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CASE REPORT

A case of remission from pre-diabetes following intermittent hypoxic training

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Summary A female patient (49 years of age) with obesity (body mass index: 35.3 kg/m^2) and diagnosed with pre-diabetes presented to the clinic of one of the authors (RC) with recent weight gain (approximately 10 kg) over the preceding 12 months, despite several unsuccessful attempts at weight loss. She reported being short of breath performing light activities and feeling fatigued the majority of the time. Treatment consisted of a run in period of five weeks following the Commonwealth Scientific and Industrial Research Organisation (CSIRO) diet, followed by four weeks of the CSIRO diet plus intermittent hypoxic training (IHT) using the GO2® altitude training device. Anthropometric measures, bloods and questionnaires were completed before treatment (week 0), end of diet phase (week 5), and end of diet plus IHT phase (week 9). At the end of week five, the patient had lost some weight and had an improvement in glycaemic control. However, there was a clinically greater improvement in weight loss and glycaemic control from week five to nine following the IHT, resulting in remission from pre-diabetes. This case study shows that incorporation of IHT has benefits existing beyond a standard dietary approach, helping to achieve remission from pre-diabetes back to a normal fasting glucose state.

Introduction

A novel approach to weight loss that might help appetite control and working capacity incorporates the use of controlled intermittent exposure

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to mild to moderate hypoxia under varying conditions of rest, exercise and calorie restriction [1—3]. Hypoxic exposure similar to that found in high altitude environments has long been known to contribute to appetite reduction and weight loss [4], as well as improved energy efficiency and exercise capacity [5]. A beneficial effect of moderate controlled hypoxia has been shown for a number of metabolic parameters associated with obesity including improved insulin sensitivity and glucose tolerance, and decreased cholesterol levels [6,7]. Improvements in metabolic markers are accompanied by improved cardiorespiratory function and improved exercise capacity [8].

Therapeutic protocols for administration of intermittent hypoxia for the purposes of improving tolerance of high altitude environments, sporting performance and some medical conditions [9,10] were researched extensively in Russia and the former Soviet Union over several decades [11]. Intermittent Hypoxia Therapy or Training (IHT), which evolved from these research activities, utilises varying levels of hypoxia as a training stress under conditions of rest or physical activity according to the individual's adaptive capacity and training objectives [12]. IHT involves regular sessions of alternating between breathing hypoxic air (in the range of 11—15% oxygen) and normal room air (21% oxygen), through intervals typically several minutes long. A course of IHT is typically 20—30 sessions over a period of 3—4 weeks [13].

Some research has shown that intermittent hypoxia used in conjunction with exercise training results in greater weight loss than exercise training performed under conditions of normoxia [1,3]. To our knowledge there are no published clinical reports of IHT being used independent of exercise training in a clinical setting for purposes of assisting weight loss and improving glycaemic control. The current case study reports on the effects of IHT delivered at rest, during normal wake hours, utilising a hypoxicator device (GO2® altitude) in a person who was overweight and at high risk of metabolic disease.

Methods

Patient characteristics

A female patient (49 years of age) with obesity (body mass index (BMI) 35.3 kg/m^2) and diagnosed with pre-diabetes as per the according to the American Diabetes Association (ADA) Guidelines [14] (fasting blood glucose 5.8 mmol/L) presented on 27 May 2015 at the clinic of one of the authors (RC) with recent weight gain (approximately 10 kg) over the preceding 12 months, despite several unsuccessful attempts at weight loss. She reported being short of breath performing light activities and feeling fatigued the majority of the time. She was planning a trek to Nepal with a group of women and wanted to lose weight and pre-acclimatise to altitude before leaving. No medications were being taken.

Intervention

Treatment consisted of a run in period of five weeks following the Commonwealth Scientific and Industrial Research Organisation (CSIRO) diet, followed by four weeks of the CSIRO diet plus intermittent hypoxic training (IHT) using the GO2® altitude training device. The use of a run-in period of diet alone for a similar period of time before beginning IHT allowed the comparison of diet alone with IHT plus diet. The CSIRO diet is based on a higher protein macronutrient composition with the inclusion of low glycaemic index foods. There is no specific calorie counting involved and it allows one indulgence food per day (for example, 100 ml wine, 4 squares chocolate, 1 scoop ice-cream, 1 chocolate biscuit). IHT involved daily hour long sessions of alternating hypoxia intervals (lasting 6 min) and normoxia intervals (lasting 3 min). During hypoxia intervals blood oxygen concentrations (SpO_2) were monitored with a pulse oximeter and oxygen concentrations were adjusted via biofeedback to maintain the patients SpO_2 levels between 83% and 91%. No exercise programme was prescribed to the patient over the nine week intervention.

Outcome measures

Anthropometric and blood pressure measures were performed at the Boden Institute, the University of Sydney. Anthropometric measures and blood samples were completed before treatment, end of diet phase (week 5), and end of diet plus IHT phase (week 9). A three-day self-reported food diary was collected before treatment and at week 9. The Chalder Fatigue scale [15] was completed at weeks 5 and 9. Body weight was measured using a calibrated scale (correct to the nearest 0.1 kg), waist circumference was measured at the mid-point between the highest point of the iliac crest and lowest part of the costal margin in the midaxillary line (to the nearest 0.5 cm), and systolic and diastolic blood pressure were measured twice in the same arm each time (if a