[13] and blood [14] metabolites. Validation [6,15,16] and reliability [1,2,17] studies have also been undertaken, and a theoretical model for muscle oxygenation (i.e., oxidative metabolism) measured by NIRS has been presented [18]. More recently, NIRS has been used to examine the effects of short-term endurance training on muscle oxygenation in a group of healthy untrained subjects [19], and competitive well-trained cyclists [20]. These studies showed that NIRS was a viable non-invasive technique to monitor muscle oxygenation, and to reflect the physiological adaptations in peripheral skeletal muscle following a short-term endurance-training program.

Tapering is a training method performed by athletes during the days (3-21d) immediately prior to competition to create a "rebound" effect to improve performance. Physiological adaptations have also been reported during a period of tapering [21-26]. Both central cardiovascular (i.e., VO_2max) and peripheral muscular (i.e., oxidative enzyme) changes have been documented and are correlated with improvements in performance following the taper period. It is likely that the enhanced oxidative capacity following tapering would elicit significant changes in muscle oxygenation. However, this has not been tested prospectively. The focus of this pilot study (due to the limited sample size in each group) was to test the hypothesis that muscle oxygenation changes, measured by NIRS, will occur following a period of tapering in a group of trained competitive cyclists. Furthermore, the possibility exists that NIRS can be used to monitoring the training status of an athletic and/or non-athletic population. Having a non-invasive technique that allows one to monitor peripheral changes and training adaptations occurring in the local muscle tissue will have a great impact on the understanding of local muscle tissue metabolism and haemodynamics.

Methods

Subjects

These data are based on eleven competitive male cyclists between the ages of 19–34 yr that volunteered to participate in this study. Some of these subjects completed more than one taper, explaining why each group had an equal number of five subjects per group. Two subjects completed all three tapers, while three subjects completed two of the tapers. Physical characteristics for the eleven subjects were: age (Mean ± SD) = 22.6 ± 4.7 yr, height = 177.0 ± 5.0 cm, body mass = 70.3 ± 5.0 kg, thigh skinfold thickness = 9.0 ± 1.8 mm, VO_2max = 4.68 ± 0.57 $L \cdot min^{-1}$ (66.5 $mL \cdot kg^{-1} \cdot min^{-1}$). Each subject completed a written informed consent after a thorough explanation of the protocols and procedures involved in accordance with an institutional ethics review committee.

Testing

Prior to the taper phase, each subject completed an incremental VO_2max test on a calibrated Monark cycle ergometer (Model 818E, Varberg, Sweden) as described previously [27]. Following a two minute rest period while sitting stationary on the cycle ergometer, each cyclist began pedalling at an initial work rate of 80 watts (W) for 2 min, followed by 45 W increments every minute up to 260 W. Thereafter, work rate was increased each minute by 20 W increments to volitional fatigue. This test lasted approximately 10–14 min in duration. Expired gases were collected and analysed by open circuit spirometry by using an automated metabolic analysis system (Vmax, Sensormedics, California, USA). The data were averaged in 20 sec intervals. The gas analysers were calibrated with primary standard gas (16.0% O_2, 4.0% CO_2, balance N_2) before and after each individual test. The pneumotach was calibrated using a 3L syringe. The following criteria were used to verify VO_2max: a respiratory exchange ratio (RER) greater than 1.12, and an increase in VO_2 uptake less than 100 mL with an increase in work rate [28]. All subjects achieved these criteria. Heart rate (HR) was monitored continuously by telemetry (Polar monitors, Electro, Finland).

Because of the endurance characteristics of these cyclists (both road and mountain bike), a simulated 20TT performance ride was used as the criterion test (i.e., index of performance) before and after tapering to evaluate the physiological and performance effects of each taper protocol. Each cyclist was asked to complete the ride as fast as possible, with no feedback provided on how well he was performing until the end of the test. The pre-taper 20TT was used as the last workout prior to tapering. The description of this test has been reported in detail previously [27,29]. Briefly, each cyclist used his own bicycle mounted on a set of aluminium cast wind-loaded cycling rollers fitted with a stabilizing bar that was attached to the handle bar of the bicycle for safety. The air pressure of the tires was checked before and after each ride to ensure that maximum pressure was maintained. The same set of cycling rollers was used for all simulated 20TT rides with the rollers being interfaced with a computer to record velocity, distance, and cycling time. This device was calibrated by measuring the circumference of the rollers (and thus the distance was a product of the circumference and rpm, which was recorded by the computer [29]). Respiratory gas exchange responses (averaged over 20 sec) were monitored for 2–3 min every 5 km during the pre-and post-taper simulated 20TT. The same calibration procedures were performed on the gas analysers as previously stated above for the VO_2max test. HR was monitored continuously throughout the duration of the 20TT using telemetry (Polar, Finland). The Rating of Perceived Exertion (RPE) was also taken at the end of each work rate