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FUNCTIONAL ABILITY IN PATIENTS WITH ARTERIAL HYPERTENSION – A FOLLOW-UP

ABSTRACT

A population sample consisting 4.214 subjects of both sexes aged 35-54 years was examined in 1969, selected at random from the Municipal register from six regions of Croatia: two urban, two rural and two semiurban. A sample consisting of 180 subjects of both sexes from urban registry from the city of Zagreb Centre, who were grouped into persistently hypertensive, periodically hypertensive and control subjects, were followed up over a period of 15 years. In addition to clinical examination and blood pressure measurement a resting electrocardiogram and repeated post-exercise electrocardiograms were taken for all subjects. The aim of this study was to examine the effect of elevated blood pressure on ECG findings at rest and after exercise. In hypertensive male subjects the most frequent changes in resting electocardiogram were ST segment depressions. No such changes were detected in women. From the observed ST segment changes it was not possible to establish how long it would take them to manifest themselves at a higher rate than in persons having normal blood pressure. In the 15-year period, the rate of arrhythmias at exercise in males appeared to be increasing with age. It was not possible, however, to ascertain whether this may have been due to increased blood pressure only.

Introduction

Among major risk factors for cardiovascular diseases, high blood pressure[1] may be singled out, as almost 20 per cent of the adult population is reported to have

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arterial hypertensions[2]. Epidemiological studies conducted in non-selected populations in highly developed industrialized countries show that 50 per cent of hypertensive subjects have heart disease with cardiac enlargement and/or electrocardiographic signs of left ventricular hypertrophy[1]: an electrocardiogram however plays an important diagnostic role, especially during and after exercise[3,4].

Arterial hypertension induces direct and indirect effects on cardiovascular and other systems[3-6]. The presence in the population of mild forms of hypertension are also bound to induce cardiac changes which can be registered by means of resting or exercise electrocardiogram. Since population studies which could provide an answer to this question call for a great deal of effort and money[7-9], more questions invariably follow: what results may we expect to achieve on a smaller population sample, how constant are the changes registered and how long does it take for some electrocardiographic changes, that cannot be defined as accidental but occur as a results of elevated blood pressure, to become apparent. With more severe forms of arterial hypertension, left ventricular hypertrophy is an abnormality which is relatively frequently registered on the electrocardiogram[10]. With milder forms of hypertension, however, no such relatively drastic changes are expected, but only those that are connected with a lower degree of impairment according to the Minnesota code[11]. The present study aims to show whether, in a comparatively small number of subjects, over a period of years, ECG changes at rest and after exercise can be single out, which could be related to high blood pressure.

Sample and methods

A population sample from Croatia consisting of 4.214 subjects of both sexes aged between 35 and 54 was examined in 1969, selected at random from the Municipal register of the population in six regions of Croatia: two urban, two rural two semiurban in the interior and of the coast. Apart from a physical examination and laboratory tests, the examination included blood pressure measurement according to WHO criteria and an electrocardiogram at rest and at and after exercise using a bicycle ergometer. The exercise was of the same grade and lasted five minutes, with a pedalling speed of 50 r.p.m. The load for men was 150 W and for women 100 W. Blood pressure measurements were taken for the same subjects again in 1972.

On the basis of blood pressure values determined in 1969 and 1972, in 1980 we selected a group of 90 men and 90 women among subjects living in the Zagreb Centre community using a random sampling method and classified them in three groups (Table 1). The first group consisted of the subjects who had elevated diastolic pressure (95 mmHg or higher) in both 1969 and 1972. The second group included the subjects with elevated diastolic pressure in one of the two measurements. The third, control group, consisted of the subjects whose blood pressure was normal at both examinations. In the 1980 study the subjects were tested by means of the maximal exercise treadmill test according to the Bruce protocol[5]. The level of maximal work was chosen according to the subject's age and sex with respect to the pulse rate. The test was stopped if the established indications for termination of exercise were present[6] or if blood pressure reached a value of 240/130 mmHg. In

Table 1.

Data of examinee

	Years of examination	Persistently hypertensive	Periodically hypertensive	Normotensive	TOTAL
MEN	**1980**	**30**	**30**	**30**	**90**
	1984	**29**	**28**	**28**	**85**
		1 died in 1982 (malig.lymphoma)	*1 died in 1982* (reason unknown) *1 died in 1983* (myocardial infarction)	*1 died in 1982* (brain tumor) *1 died in 1982* (myocardial infarction)	**5**
WOMEN	**1980**	**30**	**30**	**30**	**90**
	1984	**28**	**28**	**27**	**83**
		1 living (stroke)	*2 living* (veneous thrombosis in the legs)	*1 living* (moved away)	**7**
		2 living (veneous thrombosis in the legs)		*1 died* (haematemasis) *1 living* (myocardial infarction)	**7**

1984 all the 1980 subjects tested were again summoned for examination, of whom 168, 85 men and 83 women, were tested under indentical conditions. The remaining twelve subjects either died in the preceding four-year period or were spared treadmill testing because of locomotive complaints. The ECG tracings were coded according to the Minnesota Codell using uniform criteria i.e. all ECGs were interpreted by the same doctors, except in 1984, when ECGs were read by two doctors independently whose interpretations showed good agreement as confirmed by subsequent control. The ECG responses were then grouped, so that, for example all ST segment changes coded 4-1 to 4-4 were placed in the same group. Thus, a greater frequency of individual finds was achieved. All data were statistically analysed along these lines.

It is possible that the responses have been modified to some extent by drugs taken by some of our subjects. Persistently hypertensive subjects who were taking drugs in non-therapeutic doses or at irregular intervals were taken in 1980 to be without therapy, the same as the control grup. This applied to a man with a daily dose of 20 mg propranolol and a woman who occasionally took 40-80 mg oxprenolol. The remaining subjects were without therapy in 1980. In 1984 the two above mentioned patients were examined after three weeks of abstinence. Among 29 persistently hypertensive male patients who were taking any drug whatsoever in 1984, three received a combination of reserpine, clopamide and dihydroergochristine, one methyldopa, one guanethidine and four beta adrenergic blocking agents. Of 28 periodically hypertensive male patients three were taking reserpine, of whom one was taking beta adrenergic blockers, one was on a combination of

reserpine and hydrochlorothiazide and one digitalis. Among 28 women with persistent hypertension four were taking, a combination of reserpine and hydrochlorothiazide of whom one also took 80 mg propanolol, two hydrochlorothiazide, two methyldopa and four beta adrenergic blocking agents. Od 28 periodically hypertensive women four were receiving a combination of resorpine, clopamide and dihydroergochristine, of whom one had taken medigoxin, and two were treated with beta adrenergic blocking agents. The control groups of both sexes, as in 1980, did not receive any therapy. The data obtained were processed using on electronic computer. Statistical analysis was done with the chi-square testl[2].

Results

Table 2. shows resting and after exercise ST-segment changes in the 15-year period. While in 1969 five out of 30 men with persistent hypertension had ST changes at rest, fifteen years later there were eight out of 30. None of control male subjects had ST-segment changes. The presence of ST-segment changes was hardly detectable among persistently hypertensive women at any examination. A small number of ST changes were identified in women with periodically high blood pressure and in the control grup.

Table 2.

ST-segment changes in the electrocardiogram at rest (and after exercise) over a 15-year period

SEX	YEARS	1969 and 1972 Elevated blood pressure		1969 and 1972 Elevated blood pressure		1969 and 1972 Elevated blood pressure		TOTAL
		Normal values	Pathologic. values	Normal values	Pathologic. values	Normal values	Pathologic. values	Normal+Pathological values
Men	1969	24 (21)	5 (8)	26 (22)	2 (6)	27 (22)	1 (6)	(85) n.s. (ns)
	1980	23 (19)	6 (10)	28 (19)	0 (9)	28 (22)	0 (6)	(85) p<0.01 (ns)
	1984	21 (15)	8 (14)	26 (19)	2 (9)	28 (21)	0 (7)	(85) p<0.01 (ns)
							p=0.9954	(p=9.949)
Women	1969	27 (22)	1 (6)	24 (21)	4 (7)	23 (20)	4 (7)	(83) n.s. (ns)
	1980	28 (22)	0 (6)	23 (18)	5 (10)	21 (17)	6 (10)	(83) p<0.05 (ns)
	1984	28 (21)	0 (7)	23 (18)	5 (10)	21 (16)	6 (11)	(83) p<0.05 (ns)
							p=0.9997	(p=9.903)

Finding post-exercise are put in parenthesis. In males, a rise in frequency with age is noted among the persistently hypertensive subjects, it is smaller among those who were periodically hypertensive, while no major change is observed in the control group. In women ST-segment changes are less common among those with hypertension and they occur more frequently in the control group.

T-wave changes at rest and after exercise over a period of 15 years are shown in, Table 3. They appear at rest to be more common in persistently hypertensive men than in the controls. The subjects with periodically elevated blood pressure tend to be somewhere in between. The finding for women is entirely different. The changes are less prevalent among persistently hypertensive subjects.

Table 3.

T-wave changes in the electrocardiogram at rest (and after exercise) over a 15-year period

SEX	YEARS	1969 and 1972 Elevated blood pressure		1969 and 1972 Elevated blood pressure		1969 and 1972 Elevated blood pressure		TOTAL
		Normal values	Pathologic. values	Normal values	Pathologic. values	Normal values	Pathologic. values	Normal+Pathological values
Men	1969	22 (22)	7 (7)	25 (20)	3 (8)	26 (22)	2 (6)	85 n.s. (ns)
	1980	25 (26)	4 (3)	27 (20)	1 (8)	27 (25)	1 (3)	85 n.s. (ns)
	1984	22 (25)	7 (4)	22 (22)	6 (6)	27 (24)	1 (4)	85 n.s. (ns)
							p=0.9954	(p=9.9970)
Women	1969	26 (22)	2 (6)	24 (21)	4 (7)	23 (22)	4 (5)	83 n.s. (ns)
	1980	27 (25)	1 (3)	24 (18)	4 (10)	24 (21)	3 (6)	83 n.s. (ns)
	1984	27 (24)	1 (4)	22 (15)	6 (13)	20 (19)	7 (8)	83 n.s. (ns)
							p=0.9890	(p=9.9830)

Post-exercise T-wave changes over the follow-up period are put in parenthesis. No rule seems to be applicable to the freqency of this finding in both sexes.

Table 4. shows the frequency of arrthythmias in the 15-year period as recorded by resting ECG and after exercise. Persistently hypertensive and control male subjects do not greatly differ with respect to this finding at rest. The difference, however, becomes much more pronounced over the 15-year period, although not significantly. The results for women are similar. There are no major differences between the groups with respect to blood pressure values, while over a period of 15 years these differences tend to become noticeable. The prevalence of arrhythmias over a period of 15 years is similar in persistently hypertensive and control subjects of both sexes.

The prevalence of arrhytmias after exercise are put in parenthesis. While in 1969 one in 29 hypertensive subjects had heart-rate imparirment after exercise testing, fifteeen years later eight men with persistent hypertension had this abnormality. Of 28 control subjects who were exercise tested in 1969 one had arrhythmia, while fifteen years later there were five. Most changes took place over the last four years. The differences are statistically significant. The findings for women are similar, but the differences are not statistically significant.

Table 4.

Arrhythmias in the electrocardiogram at rest (and after exercise) over a 15-year period

SEX	YEARS	1969 and 1972 Elevated blood pressure		1969 and 1972 Elevated blood pressure		1969 and 1972 Elevated blood pressure		TOTAL
		Normal values	Pathologic. values	Normal values	Pathologic. values	Normal values	Pathologic. values	Normal+Pathological values
Men	1969	28 (28)	1 (1)	27 (25)	1 (3)	28 (27)	2 (6)	85 n.s. (ns)
	1980	23 (29)	6 (0)	23 (28)	5 (0)	24 (27)	1 (3)	85 n.s. (ns)
	1984	23 (21)	6 (8)	27 (21)	1 (7)	24 (23)	1 (4)	85 n.s. (ns)
							p=0.4131	(p=0.0324)
Women	1969	28 (27)	0 (1)	27 (28)	1 (0)	23 (27)	4 (5)	83 n.s. (ns)
	1980	24 (27)	4 (1)	23 (27)	5 (1)	24 (25)	3 (6)	83 n.s. (ns)
	1984	24 (23)	4 (5)	27 (25)	1 (3)	20 (23)	7 (8)	83 n.s. (ns)
							p=0.4341	(p=0.7355)

Discussion

Haemodynamic stresses and biological changes over one's lifetime may cause many effects[15]. How they will affect the cardiovascular system, when and to what extent, will depend on many factors including the much referred to risk factors. It appears, however, that in interpreting certain findings the effect of risk factors may be rather difficult to assess and define strictly, even when objective measuring methods are applied[14].

For determining the effect of high blood pressure on the heart in our sample, we used the resting and exercise ECG and applied it repeatedly. The methodology was essentially the same over the 15-years. Analysis of resting ECG changes in three groups of subjects separately for sexes shows that no major significant differences between hypertensive and control subjects were present at the first examination in 1969. Thus, it took 11 to 15 years for the differences between hypertensive and control subjects to become noticeable in S-T segment depression. T-wave changes, ventricular conduction impairment, arrhythmias and other resting ECG abnormalitis did not differ within groups over the 15-year period. ST-segment depression is the most frequent ECG response which can be singled out over such a long period of study. In the sample of 4.214 persons from which ours was selected at a later stage the ECG abnormalities detected (left axis deviation, and tall R wave) were associated with high blood pressure[15]. The question of whether ECG changes, as realistic indicators, manifest themselves in hypertensive persons differently to the other subjects in the follow-up period remains to be answered. The finding for women is especially confusing as those in the 1984 control group and those who were periodically hypertensive had significantly more changes in ST-segment depressions

than the women who were classified as persistently hypertensive. Can we use here the results of other authors[16] who do not take ST-segment depression, to a certain degree, in women to be pathological or at least not in the same measure as in men to explain our own results? However, whether ST changes are the result of high blood presure or of some other cause, the fact remains that in this sample, of all resting ECG changes examined over the 15-year period, ST-segment depression in men, not in women is found to be the most common one, while all other ECG changes are less so.

Although the frequencies of ST segment depression after exercise are higher than at rest, statistical differences within groups are not significant. ST changes found to be more common in 1980 and 1984 than in 1969, are not significant within individual groups. Such findings, which are not greatly different from the ones recorded earlier, are similar to the results of analysis of T-changes but different to those pertaining to arrhythmia following exercise (mainly frequent ventricular premature beats). In males it has been possible to establish a relationship between arrhythmias and high blood pressure in the 15-year period, with the main differences occurring in the last four years. In women only tendencies could be noted as far as the finding of arrhythmias is concerned. It is pointed out that there are no statistically significant differences between hypertensive and control subjects. Thus, a key factor here appears to be the time factor of 15 and 4 years respectively, while the effect of high blood pressure on the prevalence of arrhythmias after exercise could not be separated. This finding can be compared with the results of Kramer et. a1[14]. who only established a relationship between progression of atherosclerosis and the time constant, but were unable to single out specific effects of hypertension and other risk factors. Our data indicate that the finding of arrthythmias in the examined sample is pathological. Namely, in 1984 eight (28%) out of 29 men with persistent hypertension had arrhythmias in contrast to five (18%) control subjects. Also, of 28 women with persistent hypertension five (18%) had arrhythmias in contrast to four (15%) from the control grup, which, to some extent, is similar to the prevalence of arrhythmias in patients with coronary heart disease[17,18]. Evidently, the effect of blood pressure on post-exercise ECG changes in the sense of arrhythmias has a centrain meaning and the etiopathogenesis of heart function impairment[19] has to do with arterial hypertension. However, a number of other factors are likely to be involed[20]. It should be noted that the physical exercise test in 1969 was carried out on a bicycle ergometer in contrast to later tests.

Apart from high blood pressure, it is not possible to exclude the effects of other risk factors on the obtained results.

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