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Reaction to Cold of Patients with Coronary Insufficiency

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ABSTRACT

Twenty six patients with angina pectoris and coronary insufficiency as judged by an exercise ECG test were examined. About half of the patients had more pronounced ECG changes in a cold room at -15°C than at room temperature. They worked less, their subjective rating of exertion during exercise was higher and the heart performed less work, expressed as the heart rate blood pressure product. The other half of the patients was not much influenced by cold.

During an exercise test in the supine position almost all patients got more pronounced ECG changes, worked less and the heart performed less work than in the sitting position.

It is suggested that cold exposure as well as a supine body position may to a considerable part exert their effect, i.e. lower the anginal threshold and increase ECG changes, by increasing the central blood volume and the diastolic volume of the left heart and thus *ceteres paribus* the myocardial oxygen consumption.

INTRODUCTION

Patients with coronary heart disease often experience a deterioration in their condition in cold weather (4,5). Many patients state that their symptoms are provoked by a cold wind. Some patients observe that an exertion which can be maintained without difficulty in warm weather may provoke an attack of angina pectoris in the cold. Other patients may not be much influenced by cold (5,13). An examination of the way in which patients with coronary heart disease react to cold under standardized conditions is therefore of interest. In this way experiments may be performed to elucidate the mechanism of action of cold in these patients.

MATERIAL AND METHODS

Twenty six patients from 41 to 61 years of age (mean 50 years) were examined because of angina pectoris. They were chosen out of a larger number because they showed ECG changes typical of coronary insufficiency during and after an exercise test. They were not chosen because of particular difficulties in cold weather. Most of them were under treatment with beta-blocking drugs.

The patients performed two or three exercise tests on a bicycle ergometer under different conditions. 1). Cycling in the sitting position in a room at a temperature of about +22°C. 2). Cycling in the sitting position in a room at a temperature of about -15°C. In the cold room the patients were dressed in warm clothes, gloves and a cap covering the head except for the face. Before the cycling started the subjects had stayed for about two minutes in the cold room. 3). Most of the patients also worked on the bicycle ergometer in the supine position.

During the exercise test (16,12) the work was increased stepwise with individually chosen increments every six minutes until the patient was unable to continue or the ECG change or other signs led to an interruption of the test. Heart rate, respiratory frequency, blood pressure, and the subjective rating of exertion (2) were recorded at the end of each work load.

The maximum work load performed was taken to be the heaviest load at which the subject worked for six minutes with an increment proportional to the completed period at the next higher load (17). The total work performed was calculated as the sum of work loads multiplied by time. The (heart rate) (systolic blood pressure) product was calculated for the maximum work load and used as an expression of heart work load (14). For each patient equal work loads were used under the different conditions of exercise.

A group of 17 patients of mean age 54 (range 36-70) years with angina pectoris and fairly comparable with the 26 patients described were used as controls in the room temperature - cold room study. They performed two exercise tests in the sitting position at a room temperature of about +22°C with an interval of less than one month.

As controls in the sitting-supine study 26 healthy subjects of mean age 70 (range 61-83) years (17) were used.

RESULTS

Fourteen of the 26 patients (group 1) got more pronounced ST depressions (0.5 - 1 mm) during the exercise test in the cold room compared with the test at room temperature ("cold responders"). The remaining 12 patients (group 2) did not get more ST depressions in the cold room than at room temperature on equal work load.

Fig.1 (left side) and Table 1 show results of group 1 and group 2 as well as the whole group (1+2) at room temperature and in the cold room. The average of the maximum work load performed, the maximum heart rate reached, the heart rate systolic blood pressure product as an expression of the heart work at maximum work load, the total work performed decreased, and the rating of subjective exertion increased significantly in group 1 but not in group 2. The percentage difference between the exercise performance as well as the subjective rating of exertion of the group 1 patients at room temperature and in the cold room was statistically significantly greater than the difference between the two work tests, both at room temperature, of the 17 patients of the control group with angina pectoris (Table 1).

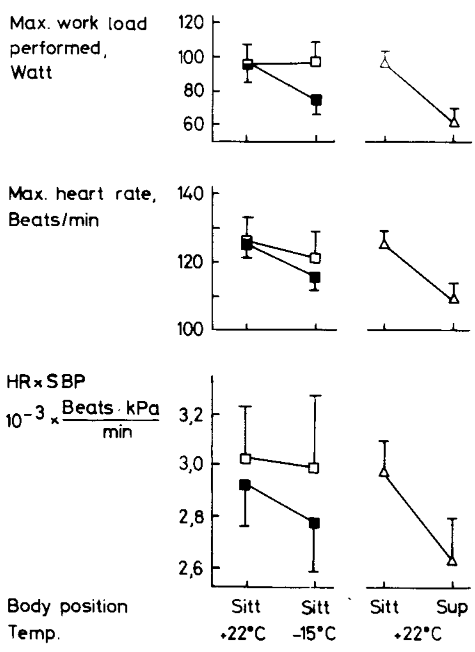

Fig.1. Results of the exercise tests at room temperature, +22°C, and in the cold room, -15°C, sitting on the bicycle ergometer for angina pectoris patients who responded with increased ECG changes in the cold, group 1(■) and for non-responders, group 2(□), left side of the figure. The right hand side of the figure shows results from tests performed at +22°C in the sitting and supine position for group 1+2(△). The symbols indicate means and vertical bars standard error of the mean.

Table 1. Maximum work load performed, total work performed, maximum heart rate, and rating of subjective exertion during work on equal load in the sitting position at room temperature, RT +22°C, (work test I) and during a second test in a cold room, CR -15°C, (work test II) for the angina pectoris group 1,2 and 1+2. The results of work test II are given as differences between work test I and II in percent of work test I, i.e. 100 •(I-II)/I.

The control group of angina pectoris patients exercised at room temperature about +22°C in the two work tests. Mean and SEM are given.

Variable Group	n	Work test I RT +22°C	Work test II % change from work test I CR -15°C	 RT +22°C
Maximum work load, W				
Group 1	14	96 ± 10	21 ± 7.6^{xx,o}	
Group 2	12	96 ± 11	1 ± 3.2	
Group 1+2	26	96 ± 7	11 ± 8.0^{x}	
Control group	17	78 ± 8		0 ± 3.9
Total work performed Wxmin				
Group 1	14	1026 ± 171	26 ± 8.4^{xx,o}	
Group 2	12	941 ± 193	-4 ± 9.5	
Group 1+2	26	987 ± 126	13 ± 6.9	
Control group	17	800 ± 130		-1 ± 6.4
Max heart rate stroke/min				
Group 1	14	125 ± 4	7 ± 1.7^{xx}	
Group 2	12	126 ± 8	4 ± 3.5	
Group 1+2	26	125 ± 4	6 ± 1.9^{xx}	
Control group	17	123 ± 7		-6 ± 5.1
Rating of exertion				
Group 1	14	15 ± 0.7	-16 ± 3.4^{xx,oo}	
Group 2	12	16 ± 0.5	- 5 ± 3.1^{o}	
Group 1+2	26	15 ± 0.4	-10 ± 2.5^{xx,oo}	
Control group	17	14 ± 0.4		4 ± 2.2

n = number of subjects, x and o indicate $0.05 > P > 0.01$, xx and oo indicate $0.01 > P > 0.001$, x and xx indicate the probability that the difference between work test I and work test II is caused by random factors. o and oo indicate the probability that the difference between the percentage change between work test I and work test II of the patient group and the corresponding percentage change between the two work tests of the control group is caused by random factors.

The systolic blood pressure during maximum work load was not significantly different between the groups or the different conditions of exercise. The mean systolic pressures were slightly higher during the exercise in the cold room.

Angina pectoris was recorded earlier in the cold room than at room temperature in 11 of 14 subjects of group 1 and in 6 of 12 subjects of group 2. Although suggestive this difference is not statistically significant.

Several of the patients in both groups performed an exercise test in the supine position. There was no significant difference between the subjects from group 1 and group 2 and therefore the results are given for all these patients together on the right hand side of Fig.1, cf also Table 2.

Table 2. Results from exercise tests performed at room temperature, +22°C, sitting (work test I) and supine (work test II) for the angina pectoris patients of groups 1,2,1+2 and a control group of healthy males (17)

Variable Group	n	Work test I Sitting	Work test II % change from work test I Supine
Maximum work load, W			
Group 1	9	88 ± 11.5	37 ± 10.2xx
Group 2	10	97 ± 12.6	30 ± 6.1xxx
Group 1+2	19	93 ± 8.4	33 ± 5.5xx
Control group	26	136 ± 5.4	18 ± 2.0xx
Total work performed Wxmin			
Group 1	7	964 ± 263	45 ± 10.5xx
Group 2	7	864 ± 185	52 ± 10.9xx
Group 1+2	14	914 ± 158	48 ± 7.3xx
Control group	26	1591 ± 107	28 ± 1.0xx
Max heart rate stroke/min			
Group 1	11	123 ± 11.7	17 ± 2.9xxx
Group 2	10	126 ± 9.1	8 ± 1.9xx
Group 1+2	21	125 ± 5.0	12 ± 2.0xxx
Control group	26	153 ± 3.4	9 ± 3.9xx

Symbols as in Table 1

The maximum work load performed, the total work performed, the maximum heart rate and the heart work load, calculated as the heart rate systolic blood pressure product, were all lower in the supine position.

The impairment of exercise performance in the supine position, expressed as the percentage of the result in the sitting position, for the angina pectoris patients was not statistically significantly greater than that found in the control group of 26 healthy old subjects, see Table 2.

There was no significant difference between systolic blood pressure during maximum exercise load in the sitting and supine positions. ST depressions were in all cases but three more pronounced in the supine than in the sitting position.

In a few cases the exercise test in the cold room was of significance for the diagnosis of coronary insufficiency, as there were no significant ECG changes at room temperature, while ECG changes typical of coronary insufficiency appeared during and after the exercise test in the cold room. Exercise in the supine position was even more effective in this respect.

DISCUSSION

Several patients in group 1 were very incapacitated during the winter and in these patients the examination of the reaction to an exercise test in the cold room was of interest for the evaluation of their degree of incapacity.

Patients of group 2 demonstrated a low sensitivity to cold. It is possible that their reaction to cold is the result of an adaptation to cold (1). About half of the angina pectoris patients reacted to cold exposure or approximately the same proportion as that reported by other authors (5,13).

Several mechanisms have been discussed as an explanation for the effect of cold in patients with coronary insufficiency, such as reflex contraction of coronary arteries as result of the cold stimulus to the skin (5,11,12) increased vascular resistance and increased blood pressure (4,7) and therefore increased work for the heart (9).

Another explanation (10) might be that cold results in a general vasoconstriction of cutaneous vessels and consequent redistribution of the blood volume, with an increase in the central blood volume (6) and probably increase in central venous pressures, at least initially. In this way an effect is obtained which may be similar to that obtained by changing from an upright to a supine body position (3) or by the intravenous administration of dextran (8). The similarities between the changes obtained in cold and in the supine position are suggestive. It is likely that cold as well as the supine position results in some increase in the diastolic volume of the left heart. Changes in ventricular volume are of critical importance in determinating myocardial oxygen consumption, since an increase means that an augmented wall tension will be required by the heart for the same external work (15).

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