Is Potassium Deficiency a Factor in the Pathogenesis and Maintenance of Hypertension?

Other than sex, money, and professional football, nothing seems to intrigue Americans more than the possibility that what they eat — but not how much they eat — causes disease. Anyone who has stood in the checkout line of a supermarket can easily find evidence of these preoccupations by reading the covers of popular magazines. Multiple dietary factors have been implicated in the past and it seems likely that more are to come. The accompanying editorial, The Role of Potassium Manipulation in Blood Pressure Control, is a case in point. It presents the fragmentary evidence that potassium supplementation can lower arterial pressure in some hypertensive patients and, by extrapolation, suggests that dietary potassium deficiency is a factor in the pathogenesis of hypertension. The possibility is intriguing and it is important to obtain an answer to the question, but before firm recommendations are made for a wholesale increase in dietary potassium intake by the American public, in general, and hypertensive patients, in particular, much more information is needed, as the authors of this editorial wisely point out.

One wonders how this area of interest is going to evolve. Up until recently the focus was solely on sodium as a dietary factor in hypertension; now it seems to be shifting to potassium and there are other candidates in the wings — calcium, saturated fats, and meat. Caution is the watchword in accepting these studies because dietary factors are as complicated and probably as interrelated as the hormonal, volume, and neural systems that we know participate in the control of arterial pressure. Unfortunately, diet seems a topic that is more subject to bias than are other areas in hypertension research.

It seems to me that the authors of the accompanying editorial are clearly biased in favor of potassium deficiency being an important factor in hypertension. Because of this, I propose to review the evolution of the concern about potassium against a background of my own bias which is: we do not have enough evidence to justify sweeping conclusions and wholesale recommendations.

Interest in potassium has had a long and uneven history. Addison, in 1928, used various potassium salts to treat five hypertensive patients on salt-poor, protein-restricted diets and found that arterial pressure fell, sometimes strikingly. Priddle, taking a cue from Addison, added potassium citrate to the low sodium, calcium, and magnesium diets of 45 hypertensive patients and reported that most experienced a fall in pressure. One of the most frequently quoted studies is that of MacQuarrie et al. which described the feeding of large quantities of sodium chloride (> 80 gm) to diabetic children, the rise in blood pressure that occurred, and its amelioration by supplemental potassium feeding.

For the next studies of note, the scene changes to animal experiments. In the 1940s Selye et al. showed that potassium feeding decreased the pressor effects of DOCA-salt administration to rats and later, Meneely et al., in the now classic experiments, found that the hypertension produced in rats by feeding a high salt diet (8% by weight of food) could be somewhat ameliorated by the addition of potassium and that, perhaps more important, the life span of the animals was considerably prolonged. Based on these experiments of Meneely, Dahl bred two strains of rats, one that developed hypertension on exposure to a high salt intake (salt-sensitive, S), and another that remained normotensive regardless of the salt intake (salt resistant, R). He found that the intake of potassium strongly influenced the pressor effectiveness of the high salt diet in S rats: the higher the sodium/potassium (Na/K) ratio, the more severe the hypertension, and with a Na/K ratio of 1, arterial pressure rose only to 135 mm Hg, in contrast to 170 mm Hg with a Na/K ratio of 10.
About this same time, it was observed that primitive populations have a relatively higher potassium intake than acculturated populations. This finding was noted although, at the time, the lower prevalence of hypertension in primitive peoples was credited to their lower sodium intake.\textsuperscript{10-12} Not widely recognized, however, is the fact that primitive populations differ greatly from those in industrialized countries, in other ways than sodium and potassium intake; they are smaller in size, do not become obese as they age, and they are more physically fit.\textsuperscript{13} Furthermore, they are genetically more homogeneous. Nobody seems to pay any attention to these differences, and there is a likelihood that they are as important as sodium and potassium intakes in regard to the prevalence of hypertension.

Does potassium intake really influence hypertension? In answer, one can only quote the reports, assess them, and leave it to the reader to decide. Grim et al.\textsuperscript{14} found that the potassium excretion and potassium intake of blacks was lower than those of whites in Evans County, Georgia; Langford and Watson\textsuperscript{15} reported that the arterial pressure of young Mississippi women was related to the Na/K urinary ratio. This suggests that hypertension in blacks, at least, may be influenced by a relative potassium deficiency.

More recently, there have been several reports of potassium supplementation that clearly raise the possibility that a relative potassium deficiency is a factor in hypertension. Skrabal, Auböck, and Hörtngal\textsuperscript{10} studied 20 normotensive subjects (10 with a family history of hypertension) during moderate sodium restriction and/or a high potassium intake. They found that a high potassium intake (200 mmol) reduced diastolic arterial pressure by 5 mm Hg in 10 subjects, seven of whom had a positive family history for hypertension. The high potassium intake also promoted sodium loss, prevented the rise in plasma catecholamines that accompanied the low sodium diet, and increased the sensitivity of the baroceptor reflex responses to infusions of norepinephrine. Bulpitt, Shipley, and Semmence,\textsuperscript{17} in an epidemiologic study of 2328 men and 1496 women, found both systolic and diastolic pressure to be negatively associated with plasma potassium concentration, while Ueshima et al.\textsuperscript{18} also found a negative correlation between serum potassium and the prevalence of hypertension in six population groups in Japan. Of interest was the finding that potassium intake was highest in the group with the lowest serum potassium and the highest prevalence of hypertension. This suggests that factors other than intake determine the influence of potassium on arterial pressure.

A recent report by MacGregor et al.\textsuperscript{19} has created much interest and may have been responsible for the accompanying editorial. It was a double-blind, crossover study of the effects of a potassium supplement of 60 mmol/day (without change in dietary sodium or potassium intake) in 23 patients with mild to moderate hypertension. They found that, during the month of increased potassium intake, arterial pressure fell from 155/99 ± 3/1.7 (SEM) to 148/95 ± 2.9/1.6 mm Hg. The fall in both systolic and diastolic pressures was significant at $p < .025$. There were associated increases in urinary sodium excretion, serum potassium, and blood urea.

Thirty years ago, low potassium diets reportedly reduced arterial pressure in hypertensive patients and, in experimental renal hypertension, prevented the development of hypertension or lowered pressure when given to animals with established hypertension.\textsuperscript{20}

What conclusions that have relevance for the pathogenesis and maintenance of hypertension can be drawn from these studies? In my view, although the studies are highly suggestive, they are not conclusive. Tons of potassium have been given to millions of hypertensives in the more than 25 years that diuretic therapy has been in use, yet no one has suggested that it lowered arterial pressure. Thus, I would urge caution in accepting the theory that a relative potassium deficiency is an important factor in the pathogenesis and maintenance of hypertension in humans. A rush to the judgment that it is important could be an unfortunate error.

I agree with Drs. Heyden, Nelius, and Schneider that more studies should be done. Let's settle this issue with controlled trials before recommending that everyone use potassium salts for the prevention or control of hypertension. Also, just remember, potassium can cause fatal hyperkalemia in people with decreased kidney function.
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