PAPERS AND SHORT REPORTS

Sodium and potassium in essential hypertension

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Abstract

A study was carried out of arterial pressure and body content of electrolytes in 91 patients with essential hypertension and 121 normal controls. Exchangeable sodium was found to be positively correlated with arterial pressure in the patients, the correlation being closest in older patients; values of exchangeable sodium were subnormal in young patients; and plasma, exchangeable, and total body potassium correlated inversely with arterial pressure in the patients, the correlations being closest in young patients. Three hypotheses were proposed to explain the mechanisms relating electrolytes and arterial pressure in essential hypertension—namely, a cell-salt hypothesis, a dietary salt hypothesis, and a kidney-salt hypothesis.

It was concluded that two mechanisms probably operate in essential hypertension. In the early stages of the disease blood pressure is raised by an abnormal process related more closely to potassium than to sodium. A renal lesion develops later, possibly as a consequence of the hypertension. This lesion is characterised by resetting of pressure natriuresis and is manifest by an abnormal relation between body sodium and arterial pressure and by susceptibility to increased dietary sodium intake.

Introduction

"If too much salt is used in food the pulse hardens. . . . When the heart pulse beats vigorously and the strokes are markedly prolonged, the corresponding illness makes the tongue curl up and the patient unable to speak."[1] This may be the first record of a hypothesis on dietary salt in hypertension.[2] Subsequent studies have shown that modern Western societies eat more sodium chloride and have higher blood pressure than primitive societies, but the idea that excess dietary sodium causes hypertension is disputed.[3,4] Meanwhile, other work has centred on a related hypothesis: that arterial pressure is normally regulated, in the long term, by a balance between the natriuretic effect of increased arterial pressure and the pressor effect of sodium retention[5] and that a disturbance of this balance raises pressure in essential hypertension.[6-8] A third development began with the finding of excess sodium in the blood cells of patients with essential hypertension.[9-12] It was later suggested that the abnormality is generalised and that a similar excess of sodium in the cells of vascular smooth muscle produces vasoconstriction and hypertension.[13,14] We shall refer to this as the "cell-salt hypothesis."

These three mechanisms are not necessarily independent or exclusive. Increased dietary sodium may cause hypertension only in patients in whom the natriuretic effect of increased arterial pressure is abnormal,[15] and the cell-salt abnormality might be produced by a circulating inhibitor of sodium transport that also increases urinary excretion of sodium.[16] This paper, based on a recent lecture,* is concerned with these ideas. The first part summarises the main findings of a study of body sodium and potassium in patients with essential hypertension[15,16a]; the second part considers the relation of these findings to ideas on a role for sodium and potassium in the pathogenesis of the disease.

Body content of sodium and potassium in patients with essential hypertension: a study of arterial pressure and electrolytes

Corticosteroids capable of retaining sodium raise arterial pressure in man and animals. Exchangeable sodium, a measure of total body sodium,[15,16a,17] is increased in patients with primary hyperaldosteronism and is positively related to arterial pressure.[18] Chronic renal failure also causes sodium retention and hypertension, and again exchangeable sodium is usually in-

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creased and is positively correlated with arterial pressure.[18-22] Possibly, therefore, sodium retention causes, or contributes to, the hypertension in these states. Removal of sodium by medical and surgical treatment in Conn's syndrome[23] and by haemodialysis in chronic renal failure[20 24] certainly lowers blood pressure.

The findings in essential hypertension are less easy to explain. Mean exchangeable sodium is not normally increased[18 25-29] and yet arterial pressure and exchangeable sodium are positively correlated.[18] Either sodium retention has no role in the pathogenesis of this disease or it has a role initially but equilibrium is reached with increased arterial pressure in the presence of normal body sodium.[5 18] We describe a further analysis of this.

METHODS

Exchangeable sodium, plasma electrolyte concentrations, and arterial pressure were measured in 91 patients with essential hypertension and 121 normal controls. Exchangeable sodium was expressed in relation to body weight, leanness index, and body surface area. The findings using all three methods were similar,[15 16a] and most of the data given here are on exchangeable sodium related to body surface area. Total body sodium was measured in 38 patients using in-vivo activation analysis.[17] Total body potassium was estimated in 61 patients using external counting of potassium-40 and exchangeable potassium in 60 patients using isotope dilution. Details of these techniques and of the methods used to express electrolyte data are given elsewhere.[15 16a 18]

All patients were studied in a metabolic ward; in all the fifth phase diastolic pressure had been greater than 100 mm Hg in the outpatient department. None was being treated at the time of study; fifty had never received treatment for hypertension and in the remainder all hypotensive drugs, including diuretics, had been withdrawn for four weeks or more before study. No patient had haemorrhages, exudates, or papilloedema in either retinal fundus. An intravenous pyelogram, urinary excretion of vanillylmandelic acid, and plasma concentrations of urea, cortisol, and aldosterone were normal in all patients before the study. Blood pressure was measured with the patients recumbent, and the values used in the analysis were the means of at least six recordings made during a 36-hour period before and during estimation of exchangeable sodium. Normal subjects had no evidence of vascular disease and a blood pressure consistently below 140/90 mm Hg before the study; arterial pressure, exchangeable sodium, and plasma plasma electrolyte concentrations were measured by the same methods as in the patients.

RESULTS

Arterial pressure and electrolytes

Mean plasma sodium concentration was slightly lower than normal in the hypertensive patients (table I), but mean exchangeable and plasma potassium concentration were not different from normal. Total body sodium, exchangeable potassium, and total body potassium in the hypertensive patients were close to predicted normal values. Exchangeable and total body sodium correlated closely in patients in whom both variables were measured ($r=0{\cdot}91$, $p<0{\cdot}001$), as did exchangeable and total body potassium ($r=96$, $p<0{\cdot}001$).

TABLE I—*Mean (± SD) blood pressure and electrolyte concentrations in normal subjects and patients with hypertension*

	Normal subjects	Patients with hypertension
Ratio of men to women	71:50	68:23
Age (years)	39 ± 17	42 ± 12
Blood pressure (mm Hg):		
Systolic	120 ± 11	160 ± 20***
Diastolic	76 ± 9	102 ± 15***
Plasma sodium (mmol/l)	140·1 ± 2·0	139·3 ± 2·3**
Plasma potassium (mmol/l)	4·07 ± 0·33	4·09 ± 0·39
Exchangeable sodium (%)	100·0 ± 7·3	99·1 ± 7·1
Total body sodium (%)		98·6 ± 8·9
Exchangeable potassium (%)		104·5 ± 8·5
Total body potassium (%)		99·7 ± 10·2

Significance of difference: **$p<0{\cdot}01$; ***$p<0{\cdot}001$.
Conversion: SI to traditional units—Plasma sodium and potassium: 1 mmol l = 1 mEq/l.

Exchangeable sodium was positively and significantly correlated with systolic and diastolic pressure in the hypertensive patients, but there was no such relation in the normal subjects (figure 1, table II). Total body sodium was similarly related to systolic and diastolic pressure in the patients. There was also a weak but significant positive correlation between plasma sodium concentration and diastolic pressure in the patients.

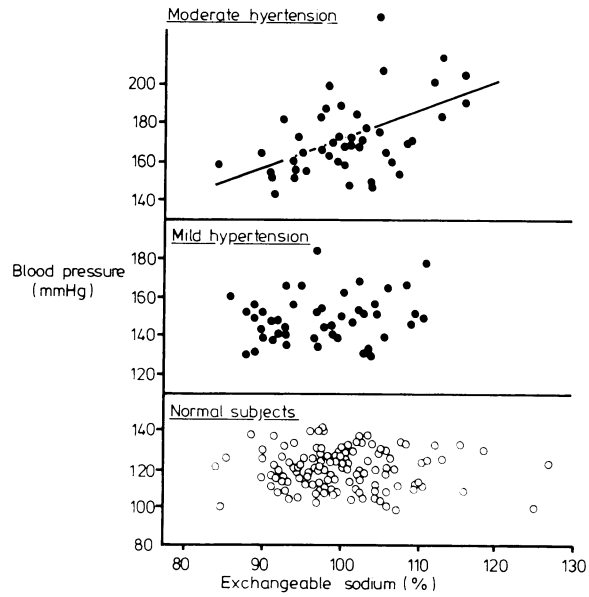

FIG 1—Relation of exchangeable sodium (related to body surface area) and systolic blood pressure in normal and hypertensive subjects. The hypertensive patients are divided in two groups by severity as described elsewhere.[15] In those with moderate hypertension $r=0{\cdot}53$, $p<0{\cdot}001$; in those with mild hypertension $r=0{\cdot}23$, $p<0{\cdot}05$; and in normal subjects $r=0{\cdot}04$.[15]

TABLE II—*Relation of arterial pressure with age and electrolytes (figures are correlation coefficients)*

	Normal subjects		Patients with hypertension	
	Systolic pressure	Diastolic pressure	Systolic pressure	Diastolic pressure
Age	0·36**	0·40**	0·23*	0·31*
Plasma sodium	0·12	0·10	0·20	0·23*
Exchangeable sodium	0·04	−0·03	0·44***	0·31*
Total body sodium			0·55***	0·44**
Plasma potassium	0·17	0·09	−0·32**	−0·41**
Exchangeable potassium			−0·28*	−0·28*
Total body potassium			−0·28*	−0·28*
Plasma sodium: potassium	−0·13	−0·06	0·46***	0·36**
Exchangeable sodium: potassium			0·51***	0·40**
Total body sodium: potassium			0·60***	0·58***

Significance of difference: *$p<0{\cdot}05$; **$p<0{\cdot}01$; ***$p<0{\cdot}001$.

Plasma potassium concentration, exchangeable potassium, and total body potassium were all significantly but negatively correlated with both systolic and diastolic pressures in the patients with hypertension (table II). Plasma potassium concentration was not related to arterial pressure in the normal subjects. Three different ratios of sodium to potassium were calculated: all correlated significantly with arterial pressure in the patients. In the normal subjects the ratio of plasma sodium to potassium was not related to arterial pressure.

Influence of age and urea

Arterial pressure correlated positively with age in both the normal and the hypertensive subjects (table II). Exchangeable sodium was also related to age but only in the patients ($r=0{\cdot}36$, $p<0{\cdot}001$). This

raised the possibility that the relation of exchangeable sodium and arterial pressure in the patients depended on age, but when partial regression analysis was done excluding the influence of age the correlation of exchangeable sodium and arterial pressure remained significant ($r_p = 0{\cdot}37$, $p < 0{\cdot}01$ for systolic pressure; $r_p = 0{\cdot}27$, $p < 0{\cdot}05$ for diastolic pressure). Plasma, exchangeable, and total body potassium were not related to age in the patients but in the normal subjects plasma potassium was significantly correlated with age ($r = 0{\cdot}26$, $p < 0{\cdot}01$).

Patients and normal subjects were divided into three groups by age. Mean exchangeable sodium was subnormal in young patients and slightly, but not significantly, above normal in older patients (table III). Interestingly, the relation of exchangeable sodium and arterial pressure was closest in older patients while the inverse relation of arterial pressure with plasma, exchangeable and, total body potassium was closer in young patients (table IV).

TABLE III—*Mean (± SD) values of exchangeable sodium (%) in young (<36 years) and old (>49 years) subjects*

Exchangeable sodium related to:	Young subjects		Old subjects	
	Normal subjects (n = 63)	Patients with hypertension (n = 30)	Normal subjects (n = 37)	Patients with hypertension (n = 29)
Body weight	101·3 ± 7	94·0 ± 5·7**	97·3 ± 9·4	100·1 ± 9·1
Surface area	100·2 ± 7·1	96·6 ± 5·2*	99·1 ± 8·0	102·6 ± 7·7
Leanness index	99·8 ± 7·7	95·3 ± 5·0	99·4 ± 7·9	101·3 ± 7·1

Significance of difference (*t* test): *$p < 0{\cdot}05$, **$p < 0{\cdot}01$.

TABLE IV—*Correlation of arterial pressure with electrolyte values in young (<36 years) and old (>49 years) patients with essential hypertension*

	Young patients			Old patients		
	n	Systolic pressure	Diastolic pressure	n	Systolic pressure	Diastolic pressure
Potassium:						
Plasma concentration	30	−0·41*	−0·51**	29	−0·36	−0·16
Exchangeable	16	−0·39	−0·52*	20	−0·38	−0·27
Total body	23	−0·32	−0·52*	18	−0·03	0·14
Exchangeable sodium related to:						
Surface area (%)	30	0·12	0·15	29	0·64***	0·48**
Leanness index (%)	30	0·22	0·15	29	0·69***	0·59***

Significance of coefficients: *$p < 0{\cdot}05$; **$p < 0{\cdot}01$; ***$p < 0{\cdot}001$.
Results for patients of intermediate age and all normal subjects are given in ref 15.

SUMMARY OF FINDINGS

The main findings then were that exchangeable sodium correlated positively with arterial pressure in the patients with essential hypertension but not in the normal subjects; that total body sodium also correlated positively with arterial pressure in patients; that values of exchangeable sodium were subnormal in young patients; that the correlation of exchangeable sodium and arterial pressure was closest in older patients; that plasma, exchangeable, and total body potassium correlated inversely with arterial pressure in hypertensive patients; and that these correlations of potassium were closest in young patients. Such correlations might have arisen as a consequence of hypertension or may in some way have been related to its cause.

Mechanisms relating electrolytes and arterial pressure in essential hypertension

CELL-SALT HYPOTHESIS

It is proposed that in patients with essential hypertension the cells of vascular smooth muscle contain an excess of sodium, which causes or enhances vasoconstriction.

The blood vessels of hypertensive animals have thicker walls that contain more sodium and water than the blood vessels of normal animals. These changes might increase resistance and arterial pressure in several ways.[30 31] As noted above the blood cells of patients with essential hypertension contain an abnormal excess of sodium. Inhibition of one of the pumps actively transporting sodium from the cell is probably responsible. Some pumps are underactive[10 32] while others are overactive[32 33]; the second may be a compensatory response.[32] It has been suggested that these abnormalities are generalised and that their occurrence in vascular smooth muscle causes vasoconstriction and hypertension,[13 14] and that excess of an inhibitor of sodium transport circulates in blood and is ultimately responsible.[14 16]

There is a problem in linking these ideas with our findings. We measured electrolytes in the body and in plasma, while the cell-salt hypothesis is concerned with the distribution of electrolytes across cell membranes. Most body potassium is within the cell and thus exchangeable and total body potassium are some measure of cell potassium. Plasma potassium is a measure of extracellular potassium concentration. The inverse correlation of arterial pressure with plasma potassium concentration (table II) is compatible with the cell-salt mechanism since a fall in extracellular potassium produces vasoconstriction,[13 14] possibly by a mechanism similar to that inhibiting transport in the blood cells of patients with essential hypertension.[34] The inverse relation of arterial pressure with exchangeable and total body potassium is less easy to explain unless loss of potassium from the cell leads to loss of potassium from the body. The cell-salt hypothesis does not predict subnormal values of exchangeable sodium in young patients with hypertension unless the subnormality is confined entirely to the extracellular space. Nor is it easy to reconcile subnormal values of exchangeable sodium with the proposal that expansion of the extracellular space in essential hypertension leads to release of transport inhibitor, causing vasoconstriction.[16] An alternative possibility is that the transport inhibitor is present in excess but that its stimulus is not sodium retention; excess of the inhibitor could then contribute to sodium loss by its natriuretic effect.

Because of the difficulty of extrapolation our data are probably not important evidence for or against the cell-salt hypothesis, though there is obvious common ground: the hypothesis predicts the positive relation of arterial pressure with intracellular sodium and, possibly, a negative relation with extracellular potassium. We found a positive relation with total body sodium and a negative relation with plasma potassium.

DIETARY SALT HYPOTHESIS

It is proposed that the rise in arterial pressure with age in Western society and the greater prevalence of hypertension results wholly or partly from increased dietary sodium or decreased dietary potassium intake, or both.

This idea derives mainly from comparison of populations. It has been rightly criticised, partly because the comparison is based on recordings of blood pressure that are not always standardised (for observers, blood-pressure recorders, criteria of measurement, or conditions of recordings) and partly because the populations compared differ in ways other than dietary salt intake.[3 4] Changes in dietary sodium within the Western range are also said to be unlikely to influence arterial pressure because the curve relating intake and pressure has reached a plateau. This is borne out by the data in the left-hand panel of figure 2, but here sodium intake is plotted on a linear scale with arterial pressure plotted logarithmically, which is the opposite of the conventional representation of the relation between a biological cause and its effect. Replotting the data on a conventional semilogarithmic scale shows no plateau (right-hand panel). This implies, if the dietary hypothesis is correct that an increase in sodium chloride intake from 1 to 4 g/day in a population will bring about a similar increment in arterial pressure as an increase from 10 to 40 g/day.

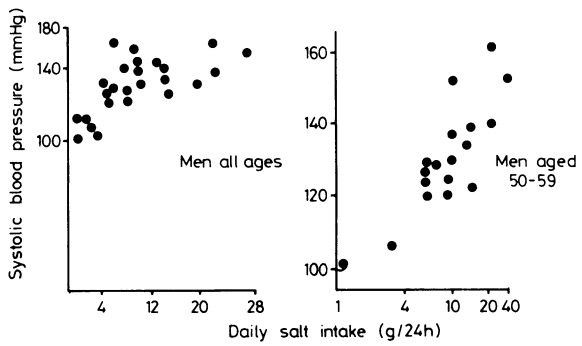

FIG 2—Left: mean systolic blood pressure in 25 populations related to their mean daily intake of sodium chloride.[35] Right: data from the same analysis restricted to men aged 50-59 and with sodium chloride intake plotted on a logarithmic scale.

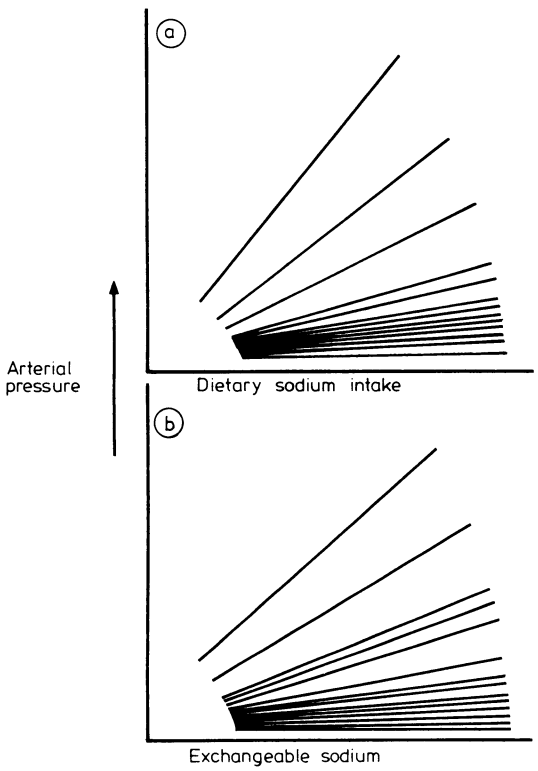

FIG 3—*A*. Relation of arterial pressure and dietary sodium intake in different people, each represented by a single regression line. Most people show little or no increase in pressure on increasing sodium intake, while a few show a distinct increase. *B*. Relation of arterial pressure with exchangeable or total body sodium. Again, most people show little change on changing body sodium while a few show a distinct change.

Another source of confusion is that two dietary salt hypotheses are being debated, with criticism focused on one and advocacy on the other. The first hypothesis proposes that a high dietary sodium intake raises blood pressure in most people. It follows, if this is correct, that the blood pressure of people within a population will correlate with their sodium intake and that hypertensive subjects will eat and excrete more sodium than normal subjects. Neither of these predictions has been borne out.[3 4] The second hypothesis has more advocates[36-38] and probably fewer critics. It proposes that sodium intake is sufficiently high in Western society to raise blood pressure but only in a susceptible minority (fig 3). Two elements—namely, susceptibility and sufficient sodium—are needed for blood pressure to rise. If the proportion of susceptible people is similar in the populations compared a correlation would be expected between the mean blood pressure of the populations and their mean dietary sodium intake. This second hypothesis does not *necessarily* predict a correlation between the blood pressure and dietary sodium intake of individuals within a population, particularly if the range of sodium intake is fairly small. Theoretically, if all members of a particular Western population had an identical sodium intake (say 100 mmol (mEq)/day) blood pressure would still rise in some by virtue of that sodium intake and there would, of course, be no correlation of arterial pressure and sodium intake.

Our data are relevant here: the correlation of exchangeable sodium and arterial pressure in hypertensive subjects (fig 1, table II) suggests that a hypertensive subject, particularly an older one, may be one in whom a given increase in body sodium produces a greater than normal increase in arterial pressure (fig 3). Greater susceptibility would then be reflected by a steeper slope to the curve relating exchangeable sodium and arterial pressure. Another possibility is that more sodium is retained by the hypertensive subject during sodium loading and this combined with a steeper slope raises arterial pressure. There is some support for these ideas: in normal subjects increased dietary sodium intake raises exchangeable sodium[39] but does not usually affect arterial pressure[39-42] unless the intake is considerably increased.[43] In hypertensive subjects increased dietary sodium also increases exchangeable sodium[39] but arterial pressure now rises[39 44-46] on average more than in normal subjects.[41] The rise in blood pressure produced by such sodium loading varies widely in hypertensive subjects[41 45 46]; it relates to the amount of sodium retained[45] and to the increase in exchangeable sodium.[39]

These observations, together with our data, are compatible with the idea that an older hypertensive patient is a person in whom a change in body sodium produces a greater than normal change in arterial pressure. We shall return later to the different findings in young hypertensive patients; it is necessary first to consider the phenomenon of pressure natriuresis.

KIDNEY-SALT HYPOTHESIS

A reduction in the ability of the kidney to excrete sodium at a given arterial pressure leads to sodium retention, which raises blood pressure to the point where sodium balance can be restored.

A rise in renal arterial pressure greatly increases urinary sodium excretion. This is the phenomenon of pressure natriuresis.[5] A central point of some theories is that pressure natriuresis is reset in essential hypertension, with the curve relating pressure and sodium excretion displaced to the right, higher pressure being needed to maintain a given sodium excretion. Guyton *et al* maintain that resetting is a feature of all hypertensive states. Resetting has been shown in the isolated kidneys of hypertensive animals,[47-49] and some evidence exists that it is present in hypertensive man.[18] Its mechanism is uncertain, but different mechanisms probably obtain in different hypertensive states.[5] Increased resistance in the preglomerular circulation is a possible explanation in essential hypertension for which there is some evidence.[50 51]

One view of the pathogenesis of essential hypertension is that two mechanisms are at work. Blood pressure is raised at first by a process that is not primarily a resetting of pressure natriuresis. Later, and as a possible consequence of the earlier hypertension, a renal lesion develops that is characterised by resetting and causes a further increase in blood pressure. Interaction of the two mechanisms then produced progressive hypertension (fig 4).

Our findings are compatible with this if the abnormal relation of exchangeable sodium and arterial pressure is a manifestation of the abnormality that develops during the progression of essential hypertension. Favouring the idea is the closer relation of exchangeable sodium with arterial pressure in older patients (table IV), patients with higher blood pressure,[15 16a] and patients with higher (but still normal) plasma urea concentrations.[15 16a]

The increase of renal vascular resistance that may cause resetting[8] is also probably progressive in essential hypertension since it correlates significantly with age.[52] For reasons discussed below, however, it is unlikely that the same renal abnormality raises arterial pressure in the early stages of renal hypertension, nor is it likely that the renal abnormality in essential hypertension is the same as that causing hypertension in chronic renal failure. Blood pressure in essential hypertension is higher for a given level of exchangeable sodium,[18] and the relation of sodium excretion and blood pressure is different in the two forms of hypertension.[53]

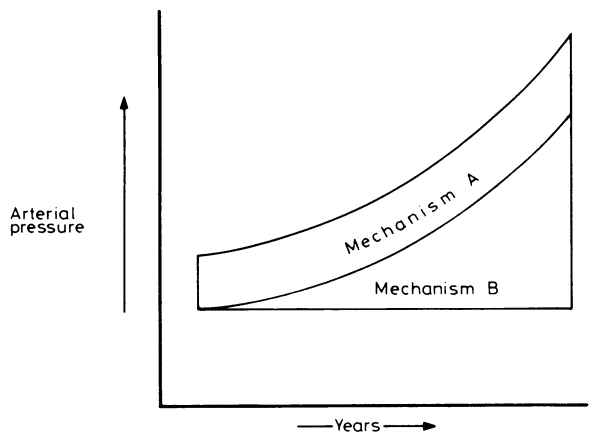

FIG 4—Schematic representation of a way in which two mechanisms might raise blood pressure in essential hypertension. Only mechanism A is evident at the early stage; it raises blood pressure slightly. As a result of the increase in pressure a renal lesion (mechanism B) develops. This can maintain increased arterial pressure in the absence of mechanism A. Blood pressure rises further as a consequence of continued activity of mechanism A and the sequence is repeated with mechanism B making an increasing contribution to the maintenance of arterial pressure.

POTASSIUM AND SUBNORMAL SODIUM VALUES IN YOUNG PATIENTS WITH HYPERTENSION

Young patients with hypertension differ from older patients in having an abnormal relation of potassium and arterial pressure (table IV), subnormal values of exchangeable sodium, and no correlation of exchangeable sodium with arterial pressure. This suggests a greater influence of potassium on arterial pressure (or vice versa) in the earlier stages of the disease, but it does not exclude a relation with sodium since charges of dietary and body potassium influence sodium balance.

Changes of dietary potassium also influence the development of experimental hypertension including the form produced by excess dietary sodium.[54] The diet of Western society is high in sodium but low in potassium. Parfrey *et al*[44] recently showed that the combination of low dietary sodium and high potassium reduces blood pressure in patients with mild hypertension. They also showed that the sons of hypertensive patients respond to increased dietary potassium with a significant fall in arterial pressure while the sons of normotensive patients respond with a slight (but not significant) rise in pressure. The pressor effect of increased dietary sodium was no different in the two groups. They suggested that a genetically determined susceptibility to the pressor effect of low dietary potassium is important in the early stages of essential hypertension and that increased susceptibility to dietary sodium develops later. They also proposed that the potassium effect is mediated by the autonomic nervous system. This agrees with the idea of a double mechanism in essential hypertension (fig 4) and with the view that autonomic nervous overactivity is important in the early stages of the disease.[7 8] It also agrees with the finding described here, provided abnormal sensitivity to dietary potassium is manifested by a steeper than normal regression of arterial pressure with plasma and body potassium. Hypokalaemia has a vasoconstrictor effect, but we do not know if the effect is greater in young hypertensive patients. The vasodilator action of increased plasma potassium concentrations has been studied[55] but was not more pronounced in patients with essential hypertension, though the patients in that study were considerably older (49 years on average) than those in our group of young patients.

The subnormal values of exchangeable sodium in young patients with hypertension is an interesting finding. It is unexpected in a disease thought to be caused by excess sodium. It does not accord with the view that essential hypertension passes through an early phase with volume expansion; nor with the idea that resetting of pressure natriuresis is the primary and only fault at all stages of essential hypertension. It does, however, agree with the proposal outlined in figure 4.

Subnormal values of exchangeable sodium also occur sometime in patients with unilateral renal artery stenosis[56 57] in whom sodium loss occurs from the normal kidney, probably because blood pressure is raised by a mechanism that is not primarily sodium retaining and, in the absence of resetting, sodium depletion results.[18] A similar mechanism may operate in young patients with essential hypertension. Our findings and those of Parfrey *et al*[42 44] suggest that this mechanism is in some way related to potassium. We do not imply that there is no resetting of pressure natriuresis at this stage, merely that resetting is not the primary cause of the increase in arterial pressure.

Our tentative conclusions, therefore, are that two mechanisms operate in essential hypertension. In the early stages of the disease blood pressure is raised by an abnormal process related more closely to potassium than to sodium. A renal lesion develops later, possibly as a consequence of the hypertension. This lesion is characterised by resetting of pressure natriuresis and is manifest by an abnormal relation between body sodium and arterial pressure and by susceptibility to increased dietary sodium intake.

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LADIES' MANTLE has many leaves rising from the root standing upon long hairy foot-stalks, being almost round, and a little cut on the edges, into eight or ten parts, making it seem like a star, with so many corners and points, and dented round about, of a light green colour, somewhat hard in handling, and as it were folded or plaited at first, and then crumpled in divers places, and a little hairy, as the stalk is also, which rises up among them to the height of two or three feet; and being weak, is not able to stand upright, but bended to the ground, divided at the top into two or three small branches, with small yellowish green heads, and flowers of a whitish colour breaking out of them; which being past, there comes a small yellowish seed like a poppy seed: The root is somewhat long and black, with many strings and fibres thereat. It grows naturally in many pastures and wood sides in Hertfordshire, Wiltshire, and Kent, and other places of this land. It flowers in May and June, abides after seedtime green all the Winter.

Venus claims the herb as her own. Ladies' Mantle is very proper for those wounds that have inflammations, and is very effectual to stay bleeding, vomitings, fluxes of all sorts, bruises by falls or otherwise, and helps ruptures; and such women as have large breasts, causing them to grow less and hard being both drank and outwardly applied; the distilled water drank for 20 days together helps conception, and to retain the birth; if the women do sometimes also sit in a bath made of the decoction of the herb. It is one of the most singular wound herbs that is, and therefore highly prized and praised by the Germans, who use it in all wounds inward and outward, to drink a decoction thereof, and wash the wounds therewith, or dip tents therein, and put them into the wounds, which wonderfully dries up all humidity of the sores, and abates inflammations therein. It quickly heals all green wounds, not suffering any corruption to remain behind, and cures all old sores, though fistulous and hollow. (Nicholas Culpeper (1616-54) *The Complete Herbal*, 1850.)