No effect of a single session of acute intermittent hypoxia on voluntary motor output in humans with incomplete spinal cord injury

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Summary

Previous studies suggest that alternating short periods of hypoxia and normoxia (acute intermittent hypoxia, AIH) may have therapeutic benefits for both respiratory and non-respiratory motor function following motor-incomplete spinal cord injury (SCI). The aim of this study was to examine the effects of AIH on voluntary motor output. Ten participants with chronic incomplete SCI took part in this randomised, placebo-controlled and cross-over design study, completing both an AIH and a sham session. Unlike most previous studies, AIH did not induce short-term enhancements in force or electromyographic activity (EMG) during maximal voluntary contractions in individuals with incomplete SCI.

Introduction

AIH has shown promise for improving motor function in individuals with incomplete SCI. Animal studies suggest that AIH induces serotonin release into the spinal cord, triggering synaptic changes in alpha motoneurons (i.e., neuroplasticity) to increase their responsiveness to excitatory input [1]. For example, one session of AIH can increase muscle force by 30-80% for over one hour [2]. Repeated AIH improves hand function by 11% [3] and increases walking speed and endurance in more than 30 and 70% of participants, respectively [4]. However, consistent results across independent research groups are needed to support the translation of AIH into clinical practice.

Methods

Ten individuals (53 ± 8 years; 4 females) with chronic incomplete SCI (C4-L1; time since injury: 15.1 ± 13.1 years) underwent both AIH and sham sessions on different days in a randomised order.

Five baseline maximal voluntary isometric contractions (MVICs) were performed before a 30-min AIH or sham protocol. MVICs were reassessed immediately, and at 30 and 60 min after the protocol. Muscle actions tested were below the injury level where participants exhibited muscle weakness but not complete paralysis (dorsiflexion: n=7; wrist extension: n=1; knee extension: n=1; toe flexion: n=1). EMG was collected from tibialis anterior, extensor carpi radialis longus, vastus lateralis, and flexor hallucis brevis muscles, respectively.

The AIH intervention consisted of 15 cycles of 1-min exposure to 9.1 ± 0.1% O_2, alternating with 1-min of 20.2 ± 0.1% O_2 (normoxia). Sham sessions involved alternating exposures to normoxia alone (20.2 ± 0.1% O2).

Results and Discussion

Peripheral oxygen saturation (SpO2) decreased to a nadir of 81 ± 2% on the AIH day and was unchanged during sham (96 ± 1%). Peak force (Figure 1A) and peak EMG amplitude (Figure 1B) remained unchanged in both conditions, without significant condition, time, or interaction effects (p>0.05).~

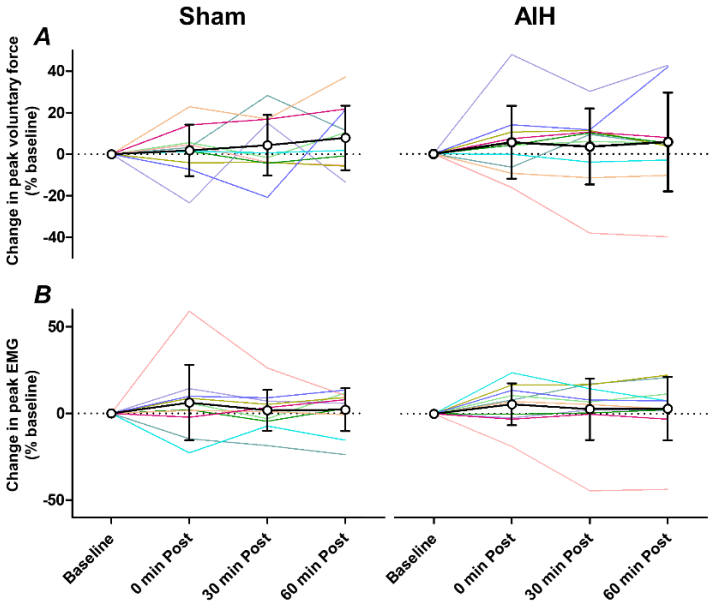

Figure 1: Individual and mean (±SD) changes in peak voluntary force (**A**) and peak EMG amplitude (**B**). Each datapoint at each timepoint represents the relative change from baseline, calculated using the mean value of five MVIC trials.

Conclusions: These findings suggest that AIH may not consistently enhance motor function in individuals with chronic incomplete SCI, highlighting the need for further research to clarify its therapeutic potential.

Acknowledgments: This work was supported by the Neurotrauma Research Program of Western Australia.

References

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