SHORT COMMUNICATION

Plasma catecholamines and renin activity in response to exercise in patients with essential hypertension

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Summary

1. The effect of physical exercise on blood pressure, plasma catecholamines and plasma renin activity was studied in fourteen patients with essential hypertension and in eight healthy subjects.

2. Resting plasma noradrenaline and adrenaline and plasma renin activity of the hypertensive patients did not differ from those of the control subjects.

3. In response to graded exercise producing successive heart rates of 120, 140 and 160 beats/min, significantly greater increases of blood pressure were found in the patients than in the control subjects.

4. Plasma noradrenaline increased significantly in both groups at all levels of exercise, the responses being significantly greater in the hypertensive patients.

5. The mean arterial blood pressure was significantly correlated with plasma noradrenaline concentration in the control subjects but not in the hypertensive patients.

6. In the hypertensive group plasma adrenaline increased significantly after exercise at all work loads whereas, in the control group, significant increase occurred only at the highest work load. The differences in the response of the two groups were significant at each work load.

7. Plasma renin activity increased significantly after exercise at the heart rate of 120 beats/min, both in the hypertensive patients and in the control subjects. The magnitude of the response was similar in the two groups.

Key words: essential hypertension, plasma renin activity, sympathetic activity, upright exercise.

Introduction

Reports from this and other centres have demonstrated that some patients with essential hypertension exhibit increased sympathetic activity as evidenced by augmented concentrations of blood catecholamine or enhanced urinary excretion of catecholamines (De Quattro & Miura, 1973; Januszewicz & Wocial, 1975). The purpose of the present study was to compare the effects of physical exercise on plasma concentrations of noradrenaline and adrenaline and plasma renin activity in patients with essential hypertension and in healthy control subjects.

Methods

The hypertensive group consisted of fourteen male patients, aged 20–48 years (mean 34.5, SD 11.0). The diagnosis of essential hypertension was established by the presence of a systolic pressure consistently exceeding 140 mmHg, diastolic pressure consistently exceeding 90 mmHg, and by exclusion of known causes of secondary hypertension. Patients with advanced retinopathy, congestive heart failure, renal failure or clinical symptoms of coronary heart disease were not included. All drugs were withheld for at least 3 weeks before the studies. The control subjects. The magnitude of the response was similar in the two groups.
group consisted of eight healthy male volunteers, aged 20–38 years (mean 30.0, SD 5.5). The subjects maintained their normal activity and were not admitted to hospital for the study. The sodium content of their diet, as monitored by 24 h urine sodium, was within accepted normal limits for our Laboratory.

The studies were made 5–6 h after breakfast. After 1 h of rest in the supine position, the subjects performed upright exercises on a bicycle ergometer (Elema Schöndanger), at three successive work loads adjusted to give a steady-state heart rate of 120, 140 and 160 beats/min respectively.

The subjects exercised for 10–12 min at each of these work loads and rested 15 min in the supine position between each exercise period. Blood pressure was measured by a conventional sphygmomanometer. During resting periods, repeated measurements were made until the blood pressure was constant; throughout exercise, measurements were made every 3 min. Mean arterial pressure was taken to be the diastolic pressure plus 39% of the systolic–diastolic difference.

Oxygen uptake was measured during the final 2 min of each exercise period. Blood samples were obtained via an intravenous catheter inserted into the antecubital vein. Plasma noradrenaline and adrenaline concentrations were determined immediately before the first exercise period and immediately after exercise at each work load by means of the fluorimetric method of Anton & Sayre (1962), an Aminco–Bowman spectrophotofluorimeter being used. The recovery of noradrenaline and adrenaline was 87 ± 9% and 89 ± 11% respectively. Plasma renin activity was measured immediately before, and immediately upon completion, of the first exercise period, by the method of Boucher, Veyrat, de Champlain & Genest (1964): results are expressed in terms of angiotensin II generated.

Blood lactate concentration was determined in arterialized fingertip blood samples before exercise and after each exercise period with the method of Ström (1949).

Student’s t-test and Pearson’s correlation coefficient were used for statistical evaluation of the results. Results have been expressed as mean values ± SD unless otherwise stated.

Results
The heart rates attained at each work load closely approximated to the protocol values of 120, 140 and 160 beats/min, both in patients with essential hypertension and in healthy subjects (Table 1). The values of absolute oxygen consumption and lactate concentrations during each exercise period were similar in both groups (see Table 1).

The resting mean arterial blood pressure was significantly higher (P < 0.001) in hypertensive patients (117 ± 11 mmHg) than in control subjects (92 ± 8 mmHg). The average increases in mean blood pressure in the ninth minute of each exercise period were significantly higher in the patients than in the control subjects during exercise at the heart rate of 140 beats/min (P < 0.05) and 160 beats/min (P < 0.01).

The pre-exercise concentrations of plasma noradrenaline and adrenaline did not differ significantly (P > 0.05) between the patients and the control subjects (Table 1).

Plasma noradrenaline concentrations were significantly elevated after each successive work load both in the patients and in the control subjects. The magnitude of the response was significantly greater in the patients than in the control subjects during exercise at the heart rate of 140 beats/min (P < 0.05) and 160 beats/min (P < 0.01).

The mean arterial blood pressure was significantly correlated with plasma noradrenaline concentration in healthy subjects (P < 0.01), but not in the hypertensive patients (P > 0.05).

In the hypertensive group, plasma adrenaline concentrations were significantly elevated after completion of each exercise period (P < 0.01). In healthy subjects, plasma adrenaline increased significantly only after exercise at the highest work load (P < 0.05). The increases in plasma adrenaline were more pronounced in patients with essential hypertension than in control subjects at each work load (P < 0.01).

Neither in hypertensive patients nor in normotensive controls did blood pressure correlate significantly with plasma adrenaline concentration.

No statistically significant difference was found between the resting plasma renin activity of the patients and that of the control subjects. In both groups, plasma renin activity increased significantly during exercise (P < 0.01). The magnitude of the response did not differ significantly between the two groups. There was no significant correlation between the simultaneously determined noradrenaline and plasma renin activity either in patients with essential hypertension or in the control group.
Exercise in essential hypertension

Table 1. Oxygen uptake, heart rate, plasma catecholamines, plasma renin activity and blood lactate concentration during exercise in hypertensive patients and healthy subjects

Mean values ± SD are given.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Oxygen uptake (l/min)</th>
<th>Heart rate (beats/min)</th>
<th>Plasma noradrenaline (nmol/l)</th>
<th>Plasma adrenaline (nmol/l)</th>
<th>Plasma renin activity (ng/100 ml)</th>
<th>Blood lactate (mmol/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before exercise</td>
<td>End of exercise</td>
<td>Before exercise</td>
<td>End of exercise</td>
<td>Before exercise</td>
<td>End of exercise</td>
</tr>
<tr>
<td>Hypertensive</td>
<td>1.037 ± 0.210</td>
<td>120 ± 3</td>
<td>3.49 ± 0.87</td>
<td>8.46 ± 3.43</td>
<td>1.74 ± 0.27</td>
<td>4.14 ± 1.69</td>
</tr>
<tr>
<td>patients (n = 14)</td>
<td>1.507 ± 0.435</td>
<td>140 ± 2</td>
<td>11.18 ± 3.84</td>
<td>4.69 ± 1.74</td>
<td>209 ± 1.26</td>
<td>472 ± 1.26</td>
</tr>
<tr>
<td></td>
<td>1.962 ± 0.400</td>
<td>159 ± 3</td>
<td>16.51 ± 4.49</td>
<td>5.13 ± 1.41</td>
<td>1.25 ± 0.13</td>
<td>2.27 ± 0.68</td>
</tr>
<tr>
<td>Healthy control</td>
<td>1.150 ± 0.221</td>
<td>120 ± 2</td>
<td>0.64 ± 0.15</td>
<td>5.92 ± 1.30</td>
<td>1.80 ± 0.32</td>
<td>1.96 ± 0.43</td>
</tr>
<tr>
<td>(n = 8)</td>
<td>1.590 ± 0.390</td>
<td>140 ± 2</td>
<td>8.40 ± 2.13</td>
<td>2.18 ± 0.49</td>
<td>212 ± 1.54</td>
<td>395 ± 1.03</td>
</tr>
<tr>
<td></td>
<td>1.937 ± 0.300</td>
<td>160 ± 2</td>
<td>11.50 ± 1.94</td>
<td>2.56 ± 0.49</td>
<td>1.34 ± 0.23</td>
<td>2.80 ± 0.74</td>
</tr>
</tbody>
</table>

Discussion

Subjects of both groups demonstrated similar working capacity and were subjected to closely comparable work loads. The two groups differed in the values of blood pressure at rest, but their resting plasma catecholamines and plasma renin activity were similar.

The greater pressure response to exercise in hypertensive patients than in healthy subjects has been previously reported (Amery, Julius, Whitlock & Conway, 1967; Julins & Conway, 1968). It has also been shown that physical work induces increases in plasma noradrenaline and adrenaline concentrations (Kotchen, Hartley, Rice, Mougey, Jones & Mason, 1971; Kozlowski, Brzezińska, Nazar & Kowalski, 1972).

The present study demonstrates that a comparable work load produces significantly greater response of plasma noradrenaline in patients with essential hypertension than in healthy control subjects. Moreover, in contrast to the control group and in spite of the greater pressor response to exercise, the hypertensive patients did not show a correlation between plasma noradrenaline and blood pressure. This finding may indicate that our group of patients with essential hypertension, although characterized by normal resting plasma catecholamine concentrations and, presumably, normal resting sympathetic activity, displayed altered response of the sympathetic nervous system to exercise. Such a conclusion can be further supported by the finding of significant elevation of plasma adrenaline occurring in the hypertensive group after exercise at all work loads, in contrast to the normal subjects, who demonstrated such an increase only at the greatest work load, the differences between the two groups being significant at all exercise levels.

The effect of upright exercise on plasma renin activity was similar in both groups. This could be related to the low work load. However, the patients with essential hypertension demonstrated a significant increase of plasma catecholamines at the same work load.

It has been shown by others that increases in plasma renin activity usually follow exercise at large work loads in normal subjects (Aurell & Vikgren, 1971; Kotchen et al., 1971). Parallel increases of blood catecholamines and plasma renin activity in response to graded exercise have been also reported in healthy subjects (Kotchen et al., 1971). Bearing in mind a possible time-lag between activation of the sympathetic system and renin release, we cannot postulate an independence of plasma renin activity.
from sympathetic activity in our experimental conditions.

Although the exact mechanism of the changes found in our subjects cannot be stated, the results of the present study suggest that patients with essential hypertension and normal resting sympathetic activity may exhibit abnormal response of the sympathetic nervous system to upright exercise.

References


