The Effects of power*BIKE*™ on Cyclical Muscle Activation Patterns

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1. Background

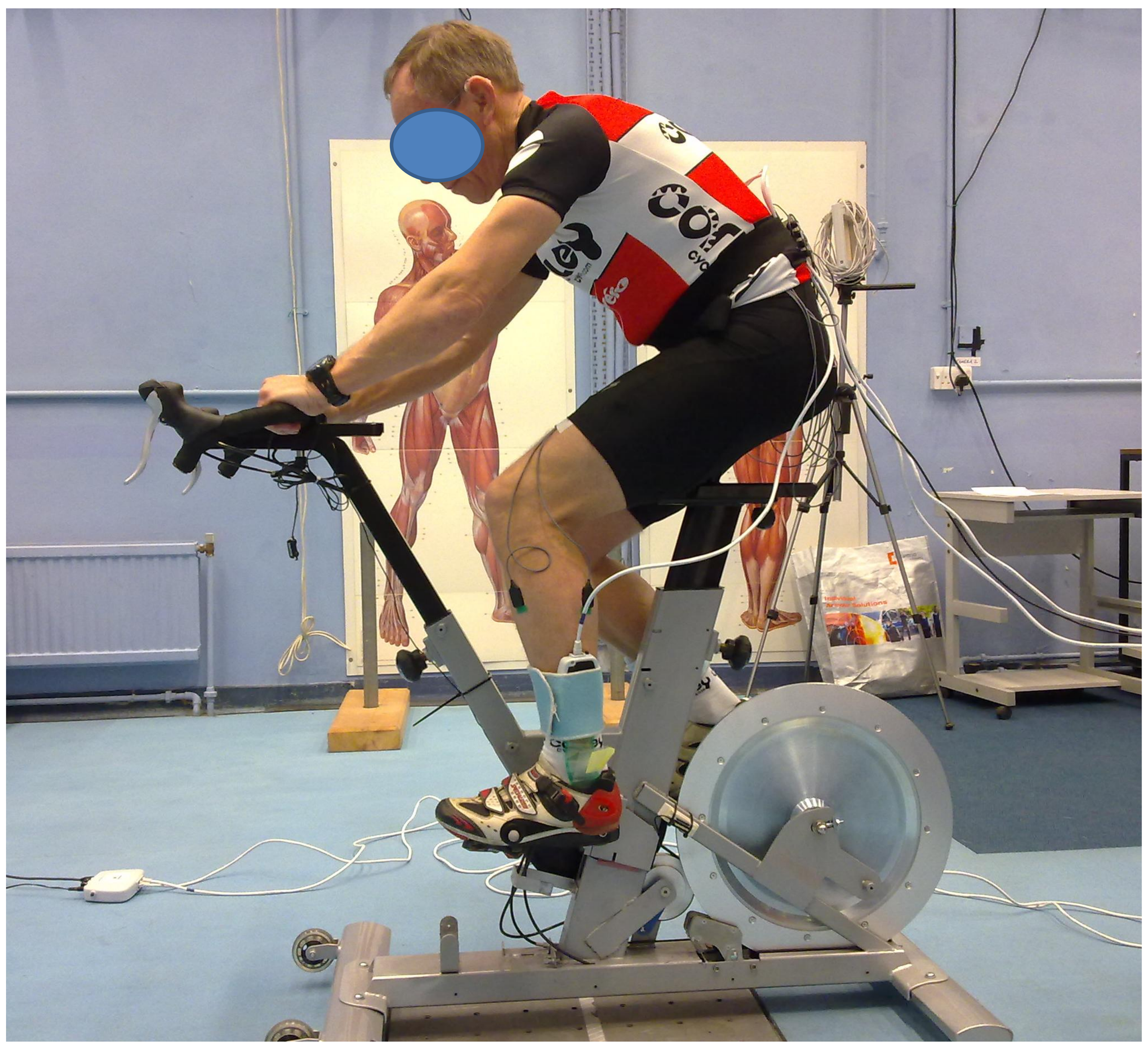
The use of vibration within training programmes has been gaining scientific credibility as an alternative method to improve muscle performance. There have been limited studies which have attempted to integrate vibration stimuli during stationary cycling to influence physiological responses, all of which used cycle frames and cranks attached directly to vibration platforms (Suhr et al 2007 and Sperlich et al 2009). Power Plate International has recently developed the power*BIKE*™ which is a new concept combining a stationary cycling trainer with inbuilt vibration technology delivering cadence-related vibration frequencies.

The aim of this preliminary study was to determine the comparative effects of cycling, with and without vibration, on activation patterns of the lower limb muscle groups.

2. Methods

Eight participants volunteered to participate in this study. The mean and standard deviation (±SD) values height and mass of the subjects were 1.79 +/- 0.04m and 74 +/- 9 kg, and all subjects were right-leg dominant. All procedures had been previously approved by the University's Research Ethics Committee and participants provided informed consent to participate. Each participant was randomised to perform either 60, 70, 80 and 90 RPM on the power*BIKE* with, or without vibration, at a fixed resistance (power*BIKE* level 4) for 3 min at each cadence. The mechanical vibration was cadence-related being equivalent to 20, 23.3, 26.7 and 30 Hz vibration respectively.

Retro-reflective markers were fixed to the crank in order to define top dead centre (TDC - 0°) and bottom dead centre (BDC - 180°) during the duty cycle. Electromyography was used to determine the activities of the major ankle flexors, quadriceps, hamstrings and hip extensors. EMG recordings were filtered, smoothed and mean activities were determined for 12 duty cycles for each cadence.

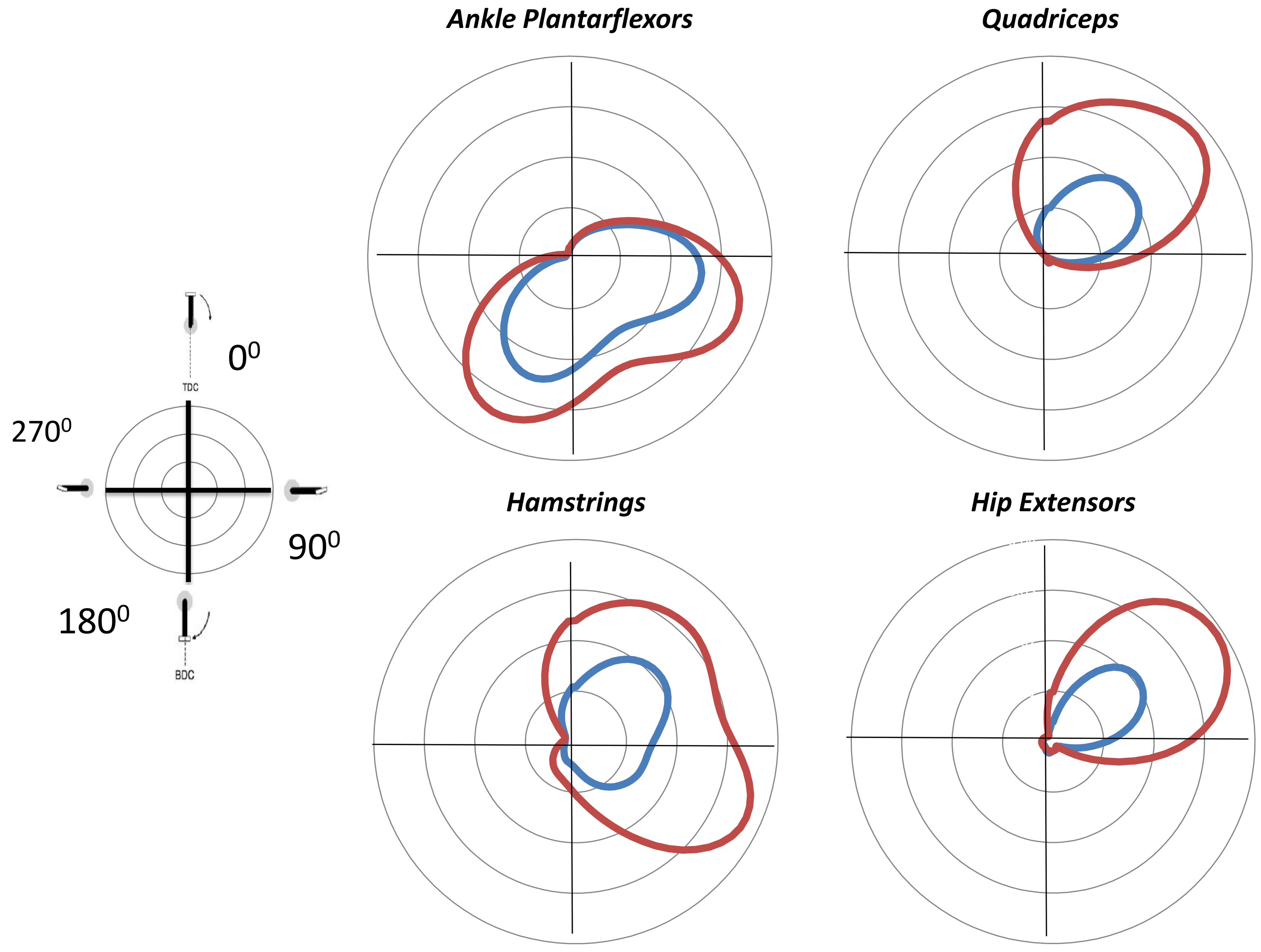


2.1 Statistics.

All EMG data were normalised to those recorded at 60 RPM without vibration. Differences between vibration and no vibration were analysed using Paired T-tests and difference between cadences we assessed using one-way repeated measures ANOVA in SPSS statistics 18 (IBM Corporation, NY, USA).

3. Results

Radar plots of selected muscle activities against crank position (clockwise rotation) at 90 RPM between vibration [**red lines**] and no vibration [**blue lines**] conditions are shown below (Fig 1). These data show that vibration causes a significant increase in the activities of the main motive muscle groups in cycling.



Individual muscle activities were summated to give a 'total' lower limb value. Comparison of total muscle activities between vibration [**red lines**] and no vibration [**blue lines**] conditions are shown in Fig 2a. The relative differences between vibration and no vibration expressed as the RPM dependent vibration frequency are shown in Fig 2b

Fig 2a

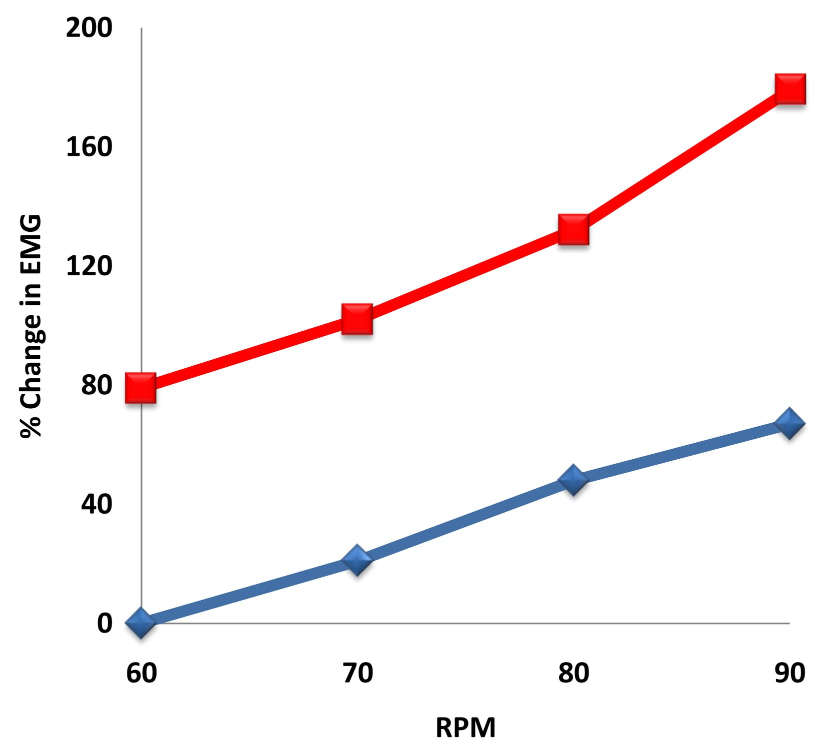
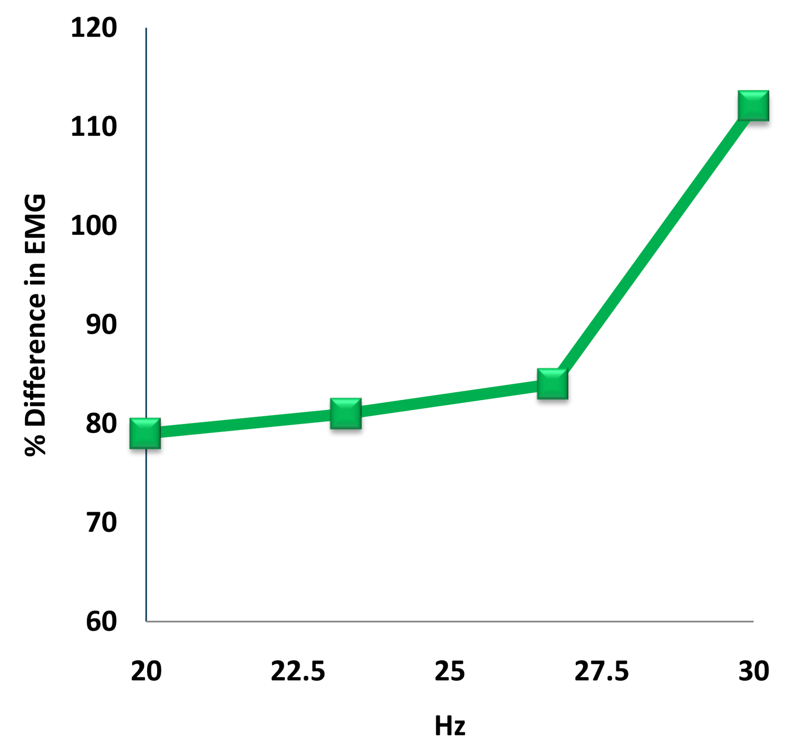


Fig 2b



4. Summary

These preliminary data show that the addition of mechanical vibration during cycling produce significant increases in muscle activation of the major lower limb muscles. Studies have suggested that vibration training initiates changes in muscle length with concomitant muscle spindle activation, eliciting the 'tonic vibration reflex' (Cardinale & Bosco 2003) and that during vibration, there is a increase in motor unit recruitment resulting in faster muscle activation (Rehn et al 2007).

This study suggests that vibration during cycling induces a greater training stimulus of the high-threshold fast twitch motor units. The total muscle activity data appears to show an exponential increase in activity at 90 RPM (equal to 30 Hz vibration frequency). Further research is needed to find out if this increase continues with increasing cadence / frequency, or whether 30 Hz elicits the highest muscle activation.

- Cardinale & Bosco (2003) The use of vibration as an exercise intervention. Ex Sp Sci Rev 31, 3-7
- Renn et al. (2007) Effects on leg muscular performance from whole-body vibration exercise: a systematic review, Scand J Med Sci Sports 17 pp. 2–11
- Sperlich et al. (2009) Physiological and perceptual responses of adding vibration to cycling. JEPonline 12(2):40-46. Suhr et al .(2007) Effects of short-term vibration and hypoxia during high-intensity cycling exercise on circulating levels of angiogenic regulators in humans . J App Physiol 103 474-483