INTRODUCTION

We, as well as others, have shown that thermoregulatory responses are compromised following head-down tilt (HDT) bed rest and space flight (2, 4-7). For example, we (2) found that after 14 days of HDT bed rest, forearm skin vascular conductance was reduced at any given internal temperature during passive heating (Figure 1). These data indicate that following microgravity exposure the individual is hotter before the cutaneous vascular begins to dilate, and once this dilation has begun, for the same increase in internal temperature there is less of an increase in skin blood flow.

Maximal cutaneous blood flow can be altered as evidenced by reduced maximal flows in the elderly (8) and in individuals with hypertension (1). Others have reported that leg maximal conductance is reduced following simulated microgravity exposure (3), but these reductions were likely confined to the muscle. It remains unclear whether simulated microgravity impairs maximal cutaneous vasodilation, which may contribute to reduced elevations in cutaneous vascular conductance during a heat stress following simulated or actual microgravity exposure. Thus, the purpose of this protocol was to test the hypothesis that 14 days of HDT bed rest impairs maximal forearm cutaneous vascular conductance and identify whether supine ergometry exercise training during bed rest would prevent this impairment from occurring.

CURRENT STATUS OF RESEARCH

Methods: Seventeen healthy subjects (14 males; 3 females) participated in this protocol. Data were obtained prior to, and on day 14 of HDT bed rest. For the female subjects, pre-HDT data were collected 28 days prior to the scheduled post-HDT data collection in an attempt to control for potential effects of the menstrual cycle on maximal cutaneous vascular conductance. Eleven of the seventeen subjects exercised (supine cycle ergometry) 3 times a day for 30 min per exercise bout at a heart rate representing 75% of pre-bed rest maximum. Six subjects did not exercise during HDT bed rest. Repeated baseline forearm blood flow measurements were obtained in thermoneutral conditions (Tsk = 32±0.2°C; via thermocouple attached to forearm) using venous occlusion plethysmography. The forearm was then heated to 42°C using a cylinder water spray device that sprayed a fine mist of heated water from jets surrounding the subject’s forearm. Maximal forearm skin blood flow was obtained via plethysmography following 45 min of heating (9). In both thermal conditions blood pressure was obtained via auscultation from the opposite arm. Forearm vascular conductance was calculated as forearm blood flow-mean arterial blood pressure⁻¹.

Units for forearm vascular conductance in the present paper are reported as ml·100ml⁻¹·min⁻¹·100mmHg⁻¹. Data were analyzed via 2-way ANOVA with main factors of bed rest (i.e. pre and post-HDT; repeated variable) and exercise (i.e. exercise and non-exercise groups; non-repeated variable). Data are reported as mean±SEM. The α level for statistical significance was set at P≤0.05.

Results: Fourteen days HDT bed rest significantly reduced baseline (i.e. normothermic) forearm vascular conductance (pre-HDT: 3.87±0.3; post-HDT: 2.9±0.2; P=0.003). No statistical interaction between bed rest and exercise main factors was identified (P=0.25), thereby suggesting that the decrease in forearm vascular conductance due to HDT was unaffected by the exercise protocol (exercise group: 3.7±0.2 to 2.9±0.2; non-exercise group:...
4.1±0.8 to 3.0±0.5). HDT bed rest did not significantly reduce maximal forearm cutaneous vascular conductance (pre-HDT: 21.4±1.4; post-HDT: 20.3±1.8; P=0.32). Likewise, no statistical interaction between bed rest and exercise main factors was identified (P=0.59; exercise group: 21.5±2.0 to 20.9±2.6; non-exercise group: 21.3±1.2 to 19.3±2.3). However, five of the six subjects from the non-exercise group showed a decrease in maximal forearm cutaneous vascular conductance following bed rest, while the sixth subject showed a large increase in this value (Figure 2). No noticeable trends were observed in the exercise group (Figure 3).

**Conclusions:** These findings suggest that reductions in baseline forearm vascular conductance following prolonged HDT exposure previously reported by us and others is not altered by supine exercise training during HDT. Moreover, HDT bed rest does not alter maximal forearm cutaneous vascular conductance, however a reduction in this variable was observed in five of the six subjects in the non-exercise group.

**FUTURE PLANS**

Four additional subjects are scheduled to participate in this study. Two of these subjects will be assigned to the non-exercise group. From these studies we have also collected data investigating the effects of HDT bed rest on sweat gland function. These data will be analyzed upon completion of the bed rest protocol.

**INDEX TERMS**

Thermoregulation, skin blood flow, head-down tilt bed rest, maximal forearm blood flow, cutaneous vascular conductance, microgravity exposure, humans, exercise.

**CITED REFERENCES**