'WARM-UP' EFFECTS ON FREQUENCY CONTENT OF EMG IN DYNAMIC EXERCISE: IMPLICATIONS FOR ASSESSING FATIGUE

Jon Kelly, Ross Sanders, Simon Coleman
University of Edinburgh, Edinburgh, UK

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INTRODUCTION: The purpose of this study was to examine the implications of the increasing muscle temperature that occurs during dynamic exercise for using the frequency content of EMG for assessing muscle fatigue in such activities. It is known that the temperature of the active muscles can be elevated to around 40°C during prolonged exhaustive exercise (Saltin et al, 1972) and that temperature changes can affect the frequency content of surface EMG (Merletti et al, 1984). Several of the previous studies in this area have shown initial increases in median frequency (f_{med}) prior to a decline with fatigue where the activity was not proceeded by other exercise (Jansen et al, 1997, Gosselin et al, 2000, Hausswirth et al, 2000). It is hypothesised that these initial rises are due to increasing muscle temperature and that this may affect the accurate measurement of fatigue.

METHODS: The subjects for this study were all competitive road cyclists (n=6) and completed three trials riding their own bikes on a Kingcycle test rig (Biotrace Ltd) each separated by at least 48 hours. The testing consisted of an initial maximal ramp test to establish maximal minute power (MMP) and two EMG trials. The first EMG (LF) was intended to cause little fatiguing (LF) and consisted of a 7 minute ramp from 30% to 70% MMP, followed by 30 minutes at 70% MMP. All subjects successfully completed this test without reaching failure point. The second EMG test (HF) required the subjects to complete a 10.5 minute ramp from 30% to 90% MMP (thus replicating the ramp rate of the LF test) and then to maintain 90% MMP till exhaustion. Exhaustion was defined as the point when the subject could no longer maintain the power output within 10 W of the target for > 5 s or voluntary test termination by the subject. Subjects were instructed to maintain the same gearing throughout the constant power output section of both EMG trials to ensure a consistent cadence and were not permitted a prior warm up. For the EMG trials subjects were prepared for bilateral surface EMG collection with electrodes being placed over the vastus lateralis (VL), semimembranosus (Sm), tibialis anterior (TA) and gastrocnemius (medial) (Ga). In all cases, in-house built electrodes were used with two 10 mm x 1mm silver bar detection surfaces mounted on a fixed platform with inter-electrode spacing of 10 mm. Data were sampled at 2058 Hz with a 12-bit analogue to digital converter (CED 1401). The output of a Spectrol Smart Position Sensor attached to the subjects' bikes to allow crank position to be recorded was also sampled. The collected EMG data were subsequently band-pass filtered at 20-500 Hz and using a fourth order Butterworth filter. The f_{med} for each minute of data were then calculated using Fast Fourier Transformations. Each minutes' f_{med} was expressed as a percentage of the value for the first minute and group means calculated.

RESULTS AND DISCUSSION: The data collection for the HF trials and much of the data analysis remains to be done, however, some trends have already emerged from the LF trials. During the LF trial, considerable variation was shown in f_{med} over time for the various muscles. Both right and left VL showed small but consistent increases over the course of the test finishing 5-10% above their starting values. Changes of similar magnitudes were also observed for both right and left Sm however, these were in the opposite direction. Although trends were less apparent for Ga and TA these also showed a decrease over time. With the exception of VL, these trends were contrary to what was predicted with increasing muscle temperature. However, their magnitude is relatively small (<15% over the course of 37 minutes of exercise) and these will need to be compared to the changes observed in the HF before further conclusions can be drawn.

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