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The role of adrenergic mechanisms in the blood pressure regulation of leg-amputees

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Summary

An increased occurrence of hypertension has been reported among leg-amputees. In order to investigate whether leg amputation is followed by an elevation of sympathetic tone, possibly enhanced by continuous mechanical irritation of the amputation stump by wearing a prosthesis, blood pressure (BP), pulse-rate (PR) and plasma catecholamines (norepinephrine, NE, and epinephrine, E) were measured in six hypertensive leg-amputees during prosthesis walking as well as during irritation of the amputation stump by vacuum suction in the supine position. Six patients suffering from essential hypertension and six normotensive subjects served as control groups.

Basal levels of plasma NE and E did not differ in the three investigated groups. Mechanical stump(limb) irritation as well as walking induced a rise of NE but not of E, accompanied by a rise of BP and PR in amputees as well as in the control subjects. Elevation of NE and BP was most accentuated in hypertensive amputees when walking with prosthesis. Within each investigated group there was a positive correlation between NE and mean arterial blood pressure (MAP), (p < 0.001 in hypertensive amputees and non-amputees, p < 0.05 in normotensives). We conclude that mechanical limb irritation induces a rise of BP by sympathetic nervous stimulation. Thus wearing of a vacuum-prosthesis may support a consistent rise in BP.

Key words: leg amputees, blood pressure regulation, sympathetic nervous system

Introduction

Elevation of BP has been reported in leg-amputees (14, 16, 18) and was attributed to an increased sympathetic tone following amputation (16, 18). Chronical stump irritation by infection was supposed to enhance sympathetic nervous activity, in this way promoting development of hypertension and other symptoms of augmented sympathetic tone (1, 18), whereas other authors denied an increased tendency to hypertension among leg-amputees (6, 10, 15). We entered this controversial topic and investigated sympathetic nervous activity in leg-amputees taking plasma catecholamine levels as an index of sympathetic nervous activity. Special

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attention was given to the question whether mechanical irritation of the amputation stump was associated with sympathetic nervous stimulation and a rise of BP.

Patients and methods

Patients

Three groups of subjects were included in this study:

1) six hypertensive leg-amputees (all male, age: mean 51 ± 6, range 43 to 63 years),
2) six essential hypertensive patients (4 males, 2 females, age: 47 ± 10 years, range 20 to 64 years), and
3) six normotensive subjects (all male, age: 28 ± 9 years, range 22 to 49 years).

Leg amputation had in all six cases been due to an accident suffered more than 15 years prior to this investigation. Hypertension had not been observed earlier than at least three years after leg amputation. Renovascular, renal or endocrine causes of hypertension had been excluded in all hypertensives on the basis of extensive diagnostic investigation. Patients who had evidence of ischaemic heart, cerebrovascular or peripheral arterial occlusive disease, impairment of renal function or pronounced retinal changes were excluded from the study. Hypertension was defined as sitting diastolic BP greater than 100 mmHg on three separate occasions. Antihypertensive treatment had been discontinued three weeks before the study. Patients were admitted to the hospital for investigation. During their hospital stay they received a diet containing 60 mmol of sodium daily. Free informed consent was obtained from each subject, and the investigation was approved by the Ethical Committee of the hospital.

Study protocol

Patients were in the supine position for 60 minutes before a cannula was inserted into an antecubital vein. After a further 60-minutes resting period, blood samples were taken for the determination of plasma epinephrine (E) and norepinephrine (NE). Thereafter negative pressure (−0.75 kg/cm²) was applied to the amputation stumps or thighs respectively for six minutes by the help of a suction-pump, commonly used in hospital for aspiration. Blood samples for E and NE determination were drawn after four and six minutes of suction. After another 60-minutes resting period, further blood specimens were obtained in the upright position after four, six and ten minutes of quiet walking.

For leg-amputees having first walked with the aid of crutches, not wearing leg-prosthesis, the protocol was continued after another 60 minutes rest by absolving a further ten-minutes walk with vacuum leg-prosthesis. Again blood samples were drawn after four, six and ten minutes of walking. BP and PR were measured throughout the whole test-procedure in two-minutes intervals.

Methods

BP was measured with a standard cuff and sphygmomanometer. The pressure at the disappearance of the Korotkoff sounds was taken as the diastolic pressure. Mean arterial pressure (MAP) was calculated as the sum of the diastolic and one third of the systolic pulse pressure. Blood samples for determination of E and NE were spun at 4 °C and plasma was stored at −20 °C immediately after sampling. Plasma E and NE were measured by a radioenzymatic method (3). Data in the text and figures are presented as \( \bar{x} \pm \text{SEM} \). Statistical evaluation was performed by analysis of variance.