$; $p<0.02$ and $r=0.73$; $p<0.02$) but not COx ($r=0.30$; $p<0.37$) were related to CP. The correlation with C/Fi was also significant with F0c ($r=0.63$; $p<0.05$). V0c did not correlate with any of the muscle characteristics.
CONCLUSION:
The present study demonstrated the importance of skeletal muscle capillarisation in CP in elite endurance athletes. Surprisingly, even in these highly endurance-trained and oxidative athletes, fibre oxidative capacity did not seem to determine CP. As expected, Pmax was mainly determined by CSA. Interestingly, the muscle characteristics determined only the force component of the initial and critical power, i.e. F0i and F0c.

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