Serum Magnesium and Plasma Sodium Levels in Essential Vascular Hypertension

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The mean serum magnesium concentration in 26 uncomplicated hypertensive patients was found to be significantly lower than that in 43 normal individuals. The mean plasma sodium concentration in these patients was significantly higher than that in a normal group. The mean plasma potassium levels were not significantly different. It is suggested that a possible explanation for these electrolyte changes is excessive adrenal cortical activity.

Although serum magnesium levels have been reported to be elevated in hypertensive disease, the possibility of retention due to renal failure has not been eliminated as a causative factor. The occurrence of hypomagnesemia in a patient with hypertension due to a mineralocorticoid secreting adrenal tumor, together with the report of increased aldosterone secretion in a small group of hypertensive patients, prompted the determination of serum magnesium levels in subjects with essential vascular hypertension.

Methods

Fasting sera were obtained in the outpatient clinic from 12 male and 14 female hypertensive patients, ranging in age from 22 to 66 years. All were adequately nourished and had a normal dietary history. The only symptoms were those due to the hypertension itself. There were no disorders, past or present, pertaining to cardiac, renal or vital cerebral functions. The blood urea nitrogen was less than 25 mg. per cent in all patients except 1 man with early malignant hypertension, in whom it was 31 mg. per cent. The greatest abnormality reported on the urinalyses was a faint trace of albumin and there were no formed elements. These patients had not been treated with antihypertensive drugs. The average systolic blood pressure was 200 mm. Hg with the range of 142 to 240 mm. Hg and the average diastolic blood pressure was 126 mm. Hg with the range from 100 to 156 mm. Hg. In addition to the serum magnesium and blood urea nitrogen, plasma sodium, potassium, and chloride were determined. Sera from a control group of 43 fasting normal adults, ranging in years from 19 to 36, were obtained for magnesium levels.

Magnesium was determined by the titration method. Blood for sodium, potassium and chloride determinations was drawn into heparinized tubes. The cells were separated by centrifugation within 1 hour of venipuncture. Determinations of sodium and potassium were done on the flame photometer. All determinations were made in duplicate on the same blood sample.

Results

The means given below are followed by the standard deviations. The mean serum magnesium level in the control group of 43 normal adults was 1.61 ± 0.14 mEq. per L., ranging from 1.36 to 1.94 mEq. per L. (fig. 1). There was no significant difference in the values among the various age, sex, and racial groups. In comparison with the control group, the mean serum magnesium level in the 26 fasting uncomplicated hypertensive patients was 1.40 ± 0.13 mEq. per L., with the range from 1.10 to 1.60 mEq. per L. (fig. 1). The probability that the difference occurred by chance alone is less than 1 in 1,000. In 4 hypertensive patients with azotemia, the magnesium levels were much higher than normal. No correlation could be demonstrated between the severity of the hypertension, as measured by the height of the diastolic pressures or the changes in the optic fundi, and the lowering of the serum magnesium level.

Plasma sodium levels were found to be sig-
significantly elevated in hypertensive patients from a control of $142.0 \pm 3.0$ mEq per L, established in a previously reported study from this laboratory using the same technique, to a level of $147.7 \pm 5.0$ mEq per L, with the range from 140.0 to 158.9 mEq per L. (fig. 2). The probability that the difference occurred by chance alone is less than 1 in 1,000. There was no correlation between the elevation of the plasma sodium and the depression of serum magnesium levels in these hypertensive patients.

The mean plasma potassium in this group of hypertensive subjects was 4.23 mEq per L with a standard deviation of 0.55 mEq per L. (fig. 3). This is not significantly different ($p > 0.05$) from the normal mean of $4.06 \pm 0.32$ mEq per L, previously determined in this laboratory.

**DISCUSSION**

The low serum magnesium level found in the present group of uncomplicated hypertensive patients is contrary to observations made by others. However, since the status of renal and cardiac functions was not stated in these studies, one cannot be certain that cases with gross renal insufficiency or cardiac decompensation were excluded. It is well known that serum magnesium levels are elevated in renal failure. In the present series, azotemic cases were excluded with the exception of 1 patient previously mentioned.

Any explanation for the lowered mean serum magnesium level would be highly conjectural. Although the subjects of this study were drawn from a low economic bracket compared to controls, dietary reasons for the hypomagnesemic tendency seem unlikely in view of the magnesium content of the average diet, which is definitely in excess of that required for maintenance of balance. Other causes for hypomagnesemia such as alcoholism, chronic diarrhea, liver and pancreatic disease, polyuria, and diabetes mellitus were not present in the patients studied.

Since a considerable number of values in the hypertensive group overlapped with the normal values, the possibility of heterogeneity in the former group must be considered. The number of cases is too small to permit the recognition of 2 or more population groups, even if such groups existed.
The finding of elevation of mean plasma sodium in the hypertensive patients used in this study confirmed the work of Holley. Furthermore, both of the plasma electrolyte changes are in the same direction as the changes found in cations in the aorta of the renal hypertensive rat by Tobian and Binion.

A possible explanation for the tendency toward hypomagnesemia and hypernatremia in these patients is adrenal cortical hyperactivity. Genest has reported finding increased urinary excretion of aldosterone, as measured by a combined chromatographic-bioassay method, in a small group of severely hypertensive subjects. If at least some hypertensive subjects have increased adrenal cortical activity, can this be responsible for the observed electrolyte changes?

Retention of sodium and hypernatremia are well known findings in clinical and experimental states characterized by excessive mineralocorticoids. The relationship between cortical steroids and hypomagnesemia is not securely established, however, the following evidence suggests that hypomagnesemia and adrenal cortical overactivity are associated. Haynes and associates and Barter and associates have shown a tendency toward a delayed negative magnesium balance after ACTH administration. Rats treated with desoxycorticosterone for 1 month have been shown to have a significant decrease in serum magnesium and a significant increase in plasma sodium level. Hypomagnesemia was observed in a patient with spontaneous hypotension, alkalosis, hypernatremia, and hypertension due to a mineralocorticoid secreting adrenal tumor. These studies suggest the possibility of increased mineralocorticoid activity in some cases of hypertension, however, even if this is correct, it cannot be determined at this time whether the hypersecretion is related etiologically to the hypertension.

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