The Effect of Hyperbaric Oxygen (HBO) Therapy on Modulation of Heart Rate Variability after Sub-maximal Cycling

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Purpose

The use of mild hyperbaric oxygen therapy (HBO) by professional and amateur athletes for speed recovery is blooming in recent years (Figure 1). It can be devastating for professional athletes if they are unable to recover in time from exercise-related fatigue, including the fatigue of the nervous system. This often means their sports performance and trainability are compromised. With this in mind, we are interested to examine the effect of mild HBO on the recovery of the autonomic nervous system and muscle power after moderate workload. This study can be achieved non-invasively by assessing heart rate variability (HRV), as some of the values closely resemble vagal activity (Task Force, 1996). Muscle activity, on the other hand, was assessed using surface electromyography (sEMG). Previous findings have reported that elevated HRV indices are associated with sound training performances (Garet *et al.*, 2004), and other studies have shown a temporal increase in HRV during HBO treatments (Lund *et al.*, 1999; 2000; 2003). If these findings are confirmed to be true, it can provide scientific evidence to support the current use of mild HBO therapy for speed recovery. Its use may improve the quality of training and enhance sport performance.

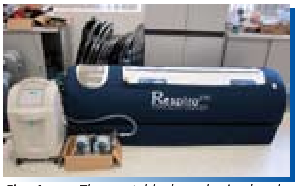

Fig. 1 The portable hyperbaric chamber (Respiro 270, Oxyhealth) at Hong Kong Sport Institute was used in this study. The maximum chamber pressure was 1.27 ATA. 80-85% O_2 oxygen was delivered to the subject via a standard gas mask for higher efficiency.

Method

Experimental Design

Ten healthy and active males (28.3 ± 6.3 yrs) were recruited for this study. All subjects visited the laboratory on four separate days. Cycling VO_{2max} and maximum aerobic power (W_M, Watts) were determined via an incremental test on 1st visit to standardise the exercise intensity throughout the study. In the 2nd - 4th visit, subjects were randomly assigned to either: (1) 90 mins HBO at 1.27 ATA, 80% oxygen; (2) 50 mins HBO at 1.27 ATA, 80% oxygen plus 40 mins in normobaric normoxia (NNO); or (3) 90 mins in normobaric normoxia (Control) to create a single-blind study. All subjects followed experimental protocol as shown in Figure 2.

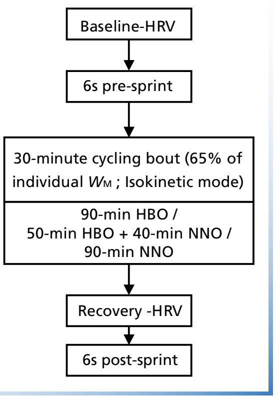

Fig. 2 The experimental protocol for the 2nd to 4th visit

Muscle Activity

Surface EMG activity of *vastus lateralis* and *vastus medialis* was recorded continuously during the 6s pre/post cycling sprint and 30-minute cycling exercise. The maximal iEMG values for each muscle in the 6s post-sprint were expressed as a percentage of the corresponding values obtained from the 6s pre-sprint. Mean integrated EMG (mean iEMG) and mean power frequency (MPF, Hz) were calculated for the 30-minute cycling exercise.

Heart Rate Variability

The subjects rested comfortably for 15 minutes in supine positions before each measurement was taken. Ventilation rate was paced at 15 cycles per minute (0.25 Hz) during the recordings. Seven minutes of supine recording was captured using a Polar RS800 heart rate monitor. Based on the recommendation of Task Force (1996), 5-minute HRV was examined in the time and frequency domains, and non-linearly using Poincaré plot analysis.

Statistics

A two-way ANOVA was used to evaluate the changes of power output and sEMG in the 6s sprints, and the HRV indices between each treatment. Multiple comparisons were made using Bonferroni post-hoc test. A significant difference was considered at the level of p-value < 0.05.

Results

Maximum power output and iEMG were not significantly different between the pre- and post-cycling sprints. Thirty minutes of cycling at approximately 65% of W_M, equivalent to 85% of VO_{2max}, has placed a significant stress on the nervous control of cardiac activity. HRV indices, including Mean R-R, RMSSD, pNN50, SD1, SD1/SD2, and lnHF were significantly reduced, while the lnLF/HF ratio was increased. Baseline values for these parameters were not restored even after 90 minutes of normobaric air treatment. This result is in line with previous studies, which demonstrates that exercise has an acute suppressive effect on vagal activities (Naoyuki *et al.*, 1992; Terziotti *et al.*, 2001; Javorka *et al.*, 2002; Mourot *et al.*, 2004). On the other hand, parasympathetic activities returned to the pre-exercise levels in both 50-min HBO followed by 40-min NNO, and 90-min of mild HBO (Figure 3 & 4), showing a beneficial effect on the recovery of the autonomic nervous system after moderate exercise.

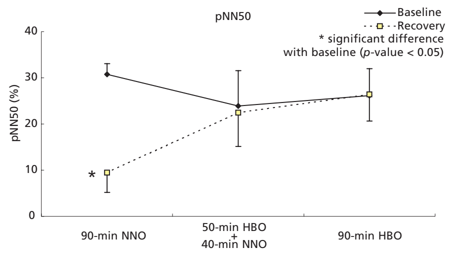

Fig. 3 pNN50 during the baseline and recovery period in three groups of subjects receiving treatment of 90-min NNO, 50-min HBO + 40-min NNO, and 90-min HBO. (Mean ± SE)

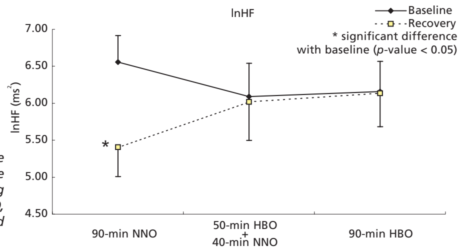

Fig. 4 lnHF during the baseline and recovery period in three groups of subjects receiving treatment of 90-min NNO, 50-min HBO + 40-min NNO, and 90-min HBO. (Mean ± SE)

Conclusion

Although mild HBO did not enhance post-submaximal anaerobic performance, the present study demonstrated that it had a beneficial effect on the recovery of HRV after sub-maximal cycling exercise. Fifty minutes of mild HBO can serve as a safe and practical mean for enhancing recovery of nervous system. It may worth to investigate whether the treatment has similar effects on athletes and under conditions when sympathovagal balance is significantly disturbed, such as post-maximal exercise and at altitude.

References

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