INDIVIDUAL DIFFERENCES IN COLD ACCLIMATIZATION OF FINGERS

Sirkka Rissanen, Hannu Rintamäki, Juhani Hassi, *Juhani Smolander and **Heikki Laapio

Oulu Regional Institute of Occupational Health, Oulu, Finland
*Institute of Occupational Health, Vantaa, Finland
**South-Eastern Military Area Headquarters, Kouvola, Finland

INTRODUCTION

Acclimatization can be either general, local or both (1). The development of cold acclimatization is evidently depending on the individual physiological and anatomical characteristics (2). The aim of this study was to examine individual differences in thermal responses of fingers during eight weeks expedition in the Antarctic.

MATERIALS AND METHODS

The crew of the Finnish Antarctic station Aboa (eight men; aged 22 - 51 years) were the subjects. The experiments in Finland were made before and after the expedition.

Finger (right hand, middle finger) blood flow and systolic blood pressure were measured with pletysmography utilizing mercury-in-rubber strain-gauges using 30 and 10°C water perfusion (Medimatic SP2, Denmark) (3). Skin temperature at the fingertip was also recorded. Pinger vascular resistance was calculated by dividing systolic blood pressure by blood flow. All the experiment were done at room temperature (22-25°C). In order to evaluate the acclimatization state of the subjects they were exposed to +10°C for 2 hours on the ship during the voyage to Antarctic and back. Rectal and skin temperatures were measured and thermal sensations were asked. The time for the onset of the first shivering bouts and of continous shivering were observed. At the station in Antarctic the time spent outdoors and the time the hands were exposed to cold were recorded by each subject on a diary.

RESULTS

Ambient temperature was on the average -4°C in December, -5°C in January and -8°C in February. Wind velocity varied from calm to ca. 10 m/s with the exception of one storm. On the average, 54 % of work was done outdoors. Hands were exposed to cold for 60 % of outdoor activity time. No significant changes occured in subjects' body weight or adiposity during the expedition. Also maximal oxygen uptake, measured directly on a bicycle ergometer, was about equal before (49.8 ± 2.5) and after (48.9 ± 2.5) ml/min/kg (mean ± SE).

After the expedition, finger blood flow was at 30°C on the average 15 ml/100 ml/min, and at 10°C 8 ml/100 ml/min higher than before the expedition. Variation between individuals was wide: 1.2 - 83 ml/100ml/min in different measurements. The systolic blood pressure of the finger was at 30°C 11 mmHg lower ($P < 0.01$) and at 10°C 4 mmHg (NS) lower after the expedition than before. Finger vascular resistance was at 10°C 15 mmHg/ml/100ml/min lower ($P < 0.01$) after the journey. Fingers were also significantly ($P < 0.01$) warmer (5.5 ± 1.4 at 30°C and 3.9 ± 0.9 at 10°C) after the expedition. Significant correlations were found when induced changes in finger vascular resistance and finger temperature were related to the individual thermal responses measured before the expedition (Fig. 1).

Rectal temperature and skin temperatures showed no significant differences during a two hour cold exposure before and after the expedition. On the contrary intermittent and continuous shivering started respectively 36 and 24 min later ($P < 0.01$) after the expedition. In the end of the first cold exposure general thermal sensation was rated "cool" and after the second one "slightly cool".

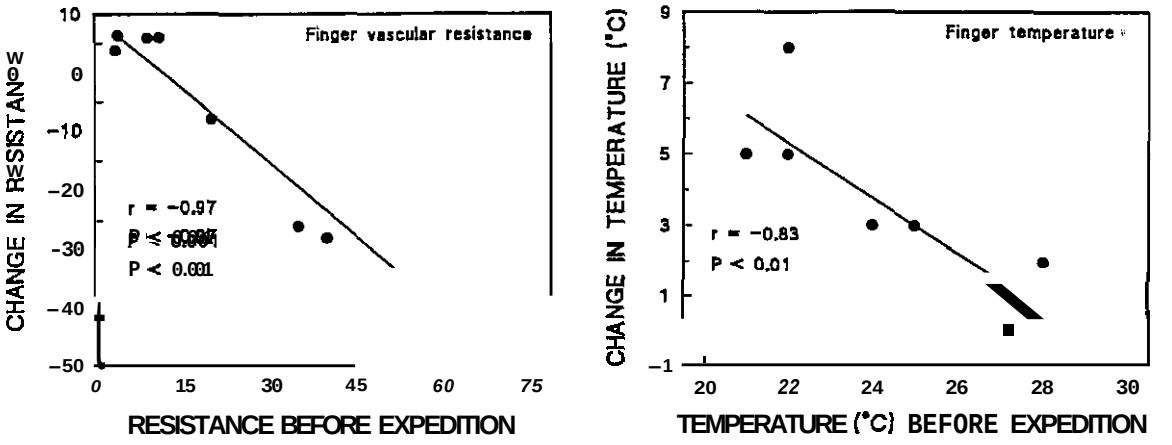

Figure 1. Changes developed in finger vascular resistance (mmHg/ml/100 ml/min) and finger temperature during the expedition in relation to the initial responses in plethysmography before the expedition.

CONCLUSIONS

Significantly delayed onset of shivering after the expedition suggests that a general cold acclimatization developed in subjects.

The observed improvement in finger circulation after the expedition, seen as decreased resistance and pressure and increased blood flow during the cold challenge, indicates that a local, peripheral cold acclimatization developed during the expedition.

Subjects with low initial vasoconstrictive responses to cold before the journey were locally acclimated less effectively than those with higher initial responses although their hands were exposed to cold in the same extent. Obviously the good initial responses in plethysmography with 10°C perfusion can be considered as signs of sufficient ability to sustain manual performance in cold exposures without a need of further improvement. Consequently, the largest acclimative changes were found to develop in subjects having high initial vasoconstriction in hands.

In conclusion the acclimatization state or the individual thermal responses before the expedition had conspicuous effects on the later development of acclimatization of fingers.

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