

Seminars on Hypertension

Treatment of Hypertensive Vascular Disease with Rice Diet^{*†}

WALTER KEMPNER, M.D.

Durham, North Carolina

THE treatment of hypertensive vascular disease with the rice diet¹⁻⁵ was suggested by observations made on the protein, fat and carbohydrate metabolism of isolated kidney cells under various pathologic conditions (cell injury and/or changes in pH, sodium bicarbonate concentration, oxygen tension and metabolizable substrate⁶⁻¹¹).

Until 1944 the consensus was that dietary treatment was useful in kidney disease but of no value in hypertensive vascular disease. "The diet in uncomplicated hypertension requires no essential change from the normal. There is no justification for restriction of protein intake, indeed, such restriction may result in anemia and other evidences of malnutrition. Likewise, in the absence of edema or paroxysmal dyspnea, the restriction of salt is unwarranted; claims that such restriction may lower the blood pressure have not been substantiated. Obesity should be avoided for the same reasons that apply to normal individuals and not because of any demonstrated relationship to hypertensive disease."¹² "No dietary treatment is known which has a specifically favorable effect on essential hypertension."¹³

The rice-fruit-sugar diet is more rigid than any of the fat-poor, salt-poor or protein-poor "hypertension" diets (the therapeutic possibilities and limitations of these will not be discussed here.) The rice diet contains in 2,000 calories not more than 5 Gm. of fat and about 20 Gm. of protein

derived from rice and fruit and not more than 200 mg. of chloride and 150 mg. of sodium. A patient takes an average of 250 to 350 Gm. of rice (dry weight) daily; any kind of rice may be used provided no sodium, chloride, milk, etc. has been added during its processing. The rice is boiled or steamed in plain water or fruit juice, without salt, milk or fat. If the sodium concentration of the plain water available is greater than 20 mg. per liter, distilled water should be used. All fruit juices and fruits are allowed, with the exception of nuts, dates, avocados and any dried or canned fruit or fruit derivatives to which substances other than white sugar have been added. Not more than one banana a day should be taken. White sugar and dextrose may be used *ad libitum*; on an average a patient takes about 100 Gm. daily but, if necessary, as much as 500 Gm. daily should be used. Tomato and vegetable juices are not allowed. Usually no water is given and the fluid intake is limited to 700 to 1,000 cc. of fruit juice per day. Supplementary vitamins are added in the following amounts: vitamin A 5,000 units, vitamin D 1,000 units, thiamine chloride 5 mg., riboflavin 5 mg., niacinamide 25 mg., calcium pantothenate 2 mg. No other medication is given unless it is specifically indicated.

During the first period of "regulation" on the diet, the patient should be under constant medical supervision and blood

* From the Department of Medicine, Duke University, School of Medicine, Durham, N. C.

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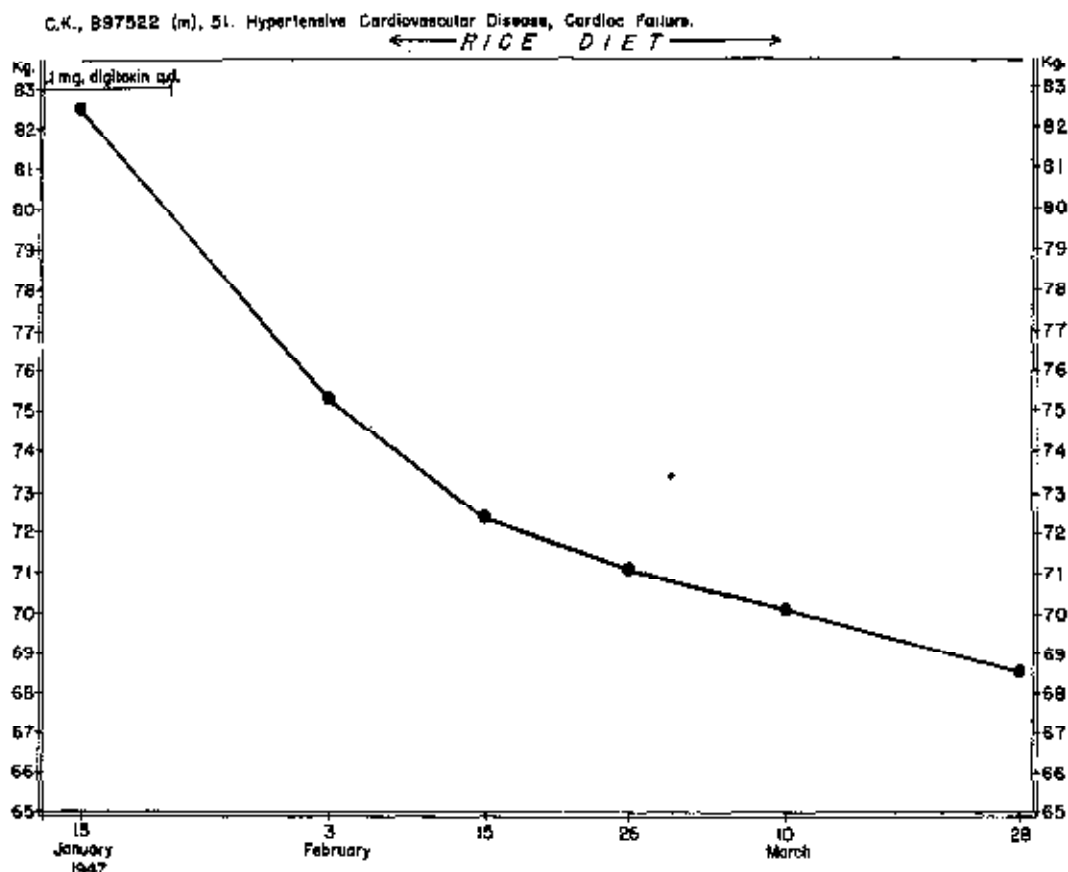


FIG. 1. C. K., male, fifty-one years of age. The patient had hypertensive vascular disease of seven years' duration, auricular fibrillation, cardiac failure of one year's duration, enlargement of liver and spleen and ascites. Previous treatment: digitalis, mercurials, ammonium chloride; codein; low salt, low fat, high protein diet; paracentesis 12 times in past year. January 15 to 21, 1947: Blood pressure, average, 174/97; NPN 44 mg. per 100 cc. blood; venous pressure 380 mm. of saline; total PSP excretion in two hours: 39 per cent. Rice diet started January 18, 1947, was strictly followed. All medication discontinued. On March 17, 1947, NPN 27 mg. per 100 cc. blood March 24 to 30, 1947: Blood pressure, average, 137/82. ———— Ascites and edema unchecked by digitalis, mercurials, ammonium chloride, low salt high protein diet disappeared on rice diet without medication. There was a 14 Kg. weight loss in sixty-eight days.

and urine chemistry should be checked frequently.

Rest in bed, unless the severity of the condition demands it, is neither necessary nor desirable.

It is not unusual for the weight to decrease more or less markedly during the first twenty days. The reason for this weight loss may be that the amount of food given does not cover the caloric requirements; in this case the amount of rice, fruit and sugar must be increased unless reduction of weight is indicated. Another reason may be that the patient does not eat the full amount of his diet during the first period of

adjustment. The most frequent cause is the loss of visible or invisible edema; for example, one patient with marked edema lost 63 pounds in the first sixteen days on the diet (no digitalis, mercurials, etc., were given).⁶ Figure 1 shows the weight chart of another patient, a fifty-one year old physician, with hypertensive heart disease and auricular fibrillation whose persistent liver enlargement, ascites and edema had not improved in spite of intensive treatment with digitalis, mercurials, ammonium chloride, salt-poor diet and frequent paracenteses.

As a rule the diet should be continued without modification until those conditions

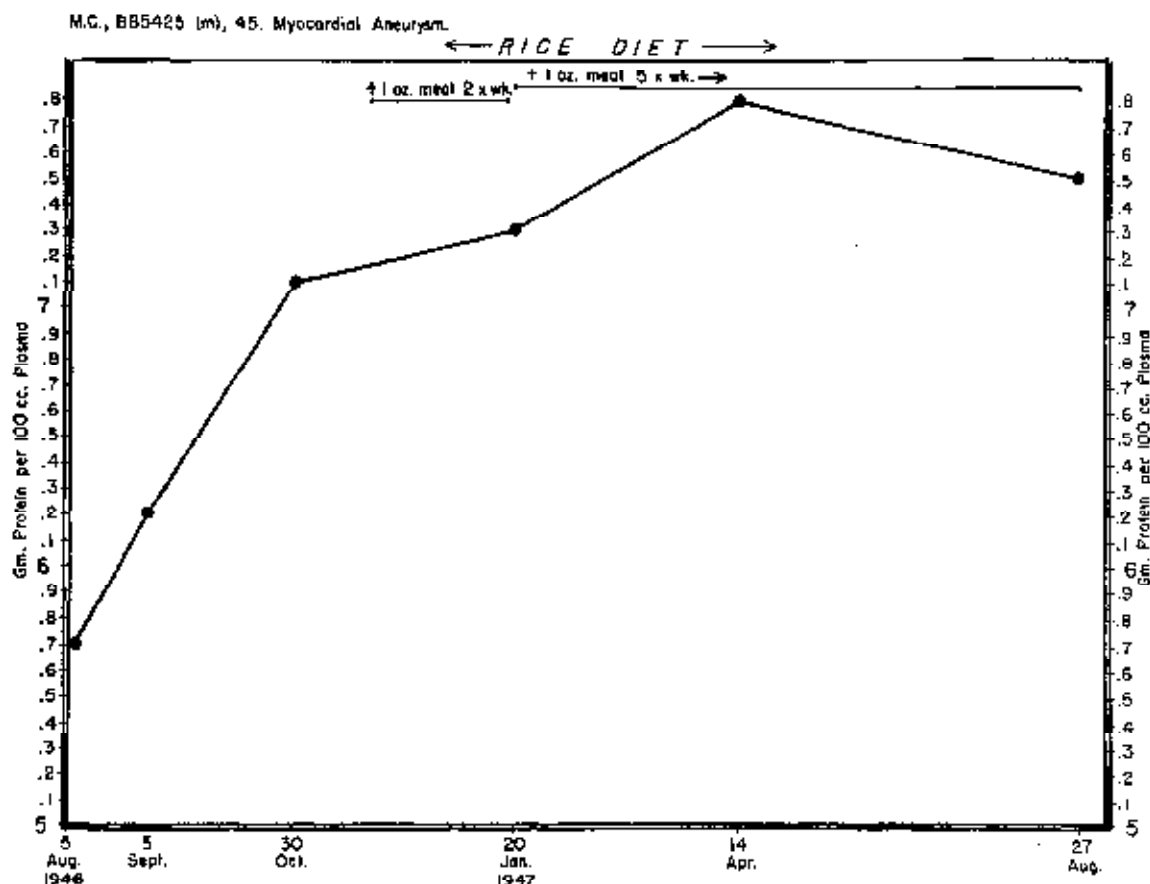


Fig. 2. Increase of plasma proteins on rice diet (for history see Figure 1).

which were the indication for its use have disappeared. Then small amounts of non-leguminous vegetables, potatoes, lean meat or fish (all prepared without salt or fat) may be added. But only so much additional food should be allowed as can be taken without producing undesirable changes in blood pressure, heart size, electrocardiogram, eyegrounds, non-protein nitrogen, etc. When a critical condition of heart, kidney or retina exists, the strict rice diet should be continued indefinitely provided that the equilibrium between intake and loss of those substances which are indispensable for the body is maintained.

CHEMICAL CHANGES PRODUCED BY THE RICE DIET

Nitrogen Metabolism. Because of the protein-sparing effect of carbohydrates, the

protein equilibrium is maintained in spite of the low protein content of the rice diet.

A minimum of 50 Gm. of protein (type of protein not specified) has been postulated as the so-called "wear and tear quota" necessary to cover the daily protein requirements. However, since this figure is derived from the total nitrogen excretion of fasting individuals, which is about 7 Gm. in the urine and 0.9 Gm. in the stools, it indicates only the amount of the body protein broken down in fasting ($7.9 \times 6.25 = 49.4$). In patients who have followed the rice diet for two months or more the daily urinary total nitrogen excretion is less than one third of that in fasting. It averages 2.26 Gm.⁶ If an allowance of 0.9 Gm. per twenty-four hours is made for the excretion of nitrogen other than that excreted in the urine, the total nitrogen loss in twenty-four hours is about 3.16 Gm. With a daily intake

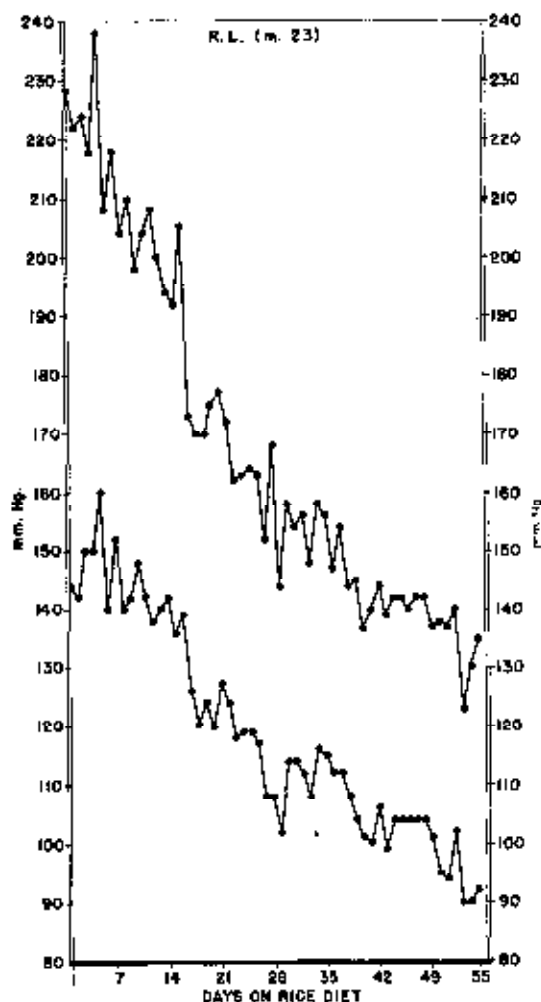


FIG. 3. R. L., male, twenty-three years of age. This patient had hypertensive vascular disease of three years' duration. He was previously treated with a "modified rice diet." EKG T₁ inverted. (Fig. 22.) Total PSP excretion in two hours: 2.5 per cent; NPN 79 mg. per 100 cc. blood; cholesterol 340 mg. per 100 cc. serum. There was advanced retinopathy. (Fig. 30.) Rice diet started December 13, 1945 and strictly followed for three months (8–21 mg. Cl per 100 cc. of urine). March 17, 1946: NPN 60 mg. per 100 cc. of blood; cholesterol 173 mg. per 100 cc. serum. ————— Decrease in blood pressure started in first week of rice diet.

of $3.16 \times 6.25 = 19.8$ Gm. of protein, these patients are in nitrogen equilibrium.

In fasting the daily urea nitrogen excretion in the urine is about 5.5 Gm. In the urine of patients who have followed the rice diet for two months or more the average daily urea nitrogen excretion is 1.1 Gm.⁶

In fasting the blood non-protein nitrogen and the blood urea nitrogen concentrations

TABLE 1
AVERAGE NPN AND UREA-N OF 261 PATIENTS WITH
HYPERTENSIVE VASCULAR DISEASE.
(Initial NPN 20 to 45 mg. Per 100 cc. Blood)

| No. of Patients | Average Period of Treatment (Days) | NPN | | Urea-N | |
|---------------------------------|------------------------------------|--------------------------|-------------------------|--------------------------|-------------------------|
| | | Average Before Rice Diet | Average After Rice Diet | Average Before Rice Diet | Average After Rice Diet |
| | | Mg. Per 100 cc. | Mg. Per 100 cc. | Mg. Per 100 cc. | Mg. Per 100 cc. |
| NPN and Urea-N Increased | | | | | |
| 13 | 62 | 31 | 35 | 12.5 | 16.0 |
| NPN Increased, Urea-N Decreased | | | | | |
| 10 | 74 | 30 | 32 | 11.4 | 7.5 |
| NPN Decreased, Urea-N Increased | | | | | |
| 3 | 83 | 32 | 31 | 8.9 | 12.8 |
| NPN and Urea-N Decreased | | | | | |
| 235 | 109 | 34 | 26 | 14.4 | 7.3 |
| Total | | | | | |
| 261 | 106 | 34 | 27 | 14.1 | 7.8 |

are higher than normal; on the rice diet they are lower than normal.⁵ Table 1 shows the non-protein nitrogen and urea nitrogen in a series of 261 non-uremic patients with hypertensive vascular disease. The non-protein nitrogen before the diet ranged from 20 to 45 mg. per 100 cc. of blood; the average was 34 mg. After the diet it ranged from 18 to 45 mg.; the average was 27 mg. The urea nitrogen before the diet ranged from 4.8 to 30.3 mg. per 100 cc. of blood; the average was 14.1 mg. After the diet it ranged from 1.2 to 30.4 mg.; the average was 7.8 mg.

In starvation, hemoglobin and plasma protein concentrations decrease; on the rice

TABLE II
EFFECT OF HIGH AND LOW PROTEIN DIETS ON URINARY
TOTAL NITROGEN AND CREATININE OF NORMAL MAN
(FOLIN¹²)

| | 120 Gm. Protein Egg-Milk Diet (3rd Day) | 6 Gm. Protein Cream- Starch Diet (7th Day) |
|--------------------------------------|---|---|
| Total nitrogen (mg. N per 24 hr.) | 16,800 | 3,600 |
| Creatinine (mg. N per 24 hr.) | 580 | 600 |

TABLE III
EFFECT OF FASTING ON URINARY CREATININE AND CREATINE
OF NORMAL MAN (BENEDICT¹³)

| | 1st Day of Fasting (Weight 59.6 Kg.) | 6th Day (Weight 55.9 Kg.) | 12th Day (Weight 53.6 Kg.) |
|---|--|---------------------------------|----------------------------------|
| Creatinine (mg. N per 24 hr.) | 480 | 390 | 370 |
| Creatine (mg. N per 24 hr.) | 0 | 130 | 120 |
| Total creatine bodies (mg. N per 24 hr.) | 480 | 520 | 490 |

diet hemoglobin and plasma protein levels are maintained,⁵ (Fig. 2.)

The excretion of creatinine plus creatine (total creatine bodies) has been supposed to remain fairly constant in spite of variations in protein intake and nitrogen excretion. (Table II).

The excretion of the total creatine bodies does not decrease in one to twelve days of fasting. The creatine fraction increases. (Table III.)

The excretion of total creatine bodies decreases markedly on the rice diet; the excretion of creatine does not increase. (Table IV.)

The decrease in the excretion of total creatine bodies ranged from 7 to 48 per cent, averaging 29 per cent; the decrease in weight ranged from 0 to 11 per cent, with an average of 6 per cent.

TABLE IV
CREATININE AND CREATINE IN URINE OF TWENTY-TWO
PATIENTS (FIFTEEN MEN, SEVEN WOMEN) WITH HYPERTENSIVE VASCULAR DISEASE

| | Before Rice Diet | After 35 Days (av.) on Rice Diet |
|---|------------------------|---|
| Creatinine (mg. N per 24 hr.) | 490 | 346 |
| Creatine (mg. N per 24 hr.) | 40 | 19 |
| Total creatine bodies (mg. N per 24 hr.) | 520 | 365 |

TABLE V
TOTAL SERUM CHOLESTEROL OF 284 PATIENTS WITH
HYPERTENSIVE VASCULAR DISEASE

| Initial Concentration (Mg. Per 100 cc. of Serum) | No. of Patients | Average Period of Treat- ment (Days) | Mg. Cholesterol Per 100 cc. of Serum (average) | | Change | |
|--|--------------------------------|---|---|-------------------------|--------|-----|
| | | | Before Treat- ment | After Treat- ment | | |
| 110-218 | Increased | 18 | 123 | 156 | +24 | |
| | Increased to 220 or over | 4 | 93 | 208 | 240 | +32 |
| | Decreased or constant | 61 | 109 | 195 | 157 | -38 |
| | | 83 | 110 | 187 | 165 | -22 |
| 220-585 | Increased or constant | 10 | 146 | 250 | 262 | +12 |
| | Decreased | 59 | 76 | 300 | 253 | -67 |
| | Decreased below 220 | 132 | 61 | 273 | 177 | -96 |
| | | 201 | 82 | 296 | 204 | -92 |
| 110-585 | 284 | 90 | | 257 | 192 | -65 |

As far as the metabolism of kidney cells is concerned rice protein cannot be indiscriminately replaced by other protein. Proteins differ from each other in regard both to the type and the relative proportion of the various amino acids of which they are composed. They also differ in regard to the rate and degree of assimilation; 30 Gm. of a protein of which 88 per cent is assimilated may be preferable to 50 Gm. of a protein of which only 40 per cent is assimilated.

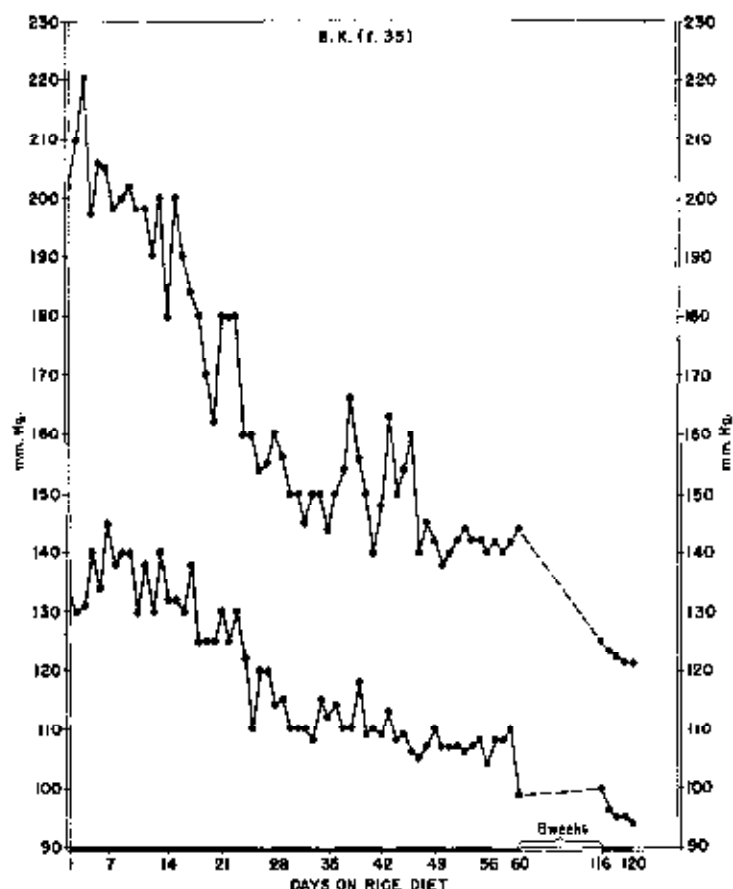


FIG. 4. B. K., female, thirty-five years of age. Patient had hypertensive vascular disease of eleven years' duration beginning during the eighth month of her second pregnancy. Of two brothers with hypertensive vascular disease, one had died at the age of thirty-seven (stroke). The patient had two retinal hemorrhages. Previous treatment: rutin, vitamin K, sedatives. Total PSP excretion in two hours 64 per cent; serum cholesterol 250 mg. per 100 cc. Rice diet was started April 23, 1947, and strictly followed (7-14 mg. Cl per 100 cc. of urine). No medication was given. A decrease in blood pressure began in third week on rice diet.

The factor of assimilation may be important not only because of the amount of protein that can be utilized to meet the body requirements but also because of the amount of the non-utilized protein fraction, the fate and rôle of which have yet to be determined.

Cholesterol. The relation between serum cholesterol and vascular disease (arteriosclerosis, coronary disease, vascular retinopathy, hypertensive vascular disease) has been the subject of extensive study.

Hypercholesterolemia, regardless of its primary cause in a given case, is just as

significant a metabolic disturbance as persistent hyperglycemia or hyperuricemia and should probably be considered as serious a disease, as far as potential consequences are concerned, as diabetes mellitus and gout.

Hypercholesterolemia decreases markedly with the rice diet.^{10,11} Table v shows the effect of the diet on the total serum cholesterol concentration of 284 patients with hypertensive vascular disease. Two hundred one of these patients (i.e., 70 per cent) had hypercholesterolemia (cholesterol concen-

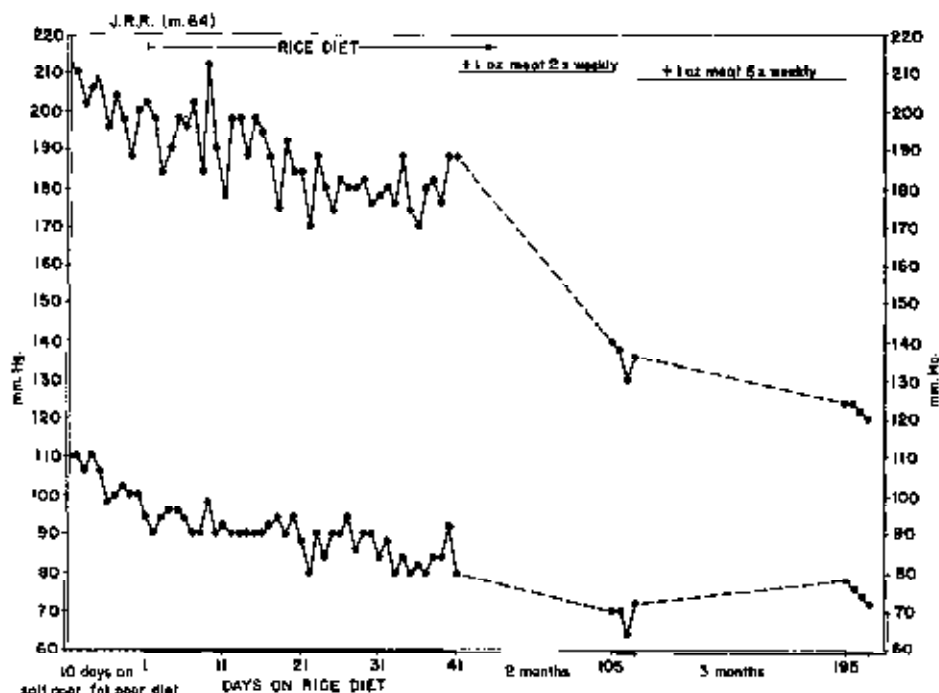


FIG. 5. J. R. R., a male, sixty-four years of age, had hypertensive vascular disease of six years' duration, four retinal hemorrhages and severe headache. He was treated previously with potassium thiocyanate. Total PSP excretion in two hours, 32 per cent. On October 7, 1946: Transverse diameter of heart, 15.2 cm.; diameter of great vessels, 10.5 cm.; weight, 62.8 Kg. Rice diet was started October 17, 1946, and strictly followed (4-9 mg. Cl per 100 cc. of urine). No medication was given. The patient was working and was asymptomatic. May 2, 1947: Transverse diameter of heart, 11.9 cm.; diameter of great vessels, 8.6 cm.; weight, 64.4 Kg. No retinal hemorrhages were present. There was reduction in heart size and in size of great vessels. (Fig. 8.)
Decrease in blood pressure was definite after 105 days.

tration of at least 220 mg. per 100 cc. serum) at the beginning of the diet.

Four patients whose serum cholesterol concentration was below the upper limits of normal had an increase to a hypercholesterolemic level (average before rice diet 208 mg. per 100 cc. serum, after rice diet 240 mg. per 100 cc. serum). One hundred thirty-two patients who had hypercholesterolemia had a decrease to a normal level (average before treatment 273, after treatment 177 mg. per 100 cc. serum). (Table v.)

Starke¹⁸ examined the concentration of free cholesterol and cholesterol esters in the serum of seventy-nine patients with hypertensive vascular disease who had a total cholesterol concentration of 220 to 463 mg. per 100 cc. of serum at the beginning of the diet. Free cholesterol and cholesterol esters

decrease on the rice diet in about the same proportion. (Table vi.)

Chloride, Sodium, Potassium. Therapeutic results with sodium chloride restriction such as those obtained by Allen and Sherrill¹⁷ and by Volhard¹⁸ were explained by Fishberg¹⁹ on the assumption that the unpalatability of the diet led to an inadequate caloric intake and thus to a reduction of the metabolic rate. According to Page¹⁹ the results obtained were due not to salt restriction but to "rest in bed and the psychotherapy of constant attention."

The treatment with the rice diet, which includes rigid sodium and chloride restriction, made it possible to determine the effect of a prolonged minimal intake of sodium and chloride on the concentration of these ions in blood, serum and urine.

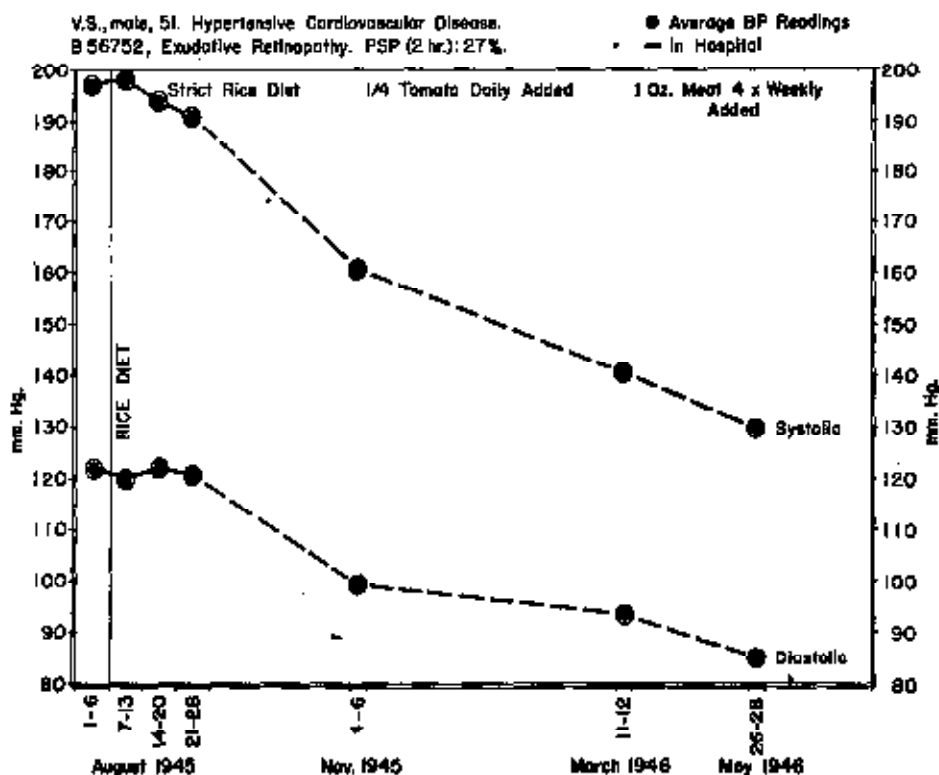


FIG. 6. U. S., a male, fifty-one years of age, had hypertensive vascular disease of eleven years' duration and retinal exudates. Previous treatment consisted of rest, sedatives and a "modified rice diet" for one month. Total PSP excretion in two hours: 21-33 per cent. Rice diet was started August 6, 1945, and strictly followed (5-20 mg. Cl per 100 cc. of urine). No medication was given. Working hours were restricted. — There was a gradual decrease of blood pressure after the third month of rice diet.

In a series of 213 patients treated with the rice diet the lowest urine chloride concentration found was 48 mg. Cl per liter with a total urinary excretion of 18 mg. Cl in twenty-four hours in a patient with hypertensive vascular disease who had been on the rice diet for seventy days. The plasma chlorides were 93.1 mEq. (as NaCl: 544 mg. per 100 cc.). The average values of 381 determinations of the plasma chlorides in ninety-one non-uremic patients with hypertensive vascular disease or primary kidney disease were: before rice diet, 97.0 mEq. per 1,000 cc. of plasma; after forty-four days (average) of rice diet, 91.7 mEq. per 1,000 cc. of plasma.⁶

Table VII gives a comparison of the concentrations of chloride, sodium and potassium in the urine of persons on a normal diet

and of patients after two months on the rice diet.¹¹

The average values of the chloride, sodium and potassium concentrations and their ratios in whole blood, serum and urine in thirty-seven patients with hypertensive vascular disease treated with the rice diet for an average of thirty-six days are shown in Tables VIII and IX.

In thirteen of the thirty-seven patients there was "secondary" renal involvement; in twenty-four patients there was no evidence of renal involvement. The sodium chloride content of the diet of many of these patients had been limited before they were started on the rice diet. None of these patients was in renal failure with sodium chloride leakage.

The following average changes were found: In the urine there was a decrease in the sodium concentration of 99 per cent and in the chloride concentration of 96 per

TABLE VI
FREE CHOLESTEROL AND CHOLESTEROL ESTERS IN THE
SERUM OF 79 PATIENTS WITH HYPERTENSIVE VASCULAR
DISEASE

| | Before Rice Diet | After 159 Days (Average) on Rice Diet |
|---|------------------------|--|
| Free cholesterol (mg. per 100 cc. serum)..... | 80 | 61 |
| Cholesterol esters (mg. per 100 cc. serum)..... | 205 | 146 |
| Total cholesterol (mg. per 100 cc. serum)..... | 285 | 207 |

TABLE VII
URINE CHLORIDE, SODIUM, POTASSIUM ON "NORMAL" DIET
AND ON RICE DIET

| | Normal Diet | Rice Diet (after 2 Months) |
|-----------------------------------|----------------|----------------------------------|
| Chloride (Gm. Cl per 1,000 cc.).. | 6 | 0.1 |
| Sodium (Gm. Na per 1,000 cc.).. | 4 | 0.01 |
| Potassium (Gm. K per 1,000 cc.).. | 2 | 3.0 |
| Gm. Na/Gm. K Ratio..... | 2 | 0.003 |

cent and an increase in the potassium concentration of 78 per cent. The sodium to potassium ratio decreased by 99 per cent and the chloride to potassium ratio by 97 per cent. There was a decrease of 79 per cent in the sodium to chloride ratio. All these changes are statistically significant.

In whole blood there was a statistically significant decrease of 4.3 per cent in the sodium concentration corresponding to an increase in hemoconcentration. There was a statistically significant decrease of 5.6 per cent in the chloride concentration. The sodium to chloride ratio remained constant. There was a statistically insignificant increase of 0.8 per cent in the potassium concentration and a statistically insignificant decrease of 3.4 per cent in the sodium to potassium ratio. The chloride to potassium ratio showed a decrease of 4.7 per cent (T value 2.1; probably statistically significant).

In the serum there was a statistically insignificant decrease of 0.7 per cent in the sodium concentration. Statistically significant changes in the serum were: a decrease of 6.2 per cent in the chloride concentration; an increase of 6.1 per cent in the sodium to chloride ratio; an increase of 11.3 per cent in the potassium concentration; a decrease of 8.6 per cent in the sodium to

TABLE VIII
CHLORIDE, SODIUM AND POTASSIUM CONCENTRATIONS IN WHOLE BLOOD, SERUM AND URINE OF THIRTY-
SEVEN PATIENTS WITH HYPERTENSIVE VASCULAR DISEASE BEFORE AND AFTER THIRTY-SIX DAYS
(AVERAGE) ON RICE DIET
(Average Values)

| | Whole Blood | | | Serum | | | Urine | | |
|----------------|---------------------|--------------------|-------------|---------------------|--------------------|-------------|---------------------|--------------------|-------------|
| | Before Rice Diet | After Rice Diet | Change % | Before Rice Diet | After Rice Diet | Change % | Before Rice Diet | After Rice Diet | Change % |
| | mEq./1,000 cc. | | | mEq./1,000 cc. | | | mEq./1,000 cc. | | |
| Chloride..... | 80.2 | 75.7 | -5.6 | 100.8 | 94.5 | -6.2 | 86.2 | 2.50 | -96.2 |
| Sodium..... | 82.0 | 78.2 | -4.3 | 142.8 | 141.7 | -0.7 | 81.7 | 0.43 | -99.2 |
| Potassium..... | 49.5 | 49.5 | +0.8 | 4.47 | 4.86 | +11.3 | 64.4 | 88.6 | +77.8 |

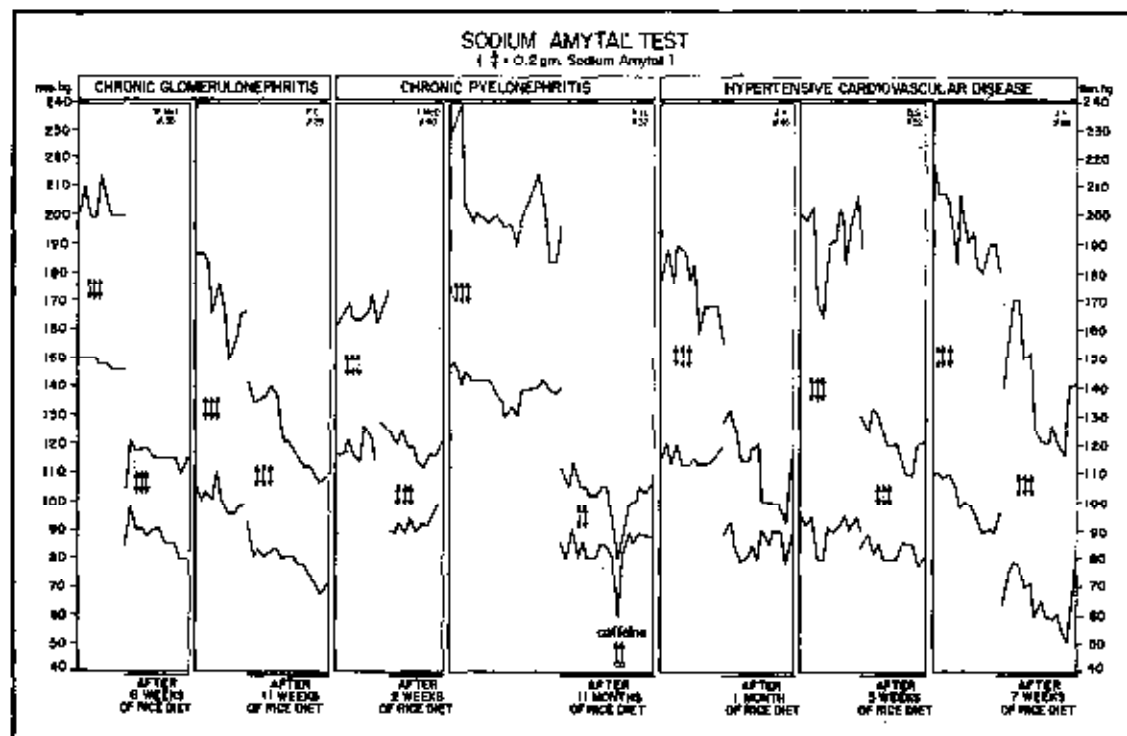


FIG. 7. Effect of 0.6 Gm. of sodium amytal on blood pressure before and after rice diet. (Reprinted from *North Carolina M. J.*, 6: 65, 1945).

TABLE IX

SODIUM CHLORIDE AND SODIUM
POTASSIUM POTASSIUM AND CHLORIDE RATIOS

IN WHOLE BLOOD, SERUM AND URINE OF THIRTY-SEVEN PATIENTS WITH HYPERTENSIVE VASCULAR DISEASE
BEFORE AND AFTER THIRTY-SIX DAYS (AVERAGE) ON RICE DIET
(Average Values)

| | Whole Blood | | | Serum | | | Urine | | |
|-------|------------------|-----------------|----------|------------------|-----------------|----------|------------------|-----------------|----------|
| | Before Rice Diet | After Rice Diet | Change % | Before Rice Diet | After Rice Diet | Change % | Before Rice Diet | After Rice Diet | Change % |
| Na/K | 1.67 | 1.61 | -3.4 | 32.7 | 29.4 | -8.6 | 1.66 | 0.006 | -99.3 |
| Cl/K | 1.63 | 1.55 | -4.7 | 23.1 | 19.6 | -14.0 | 1.71 | 0.03 | -96.9 |
| Na/Cl | 1.02 | 1.05 | +1.6 | 1.42 | 1.50 | +6.1 | 0.92 | 0.18 | -79.4 |

potassium ratio; a decrease of 14.0 per cent in the chloride to potassium ratio.

Sulfate, Phosphate and Ammonia Excretion in Urine. Chloride, sulfate and phosphate account for about 85 per cent of the acid excreted in the urine on a normal diet.

As Tables x and xi show the inorganic

sulfate excretion in patients on the rice diet decreases by 80 per cent; the inorganic phosphate excretion decreases by 60 per cent.²⁴

Ammonia is formed in the kidney by oxidative decamination of amino acids; blood and tissue acids reaching the kidney



FIG. 8. J. R. K., a male, sixty-four years of age, had hypertensive vascular disease of six years' duration, four retinal hemorrhages and severe headache. He was previously treated with potassium thiocyanate (three years). A, October 7, 1946; Blood pressure 212/110; weight, 62.8 Kg.; total PSP excretion in two hours, 32 per cent. Rice diet was started October 17, 1946, and strictly followed (4-9 mg. Cl. per 100 cc. of urine). No medication was given. B, May 2, 1947; Blood pressure 122/74; weight, 64.4 Kg. No appreciable drop in blood pressure after forty-one days of diet. The patient was working. A definite drop in blood pressure was noted after 105 days of diet. (Fig. 5.) The patient was asymptomatic and retinal hemorrhages had disappeared. There was a reduction in heart size with change in transverse diameter of 28 per cent and a reduction in size of great vessels with change of 22 per cent.

TABLE X
SULFATE EXCRETION IN URINE OF FOURTEEN PATIENTS
(TEN MEN, FOUR WOMEN) WITH HYPERTENSIVE
VASCULAR DISEASE—NO RENAL FAILURE

| | Range | | Average | | De-crease (%) |
|-------------------|-------------------|--------------------------------------|-------------------|--------------------------------------|---------------|
| | Before Rice Diet | After 36 Days (Average) on Rice Diet | Before Rice Diet | After 36 Days (Average) on Rice Diet | |
| | (Mg. S in 24 Hr.) | | (Mg. S in 24 Hr.) | | |
| Total sulfate | 761-471 | 254-58 | 592 | 126 | 79 |
| Inorganic sulfate | 547-362 | 165-40 | 452 | 81 | 82 |
| Organic sulfate | 328-32 | 115-15 | 140 | 45 | 56 |

as salts of fixed base are converted there into ammonium salts and excreted as such in the urine; thus the fixed base in the body is conserved. Under pathologic conditions (e.g., at lowered oxygen concentrations) the rate of decamination of amino acids and of ammonia production in the kidney is

TABLE XI
PHOSPHATE EXCRETION IN URINE OF SEVENTEEN PATIENTS
(THIRTEEN MEN, FOUR WOMEN) WITH HYPERTENSIVE
VASCULAR DISEASE—NO RENAL FAILURE

| | Range | | Average | | De-crease (%) |
|---------------------|-------------------|--------------------------------------|-------------------|--------------------------------------|---------------|
| | Before Rice Diet | After 34 Days (Average) on Rice Diet | Before Rice Diet | After 34 Days (Average) on Rice Diet | |
| | (Mg. P in 24 Hr.) | | (Mg. P in 24 Hr.) | | |
| Inorganic phosphate | 1055-501 | 435-170 | 761 | 289 | 62 |

decreased.^{6,6} The acid must be excreted in the urine as salts of fixed base, the fixed base in blood and tissues decreases and uremic acidosis follows.^{9,10} In considering the significance of the figures in Tables X and XI one might speculate about the possibility of forestalling an accumulation of acids in blood and tissue fluids by restricting

TABLE XII
AMMONIA EXCRETION IN URINE OF TEN PATIENTS WITH
HYPERTENSIVE VASCULAR DISEASE.

| mg. NH ₃ per twenty-four hr. | | Change (Average) |
|---|--|---------------------|
| Before Rice Diet | After 28 Days (Average) on Rice Diet | |
| 479 | 139 | -70% |

sulfur and phosphorus in the diet, i.e., by reducing the quantity of acid formed. Or, in cases in which the kidney although functioning under pathologic conditions has retained its ability to form ammonia, one might speculate about the possibility of reducing the rate of oxygen consumption by reducing the rate of ammonia production. The amount of oxygen thus saved might lead to an increase in the oxygen concentration at the surface of kidney cells where the supply of oxygen is diminished. As Table XII shows the ammonia excretion in the urine is decreased by the rice diet.

Table XIII compares the quantities of solids excreted in the urine on the rice diet and on a normal diet.

Discussion of the "Active Principle" of the Rice Diet. Since the first reports on the rice diet (1944), the importance of the rigid restriction of protein, fat, sodium and chloride has been stressed. Up to that time the therapeutic effect of this diet on blood pressure, heart size, electrocardiogram, cyclo-grounds, non-protein nitrogen, edema, etc., had been determined in 150 patients with acute and chronic nephritis and hypertensive vascular disease.^{1-4,16}

Grollman and Harrison (1945) believe that the effect of the rice diet is due to its low sodium content. They repeated some experiments with the rice diet on rats in which renal hypertension had been induced by the thread compression method. They confirmed our finding that the diet leads to marked blood pressure reduction. Since the hypotensive effect was not obtained when the strict rice diet was changed by the addition of NaCl (not of KCl), this

TABLE XIII
URINARY EXCRETION (GM. IN 24 HR.) ON "NORMAL" DIET
AND ON RICE DIET

| | Normal Diet | Rice Diet (2 Months or More) |
|-----------------------|----------------|------------------------------------|
| Total nitrogen | 15.0 | 2.3 |
| Urea nitrogen | 12.0 | 1.1 |
| Uric acid nitrogen | 0.3 | 0.08 |
| Total creat. nitrogen | 0.6 | 0.4 |
| Ammonia nitrogen | 0.6 | 0.1 |
| Sodium | 4.0 | 0.01 |
| Potassium | 2.0 | 3.0 |
| Chloride | 7.0 | 0.1 |
| Inorganic phosphate | 1.0 | 0.3 |
| Total sulfate | 0.80 | 0.13 |
| Inorganic sulfate | 0.72 | 0.08 |
| Ethereal sulfate | 0.08 | 0.05 |

hypotensive effect was ascribed by the authors to the sodium restriction.²¹

Selye and Stone (1946) kept the sodium chloride content of the diet high and varied the protein content. They produced nephrosclerosis with heart enlargement in rats by unilateral nephrectomy, lyophilized anterior pituitary gland and the substitution of a 1 per cent NaCl solution for drinking water. Each group of rats was fed exclusively on one of the following foods: skeletal muscle, cardiac muscle, "purina fox chow," peas, lentils, corn, lima beans or rice. They found that the degree of nephrosclerosis and the final organ weights were lowest in the rats fed with rice.²²

Dock (1946) compares the relative infrequency of arteriosclerosis of the coronary arteries in the Chinese and Italian population with the high incidence of this disease in the American army and stresses the importance of cholesterol. "Diets high in cholesterol, such as the American servicemen had while in this country, may hasten the process and lead to death decades earlier than if the individual had been on a diet poor in cholesterol." "As hypertension and cholesterol metabolism become better understood and controllable there is every reason to believe that there will be a decline from the present appalling death rate from coronary disease to the insignificant level

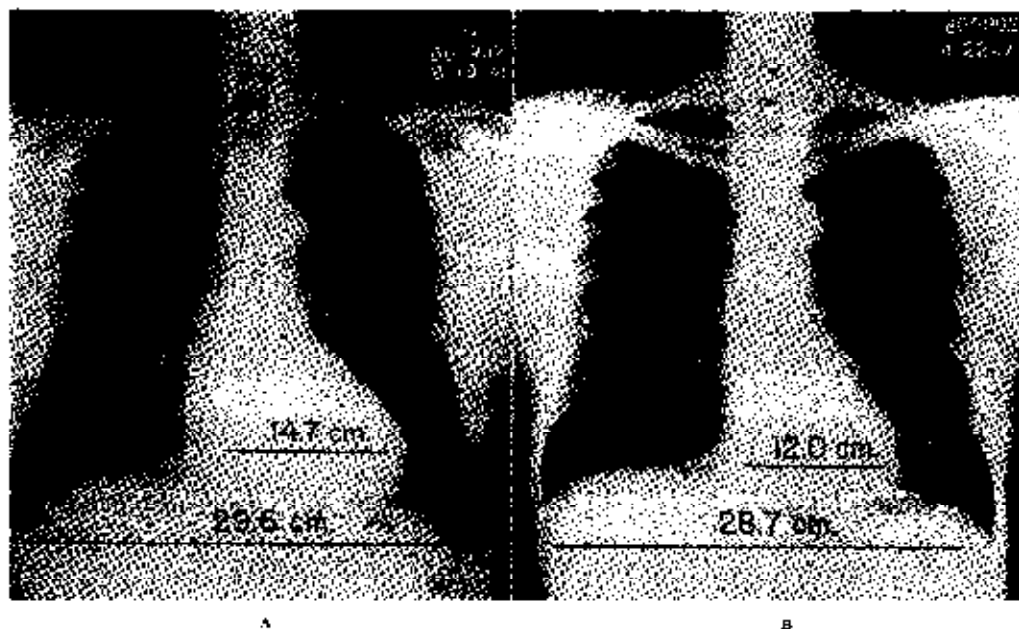


FIG. 9. I. S., a male, forty-one years of age, had hypertensive vascular disease of three years' duration, retinal hemorrhages and exudates. Previous treatment consisted of rest and phenobarbital. Total PSP excretion in two hours, 60 per cent. *a*, August 12 to 13, 1946; Blood pressure 220/150; cholesterol 290 mg. per 100 cc. serum; EKG 'T', diphasic to inverted; weight, 72.5 Kg. Rice diet was started August 17, 1946 and strictly followed for two months (2-7 mg. Cl per 100 cc. of urine); then moderately well followed (35-36 mg. Cl per 100 cc. of urine). No medication was given; the patient was working. *b*, April 21, 1947; Blood pressure 128/88; cholesterol 155 mg. per 100 cc. of serum; EKG 'T', upright. Retinal hemorrhages and exudates had disappeared; weight 56 Kg. ————— There was decrease in blood pressure and reduction in heart size with change in transverse diameter of 22 per cent.

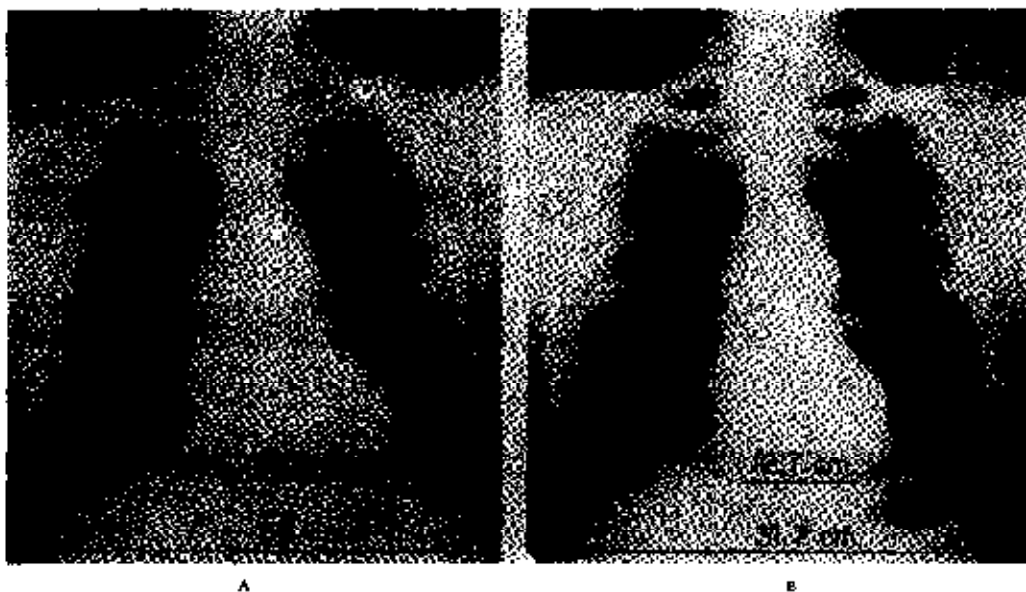


FIG. 10. H. H., a male, sixty-three years of age, had hypertensive vascular disease of at least two and one-half years' duration and a stroke 1946. Previous treatment consisted of aminophyllin, rest, sedatives, weight reduction. Total PSP excretion in two hours 56 per cent. *a*, June 3, 1947; Blood pressure 217/124; weight, 76.3 Kg. Rice diet was started June 7, 1947, and strictly followed for three months (9-23 mg. Cl per 100 cc. of urine.) No medication was given. *b*, September 7, 1947; Blood pressure 170/98; weight, 70.7 Kg. ————— There was a decrease in blood pressure and a reduction in heart size with change in transverse diameter of 14 per cent.

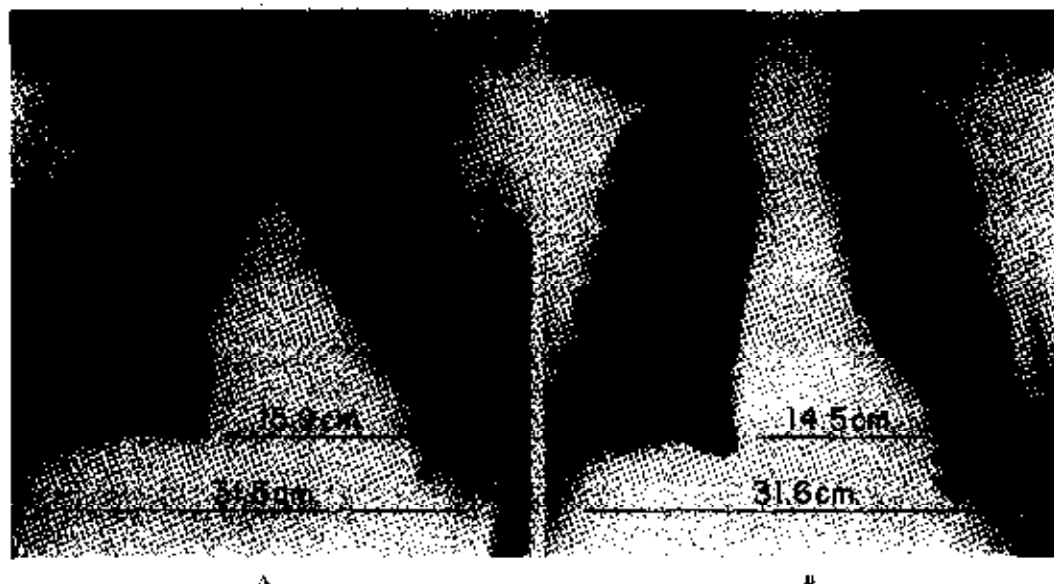


FIG. 11. R. H., a male, fifty-two years of age, had hypertensive vascular disease of three years' duration and pulmonary edema. Was treated with digitalis, mercuhydrin, aminophyllin and morphine. Total PSP excretion in two hours 39 per cent. A, June 8, 1946; Blood pressure 222/130; weight, 78.7 Kg. Rice diet was started June 12, 1946, and strictly followed for four months (11-22 mg. Cl per 100 cc. of urine); then moderately well followed (43-48 mg. Cl per 100 cc. of urine). All medication except digitalis was discontinued at beginning of rice diet. Digitalis was discontinued 7-24-46. B, May 31, 1947; Blood pressure 178/106; weight 71.2 Kg.; the patient was asymptomatic and resumed his practice as surgeon. There was a decrease in blood pressure and reduction in heart size with change in transverse diameter of 10 per cent.

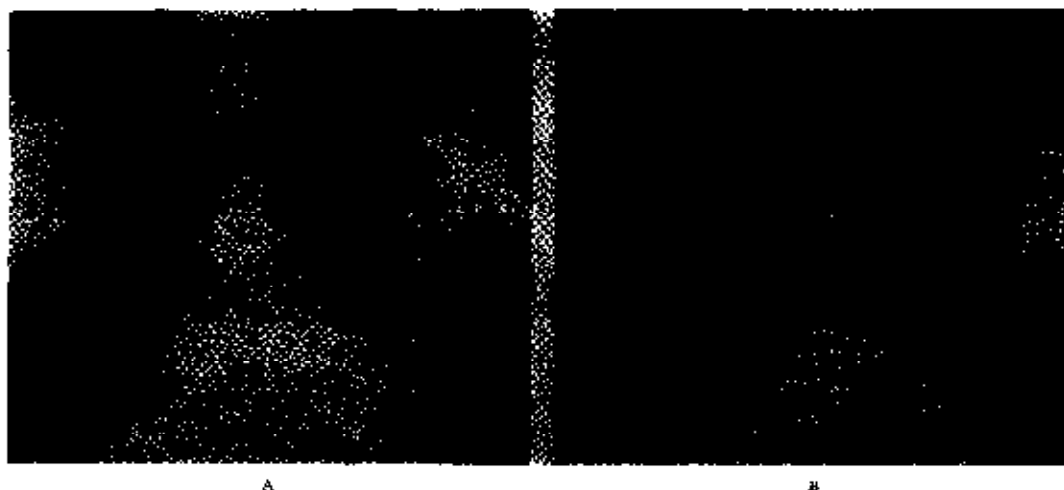


FIG. 12. A and B. G. H., a female, forty-five years of age, had hypertensive vascular disease of at least three years' duration, retinal hemorrhages and exudates. Total PSP excretion in two hours, 52 per cent. A, June 14, 1946; Blood pressure 258/138; EKG T₁ inverted; weight, 64.8 Kg. Rice diet was started June 20, 1946, and strictly followed for four months (4-13 mg. Cl per 100 cc. of urine); then moderately well followed (26-31 mg. Cl per 100 cc. of urine); no medication was given. The patient was active. B, May 28, 1947; Blood pressure 184/98; EKG T₁ upright; weight 59.6 Kg. No retinal hemorrhages or exudates were present. There was a decrease in blood pressure and reduction in heart size with change in transverse diameter of 28 per cent.

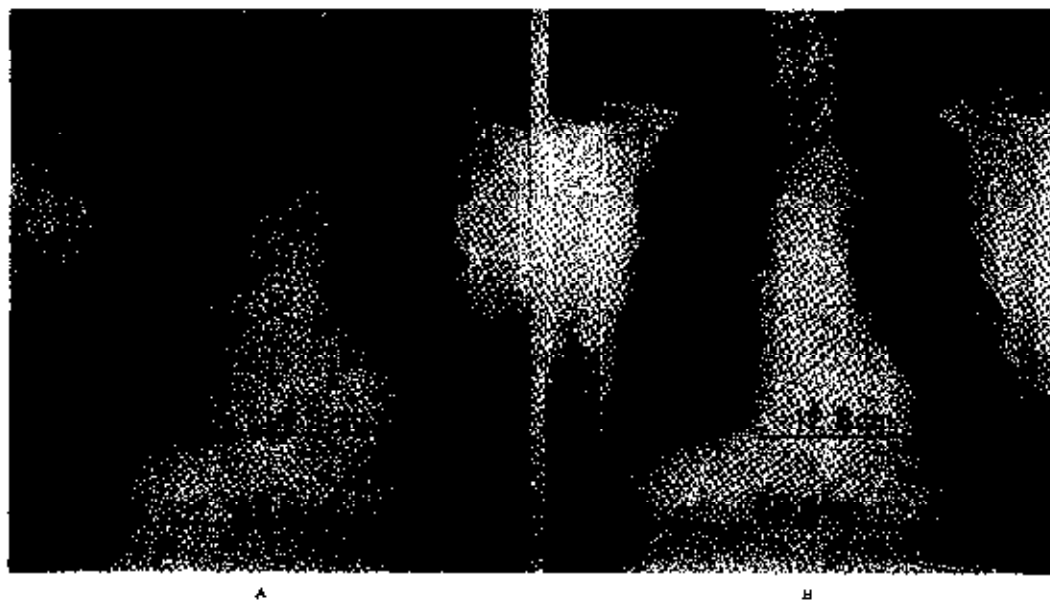


FIG. 13. A and B. O. P., a male, forty-one years of age, had hypertensive vascular disease of five years' duration with severe headache. September 5, 1946: Blood pressure 186/122; EKG T_1 inverted; total PSP excretion in two hours 79 per cent; weight 68.7 Kg. Rice diet was started September 9, 1946; no medication was given. He was asymptomatic and able to do his work. On April 1, 1947: Blood pressure 150/100; EKG T_1 upright; weight, 66.4 Kg. . . . There was a decrease in blood pressure and reduction in heart size with change in transverse diameter of 16 per cent.

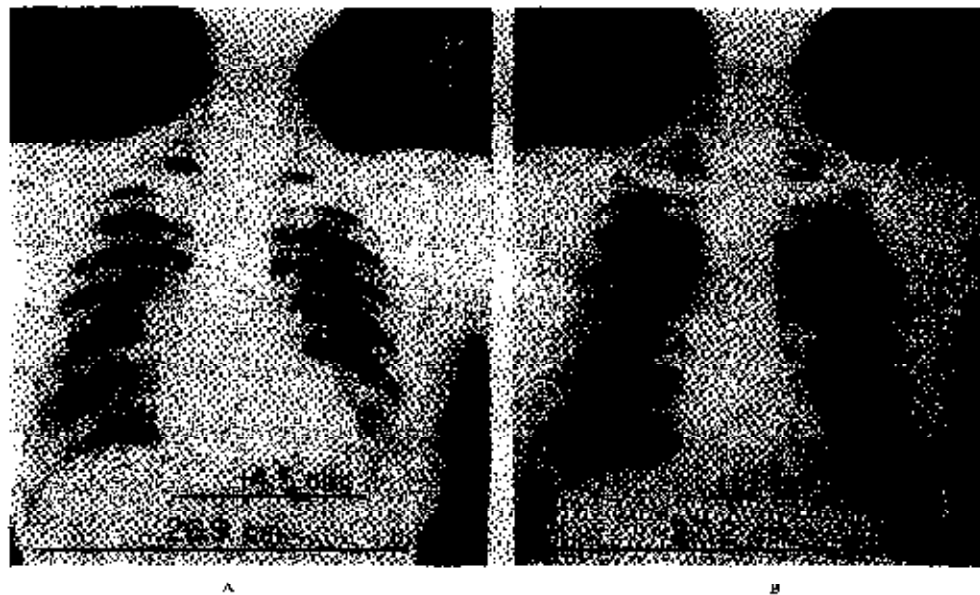


FIG. 14. A and B. R. Z., a female, fifty-three years of age, had hypertensive vascular disease (of at least five years' duration) and diabetes mellitus. Previous treatment: reduction diet (25 pound weight loss), April 19, 1945; Blood pressure 202/140; weight 53 Kg.; BMR $\times 45$ per cent; total PSP excretion in two hours 62 per cent; sugar, 231 mg. per 100 cc. blood (no insulin). Rice diet was started April 22, 1945; it was well followed (through May, 1945, and from January, 1946 to February, 1947 (7-15 mg. Cl per 100 cc. of urine). No digitalis was given. From August, 1945 to December, 1946, 10-30 units of insulin were given daily. May 13, 1947: sugar, 113 mg. per 100 cc. blood (no insulin). May 14, 1947: Blood pressure 224/112; weight, 50 Kg.; BMR -10 per cent. . . . There was reduction in heart size with change in transverse diameter of 31 per cent in spite of persistence of high blood pressure.



FIG. 15. A and B, J. P., a male, forty-two years of age, had hypertensive vascular disease of ten years' duration and cardiac failure of six months' duration. Previous treatment: sympathectomy in 1940 and from 1940 to 1946 potassium thiocyanate and phenobarbital. In 1946 pituitary irradiation was given; since 1946, digitalis, mercurials and sedatives (0.6 Gm. sodium amytal daily). May, 1947: Total PSP excretion in two hours, 32 per cent; venous pressure 195 mm. of saline. May 17 to 27, 1947; Blood pressure 220/152; weight 60.3 Kg. Rice diet was started on May 17th and strictly followed for four months. All medication was discontinued on May 17th except digitalis which was discontinued June 9, 1947. September 8, 1947; Blood pressure 214/148; weight 57.1 Kg. ——— A reduction in heart size occurred with change in transverse diameter of 27 per cent, in spite of persistence of high blood pressure.



FIG. 16. M. C., a male, forty-five. Planogram of myocardial aneurysm. (See Figure 17.)

now prevailing in other populations such as the Chinese."^{23,24}

G. Dick and Schwartz (1947) measured the arterial pressure in dogs in which hypertension had been produced by a nephrosclerosis which followed the intravenous administration of streptococci. At the time when the rice diet was started the hypertension had been maintained for two to four years. Dick and Schwartz found an average decrease of the mean arterial pressure from 181.6 to 138 mm. Hg after eight weeks on the diet. They conclude: "It appears that the Kempner regime is capable of causing significant lowering of the arterial blood pressure of dogs made hypertensive through the induction of nephrosclerosis. The role of weight loss, salt restriction, and nitrogen balance in this result requires further study."²⁵

INDICATIONS AND CONTRAINDICATIONS

The apparent simplicity of the rice diet has not infrequently proved a handicap.

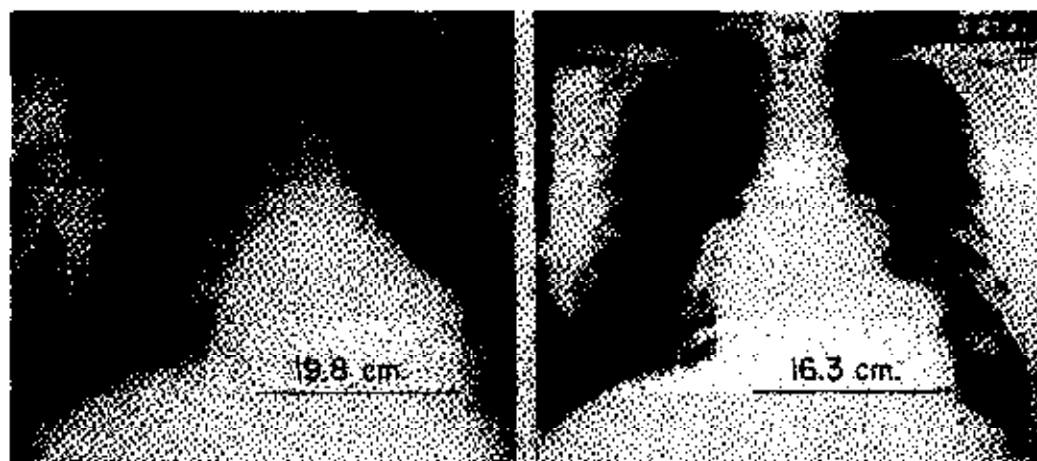


FIG. 17. A and B, M. C., a male, forty-five years of age, had a history of hypertension in 1944, myocardial infarction in 1945, followed by myocardial aneurysm.²⁶ There was progressive cardiac failure with massive peripheral edema, ascites, liver enlargement, hypoproteinemia (Fig. 2), hypocalcemia, albuminuria, decubitus ulcer and dyspnea. Previous treatment: (four months' hospitalization) low-protein, salt-poor diet, oxygen, digitalis, salyrgan, aminophyllin, ammonium chloride, theominal, coramine, sedatives; i.v. glucose; paracentesis. Rice diet was started August 7, 1946, and strictly followed; paracentesis August 15th; oxygen inhalation. No medication was given except digitalis which was discontinued October 10, 1946. Blood pressure August 6, 1946 was 138/94, August 27, 1947, 118/94. Advanced myocardial failure unchecked by previous intensive treatment was compensated by rice diet. The patient became asymptomatic and reduction in heart size occurred with change in transverse diameter of 21 per cent.

We have seen patients who had been treated with the diet just because the manometer had shown blood pressure figures above normal and in whom tumors, infections, etc. had been overlooked.

The rice diet is indicated in all serious instances of acute and chronic nephritis;^{1-5,11} in heart failure which does not respond to the customary treatment with salt restriction and drugs;^{1-5,11,20} in arteriosclerotic and hypertensive vascular disease with cardiac, cerebral, retinal or renal involvement.^{1-5,11,20}

The rice diet should be tried in uncomplicated hypertensive vascular disease when a more liberal regimen (fat-poor, salt-poor diets, weight adjustment, restriction of activities, regulation of bowel habits, sedation, etc.) has failed.

The rice diet should be used as a therapeutic test before sympathectomy is considered. If the dietary treatment proves ineffective, it can be discontinued.

In cases complicated by peptic ulcer the rice diet has to be modified. The rice is well tolerated, but raw fruit should be avoided

and only cooked, strained fruit should be used. Water or dialyzed milk may be substituted for the fruit juices.

The rice diet is not contraindicated in cases complicated by diabetes mellitus. It may in fact have a special value because of the dangerous rôle played by hypercholesterolemia in this disease.²⁷ It was expected that in order to maintain the previous blood sugar levels larger amounts of insulin would have to be given. We found instead that in many cases the blood sugar decreased on the rice diet and the insulin dose had to be reduced.

The rice diet is contraindicated unless frequent checks of the patient's blood and urine chemistry are possible. This is of especial importance in patients with renal sodium chloride leakage as the following history may illustrate:

A patient with hypertensive heart disease (Figs. 18 and 19) had been on the diet for seven months. He had followed it very strictly. After three weeks on the diet the serum chloride was 95 and the serum

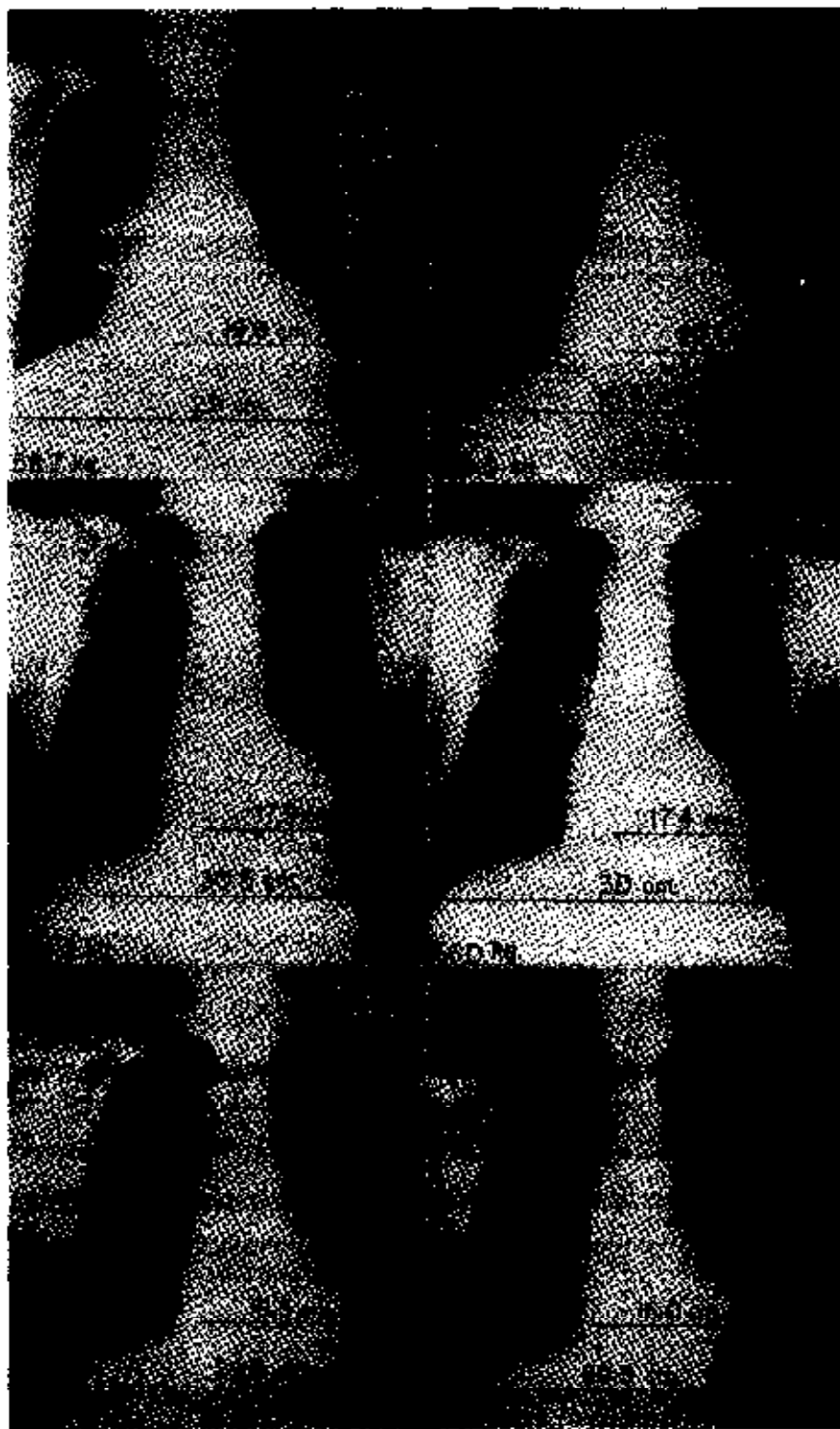


FIG. 18. P. K., a male, fifty-six years of age, had a history of nephrolithiasis, hypertensive vascular disease of more than ten years' duration, nephrectomy (left) in 1940, heart disease of three years' duration; left bundle branch block; dyspnea, edema. Previous treatment: salt-poor diet, digitalis, squill, salyrgan, mercupurin, ammonium chloride, sedatives. Total PSP excretion in two hours, 24 per cent; NPN 45 mg. per 100 cc. of blood; blood pressure 145/90. Rice diet was started April 3, 1946, and strictly followed (1-10 mg. Cl per 100 cc. of urine). All medication discontinued except digitalis. Digitalis was discontinued April 20, 1946. — — — There was a weight gain of 7.3 Kg and a gradual decrease in heart size.

sodium 135 mEq. per liter; after four months, 87 and 138 mEq. respectively. From the fifth month on he had felt well and had been completely asymptomatic. One evening, after some hours work at carpentry, he suddenly became unconscious and remained so for many hours. His hands and feet were extremely cold and, on regaining consciousness, he felt very weak and "faint." The attending internist who was familiar with the treatment made a diagnosis of stroke. However, on the addition of a few vegetables to his diet, all the symptoms disappeared and three days later when the patient was brought to our hospital, examination of the serum revealed a chloride concentration of 69 and a sodium concentration of 125 mEq. per liter.

CLINICAL CHANGES PRODUCED BY THE RICE DIET

A great many patients on the rice diet have experienced relief from headache, giddiness, fatigue, dyspnea and substernal pain. Such subjective improvement has not been accepted as evidence of successful therapy. Only measured results such as decrease in blood pressure, reduction in heart size, loss of edema and reversion of electrocardiogram or eyeground changes have been used to determine the effect of the treatment.

The therapeutic results in eighty patients with acute or chronic primary kidney disease and in 130 patients with hypertensive vascular disease were reported in 1945.⁵ By 1946 one hundred patients with primary kidney disease and 222 patients with hypertensive vascular disease had been treated with the rice diet.¹¹ This paper is limited to the changes obtained in patients with hypertensive vascular disease.

The effect of the diet has been determined in 500 patients most of whom were seriously ill and had failed to respond to other forms of treatment. The diet has been ineffective in 178 of these 500 patients if we include twenty-six patients who were in a critical condition when started on the diet and who died after an average period of thirty-nine

days. In 322 of the 500 patients the diet has proved beneficial, i.e., it has produced one or more of the following effects: decrease in "mean" arterial blood pressure of at least 20 mm. Hg; reduction in heart size with change in the transverse diameter of 18 per cent or more; a change in T_1 from completely inverted to upright; disappearance of severe retinopathy.

Blood Pressure. Five hundred patients (207 women, 293 men) with hypertensive vascular disease whose "mean" arterial pressure (sum of systolic and diastolic pressures divided by 2) was 125 mm. Hg or more were treated with the rice diet. The age ranged from nineteen to seventy-three (average, fifty-one) years. Two hundred twenty-nine patients had signs of renal involvement; in 271 no conclusive evidence of renal involvement was found.

The systolic blood pressure levels before treatment ranged from 154 to 264 mm. Hg; the average was 199 mm. The diastolic blood pressure levels ranged from 72 to 172 mm. Hg; the average was 117 mm. Hg.

After they were regulated on the diet under our supervision, most of the patients followed the diet at home, returning at intervals of two to six months for reexamination.

The blood pressure was considered improved if the "mean" arterial pressure had decreased by at least 20 mm. Hg.

The results are summarized in Table xiv. The figures given are averages of the daily readings of three to twenty-four (average, eight) days before and after treatment.

Of the 229 patients in whom the diagnosis of hypertensive vascular disease with "secondary" renal involvement was made, twenty-five died six to ninety-six days (average, thirty-nine days) after the diet was started. Of the 271 patients without evidence of renal involvement, one patient died thirty-six days after the rice diet was started.

Table xv shows the difference in the percentage of improvement when these twenty-six patients who died are not included.

TABLE XIV
EFFECT OF RICE DIET ON BLOOD PRESSURE OF 500 PATIENTS
WITH HYPERTENSIVE VASCULAR DISEASE
(PERIOD OF DIET 4-898 DAYS)
AVERAGES

| No. of Patients | Blood Pressure | | Change in Systolic and Diastolic Pressure | Change in "Mean" Arterial Pressure | Days on Rice Diet |
|--|------------------|-----------------|---|------------------------------------|-------------------|
| | Before Rice Diet | After Rice Diet | | | |
| <i>With Renal Involvement</i> | | | | | |
| <i>Hypertension Not Improved</i> | | | | | |
| 74 | 206/121 | 191/117 | -15/-4 | -9.5 | 71 |
| 25 | 226/147 | Died | | | 39 |
| <i>Hypertension Improved</i> | | | | | |
| 130 | 207/121 | 159/98 | -48/-23 | -35.5 | 81 |
| <i>Without Evidence of Renal Involvement</i> | | | | | |
| <i>Hypertension Not Improved</i> | | | | | |
| 89 | 186/109 | 167/102 | -19/-7 | -13 | 68 |
| 1 | 248/138 | Died | | | 36 |
| <i>Hypertension Improved</i> | | | | | |
| 181 | 193/113 | 147/93 | -46/-20 | -33 | 85 |
| Total | | | | | |
| <i>Hypertension Not Improved</i> | | | | | |
| 163 | 195/114 | 178/109 | -17/-5 | -11 | 69 |
| 26 | 227/147 | Died | | | 39 |
| <i>Hypertension Improved</i> | | | | | |
| 311 | 199/116 | 152/95 | -47/-21 | -34 | 85 |

TABLE XV
PERCENTAGE OF POSITIVE AND NEGATIVE BLOOD PRESSURE
RESULTS (A) INCLUDING AND (B) NOT INCLUDING
TWENTY-SIX PATIENTS WHO DIED

| A | | B | |
|--|----|--|----|
| 229 Patients with Renal Involvement | % | 204 Patients with Renal Involvement | % |
| Not improved..... | 44 | Not improved..... | 37 |
| Improved..... | 56 | Improved..... | 63 |
| 271 Patients without Evidence of Renal Involvement | % | 270 Patients without Evidence of Renal Involvement | % |
| Not improved..... | 33 | Not improved..... | 33 |
| Improved..... | 67 | Improved..... | 67 |
| All 500 Patients | % | All 474 Patients | % |
| Not improved..... | 38 | Not improved..... | 35 |
| Improved..... | 62 | Improved..... | 65 |

TABLE XVI
INFLUENCE OF THE LENGTH OF TREATMENT WITH THE
RICE DIET; BLOOD PRESSURE CHANGES IN PATIENTS
WITH HYPERTENSIVE VASCULAR DISEASE

| | Period of Treatment | |
|-------------------------|--|--|
| | 4-34 Days | 35-898 Days |
| | <i>With Renal Involvement</i> | <i>With Renal Involvement</i> |
| Number of patients..... | 86 | 143 |
| Not improved..... | 49 = 57%* | 90 = 35%† |
| Improved..... | 37 = 43% | 93 = 65% |
| | <i>Without Evidence of Renal Involvement</i> | <i>Without Evidence of Renal Involvement</i> |
| Number of patients..... | 109 | 162 |
| Not improved..... | 47 = 43% | 43 = 27%‡ |
| Improved..... | 62 = 57% | 119 = 73% |
| | Total | Total |
| Number of patients..... | 195 | 305 |
| Not improved..... | 96 = 49% | 93 = 30% |
| Improved..... | 99 = 51% | 212 = 70% |

* Including 13 patients who died.

† Including 12 patients who died.

‡ Including 1 patient who died.

TABLE XVII
CHANGES IN DIASTOLIC PRESSURE OF 406 PATIENTS WITH
HYPERTENSIVE VASCULAR DISEASE
INITIAL DIASTOLIC PRESSURE OF 100-159 MM. HG.

| | No. of Patients | Per-centage | Average Change |
|-------------------------------|-----------------|-------------|----------------|
| Decrease of 30 mm. Hg or more | 52 | 13 | -36 |
| Decrease of 20-29 mm. Hg..... | 101 | 25 | -24 |
| Decrease of 10-19 mm. Hg..... | 158 | 39 | -14 |
| Decrease of 0-9 mm. Hg..... | 77 | 19 | -5 |
| Increase of 1-22 mm. Hg..... | 18 | 4 | +7 |
| Total..... | 406 | 100 | -16.7 |

Figures 3 to 6 show typical blood pressure curves of patients on the rice diet.

The length of time required for the blood pressure to decrease varies from four days to ten months. The part played by the

TABLE XVIII

EFFECT OF RICE DIET ON HEART SIZE: AVERAGE CHANGES IN TRANSVERSE DIAMETER OF HEART IN 286 PATIENTS WITH HYPERTENSIVE VASCULAR DISEASE

| | No. of Patients | Per-centage | Period of Rice Diet (Average) Days | Diameter of Chest (Averages) | | Transverse Diameter of Heart (Averages) | | | | | |
|-------------------------|-----------------|-------------|------------------------------------|------------------------------|-----------------|---|------|------------------|-----------------|--------|---|
| | | | | Before Rice Diet | After Rice Diet | Change | | Before Rice Diet | After Rice Diet | Change | |
| | | | | | | Cm. | Cm. | | | Cm. | % (Diameter of Chest of Smaller Heart = 100%) |
| | | | | | | | | | | | |
| Decrease of 20% or more | 19 | 6.7 | 187 | 29.5 | 28.9 | -0.6 | -2.2 | 15.3 | 12.3 | -3.0 | -24.4 |
| Decrease of 10.0-19.9% | 106 | 37.1 | 114 | 29.2 | 29.1 | -0.1 | -0.3 | 14.5 | 12.7 | -1.8 | -14.2 |
| Decrease of 0-9.9% | 146 | 51.0 | 112 | 28.6 | 28.4 | -0.2 | -0.7 | 13.8 | 13.0 | -0.8 | -6.2 |
| Increase of 0-8.0% | 15 | 5.2 | 184 | 27.5 | 27.8 | +0.3 | +0.8 | 13.1 | 13.5 | +0.4 | +2.6 |
| Total | 286 | 100 | 122 | 28.8 | 28.6 | -0.2 | -0.7 | 14.2 | 12.9 | -1.3 | -10.1 |

TABLE XIX

CHANGES IN THE ANGLE OF THE ELECTRICAL AXIS IN 222 PATIENTS WITH HYPERTENSIVE VASCULAR DISEASE AFTER RICE DIET

| No. of Patients | Per-centage | Angle of Electrical Axis (Degrees) | | | Period on Rice Diet (Av.) Months | |
|-----------------|-------------|------------------------------------|------------------|-----------------|----------------------------------|------------------|
| | | Range of Change | Before Rice Diet | After Rice Diet | | Change (Average) |
| 1 | 2 | More than -25 | -10 | -55 | -45 | 2 |
| 6 | | -15 to -25 | +19 | 0 | -19 | 4 |
| 173 | 60 | -14 | +13 | +17 | -4 | 6 |
| 79 | 36 | -15 to +25 | -13 | +32 | +19 | 7 |
| 42 | | More than +25 | -6 | -43 | +37 | 8 |

length of time the diet was followed is evident from Figures 3 to 6 and Table XVI.

In 125 of the 500 patients (forty with and eighty-five without evidence of renal involvement) the blood pressure figures returned to normal or almost normal values (below 145/95 mm.). The blood pressure of these patients before the rice diet ranged from 222/148 to 158/98, average 181/107 mm.; the average pressure after four to 898 days, average ninety-four days, of rice diet was 132/85 mm. Seven patients are

TABLE XX

CHANGES OF T₁ IN 310 PATIENTS WITH HYPERTENSIVE VASCULAR DISEASE AFTER RICE DIET

| No. of Patients | T ₁ Before Rice Diet | T ₁ After Rice Diet | Period on Rice Diet (Average) Months |
|---------------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Change in Direction to Inverted | | | |
| 2 | diphasic | inverted | 3 |
| 1 | upright | diphasic | 6 |
| 3 | low upright | diphasic | 4 |
| 1 | upright | low upright | 2 |
| No Change | | | |
| 52 | inverted | inverted | 5 |
| 21 | diphasic | diphasic | 4 |
| 5 | low upright | low upright | 2 |
| 136 | upright | upright | 6 |
| Change in Direction to Upright | | | |
| 19 | low upright | upright | 5 |
| 4 | diphasic | low upright | 7 |
| 19 | diphasic | upright | 8 |
| 17 | inverted | diphasic | 7 |
| 5 | inverted | low upright | 7 |
| 25 | inverted | upright | 10 |

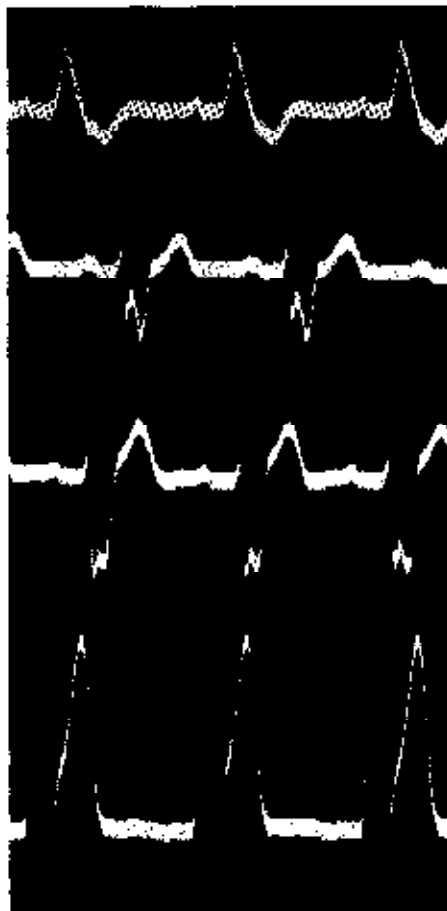


FIG. 19. P. K., a male, fifty-six, had left bundle branch block. The EKG did not change. (See also Fig. 18.)

included in this group whose "mean" arterial pressure dropped less than 20 mm. Hg and who therefore are counted as "not improved" in the previous paragraphs and tables.

The changes in diastolic pressure are analyzed separately in Table xvii.

Of 406 patients whose initial diastolic pressure was 100 mm. Hg or more 388, i.e., 96 per cent, had a decrease of 1 to 62 mm., average 18 mm., whereas only eighteen patients, i.e., 4 per cent, had an increase of 1 to 22, average 7 mm.

It has been assumed that the lowest blood pressure figure obtained after 0.6 Gm. sodium amytal indicates the maximum decrease which could be expected in the

individual patient from any form of treatment. Figure 7 shows in three typical charts that the blood pressure values obtained without sodium amytal after rice diet may be far lower than the lowest values reached during the sodium amytal test before the diet.

Heart Size. The assumption that cardiac enlargement in hypertensive vascular disease is desirable in order to overcome the increased peripheral resistance has been a pious self-deception of the physician who had no means of influencing the disease and preventing the progressive cardiac breakdown.

Cardiac enlargement in hypertensive vascular disease has been found to disappear when the patient is given the rice diet. Chest films taken before and after rice diet show decreases in the heart sizes with changes in the transverse diameter up to 30 per cent. Decrease in heart size does not necessarily coincide with decrease in blood pressure. In a number of patients whose blood pressure remained at a constant high level or showed only an insignificant reduction, a considerable decrease in heart size was found. (Figs. 14 and 15.)

Six foot chest films of 286 patients taken before and after one month or more of dietary treatment (no digitalis or other drugs) are available for comparison. Table xviii combines the averages of the measurements of the transverse diameter of the heart and of the chest diameter grouped according to the extent of change.

Before the rice diet the transverse diameters of the hearts of the 286 patients ranged from 10.2 to 19.4 cm.; the average was 14.2 cm. After the rice diet they ranged from 9.4 to 18.2 cm.; the average was 12.9 cm.

In 15 of the 286 patients (5 per cent) the heart became larger. In these patients the transverse diameter of the heart showed an average increase of 2.6 per cent. The chest diameter (average) increased by 0.8 per cent. The average period on the diet was

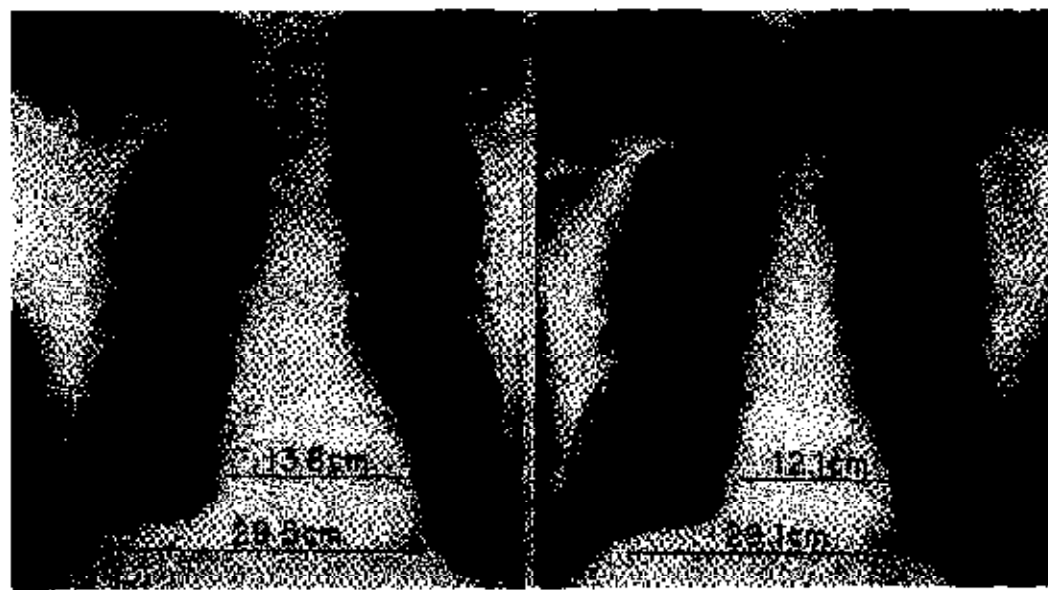


FIG. 20. A and B. C. O., a male, forty-three years of age, had hypertensive vascular disease of ten years' duration, left bundle branch block and dyspnea. Total PSP excretion in two hours, 57 per cent. Rice diet was started May 4, 1946, and strictly followed (10–11 mg. Cl per 100 cc. of urine). No medication was given. The patient became asymptomatic. — . . . There was a decrease in blood pressure and reduction in heart size with change in transverse diameter of 14 per cent. (Fig. 21.)

184 days. The average heart size in this group before treatment was the smallest found.

In 271 of the 286 patients (95 per cent) the heart became smaller with an average change in the transverse diameter of 10.6 per cent. The chest diameter decreased by 0.6 per cent (average). The average period on the diet was 118 days.

Figures 8 to 15, 17, 18, 20 show typical changes in the heart picture produced by the rice diet.

Electrocardiograms. The blood supply to the heart muscle will be inadequate whenever the coronary blood flow is decreased without a simultaneous decrease in the myocardial energy requirements, or whenever the myocardial energy requirements are increased without a simultaneous increase in the blood supply through the coronaries. In either case the effects of the deficiency in oxygen and nutrient substances, with the resulting chemical changes and consequent clinical manifestations, are easily predictable.^{7,39} The natural course

of these events is recorded by the electrocardiographic findings which indicate advancing myocardial impairment: left axis deviation, T_1 inversion, arrhythmias, conduction defects or myocardial infarction.

An attitude of resignation has prevailed with regard to the abnormal electrocardiogram in hypertensive heart disease. "It is a pertinent feature of records denoting left ventricular strain that the changes are slow in their evolution and more or less permanent once they have appeared."²⁹ "When once established the T-wave and the RS-T defects described persist and remain unaltered until the death of the patient."³⁰

Electrical axis and T_1 waves were studied in the electrocardiograms of 310 patients with hypertensive vascular disease before and after the rice diet. None of these patients received digitalis or any other drug. All electrocardiograms were made with the patient at rest in a recumbent position. The period between the two electrocardiograms compared was one month to thirty-three months, an average of six months. In 18

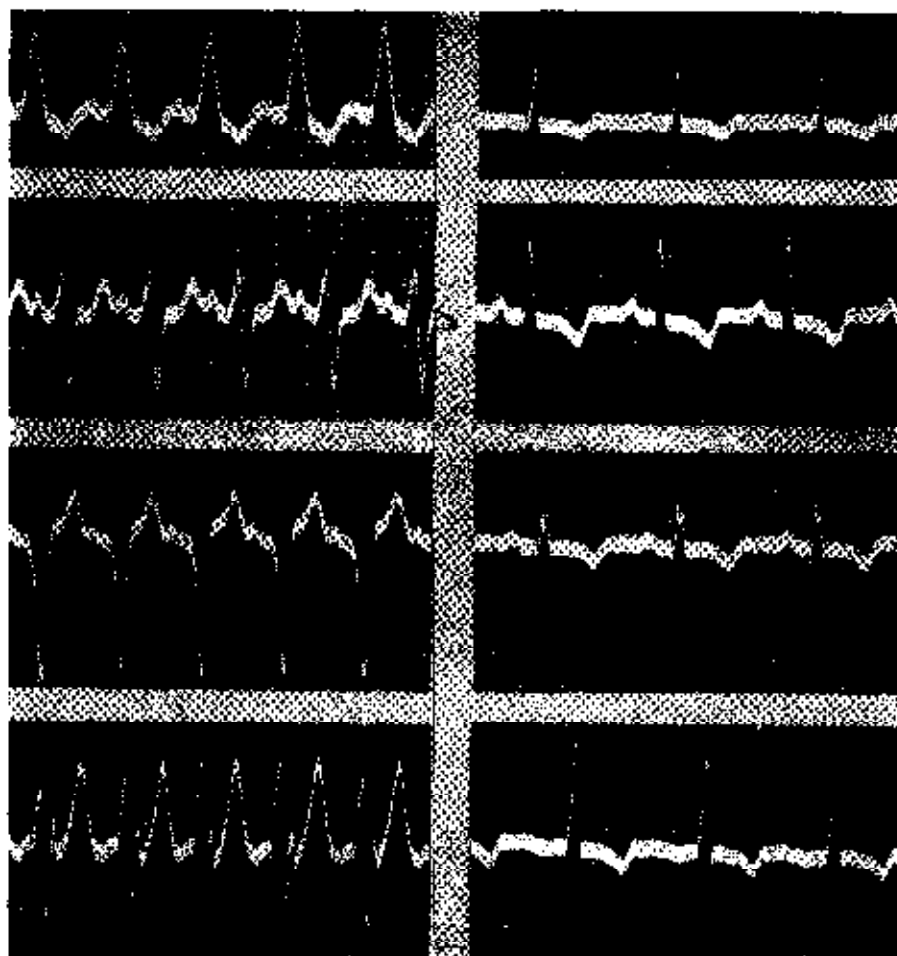


FIG. 21. C. O., a male, forty-three years of age, had hypertensive vascular disease of ten years' duration and dyspnea. April 29 to May 8, 1946: blood pressure, average, 179/126; total PSP excretion in two hours, 57 per cent. Rice diet was started May 4, 1946, and strictly followed (10–11 mg. Cl per 100 cc. of urine). No medication was given. July 24 to July 25, 1946: blood pressure, average, 157/110. The patient became asymptomatic and there was disappearance of left bundle branch block. (Fig. 20.)

of the 310 patients the electrical axis could not be evaluated. In the remaining 292 patients the angles of the electrical axis were:

| | Before Diet | After Diet |
|---------------------------------|-----------------|-----------------|
| More than +30 degrees | in 89 patients | in 131 patients |
| 0 to +30 degrees | in 97 patients | in 91 patients |
| Less than 0-degree | in 106 patients | in 70 patients |

The changes in the angle of the electrical axis of these patients are summarized in Table XIX.

Of the 119 patients whose electrical axis changed more than $\pm 14^\circ$ during the treatment 7, i.e., 6 per cent, showed a decrease; 112, i.e., 94 per cent, showed an increase in the angle of the electrical axis.

The T waves in lead I were evaluated in 310 patients. Before the rice diet was started T₁ was normally upright or low upright in 165, diphasic or inverted in 145 patients. The changes during the treatment are shown in Table XX.

In seven patients there was a change of T₁ in the direction from upright to inverted. In 89 patients there was a change of T₁ in the direction from inverted to upright. In

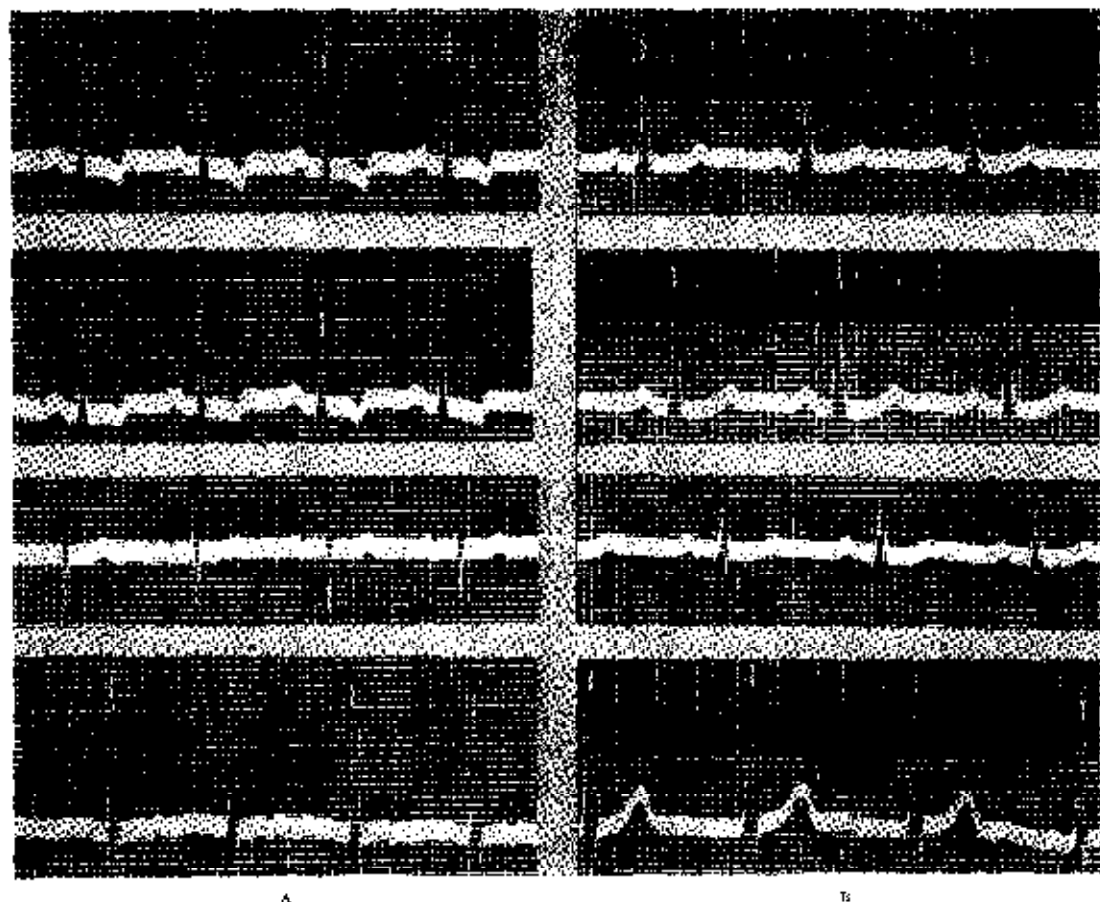


FIG. 22. A and B, R. L., a male, twenty-three years of age, had hypertensive vascular disease of three years' duration with advanced retinopathy; total PSP excretion in two hours: 2.5 per cent. No digitalis was given. Rice diet was started on December 18, 1945. Blood pressure, average, December, 18 to December 24, 1945: 222/148, January, 15 to January 21, 1946: 153/112. March, 11 to March 22, 1946: 134/94. — . . . — Inverted T_1 became upright within one month. The lowest blood pressure was reached two months later. (Figs. 5 and 30.)

ninety-nine patients the T_1 waves were completely inverted before treatment. In thirty of these ninety-nine patients T_1 became upright with the diet. In no patient did the reverse occur.

Excluding the patients who at the start of the rice diet already had an inverted T_1 (and in whom there could be no further change for the worse according to the grouping of Table xx), the percentage of those changing for the worse during the rice diet was three. Excluding the patients who at the start of the diet already had an upright T_1 (and in whom there could be no further improvement according to the grouping of Table xx), the percentage of those changing for the better was fifty-two.

The shortest time in which an inverted T_1 became normally upright was one month. (Fig. 22.) The average was ten months. In the patient whose EKG is shown in Figure 23 it took three years.

Of the 292 patients in whom it was possible to evaluate the changes both in electrical axis and in T_1 , eighty-seven patients (30 per cent) had an initial electrical axis above $+10^\circ$ and an upright T_1 . Of these eighty-seven patients 7 (8 per cent) showed a change for the worse in that the electrical axis decreased below $+10^\circ$ and/or T_1 became diphasic; 80 (92 per cent) did not change with the rice diet.

Of the 292 patients 205 (70 per cent) had an initial electrical axis below $+10^\circ$ and/or

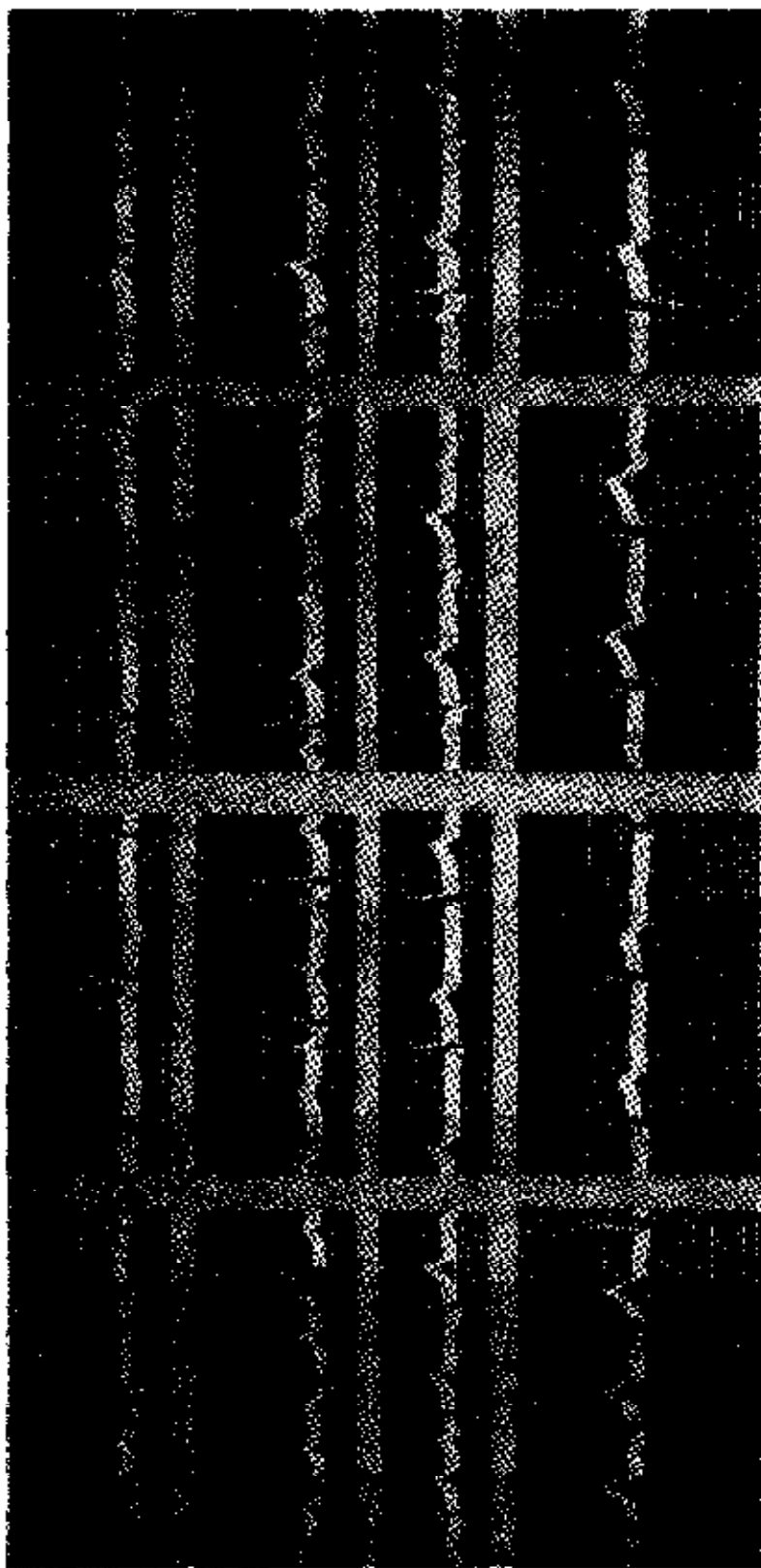


FIG. 23. A. E. H., female, thirty-six years of age, had hypertensive vascular disease of one year's duration. Chronic cyclonephritis was present. There were severe headaches and vaginal hemorrhages and "silver wire arterioles." Previous treatment with salt-poor diet; no digitalis was given. Total PSP excretion in two hours: 9-25 per cent. Rice diet was started April 13, 1943; it was moderately well followed. No medication was given. Patient was asymptomatic and working. Blood pressure averages: April 5 to April 26, 1943: 223/149; March 8 to March 10, 1944: 116/92; Feb. 20 to March 3, 1945: 159/109; May 23 to May 29, 1946: 118/79. Inverted T₁ has become normally upright three years after decrease of blood pressure.

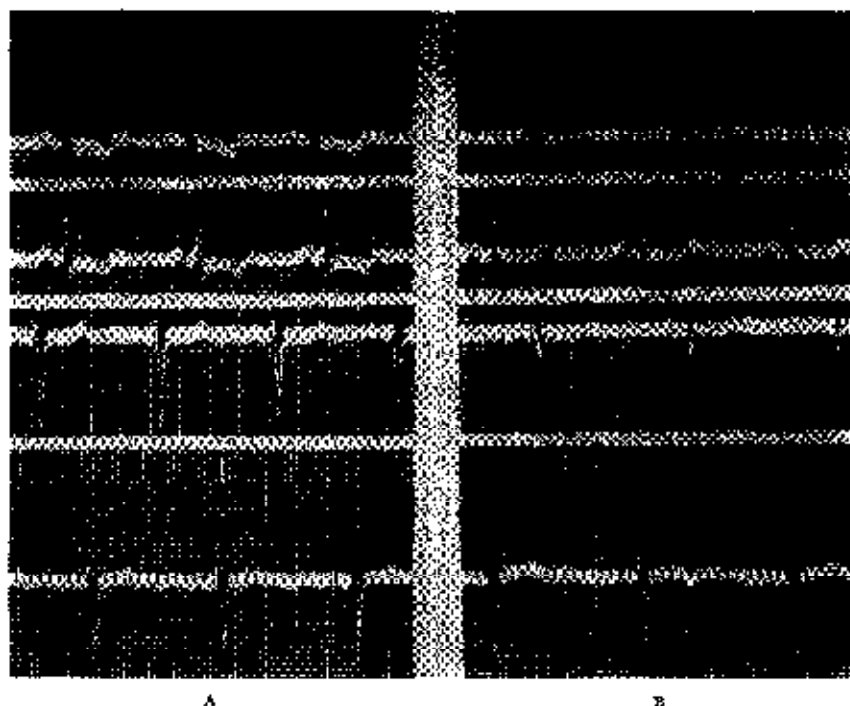


FIG. 24. A and B, C. G., a male, forty-nine years of age, had hypertensive vascular disease of two years' duration with severe headache. Two strokes occurred in 1944. He was treated with sedatives; was given no digitalis; April 6 to April 22, 1945: blood pressure average, was 196/105; total PSP excretion in two hours: 48 per cent. Rice diet was started April 24, 1945; it was followed strictly (5-20 mg. Cl per 100 cc. of urine). October 8 to October 11, 1945: blood pressure average was 136/80. — There was a decrease in the blood pressure and an increase in the angle of electrical axis. Inverted T_1 became upright.

a diphasic or inverted T_1 . Of these 205 patients 119 (58 per cent) remained unchanged; eighty-six patients (42 per cent) showed an increase in the electrical axis to more than $+10^\circ$ and/or a change of T_1 from diphasic or inverted to upright.

Retinopathy. Advanced retinopathy with papilledema, hemorrhages or exudates is a danger signal in hypertensive vascular disease. "Hemorrhages associated with white spots in the retina (hypertensive neuroretinopathy) are ominous signs. Death commonly follows within a year."¹¹

Vascular retinopathy has been found to disappear with the rice diet. The retinal improvement does not necessarily coincide with decrease in blood pressure. Very severe retinopathy has disappeared in patients when the blood pressure remained at a constant high level or showed only an insignificant reduction. (Figs. 27 to 29.)

Papilledema, hemorrhages or exudates, frequently in combination, were present in 140 of the 500 patients. In eighty-eight of these, eyeground photographs taken both before and after the rice diet (one to thirty months) are available for comparison. Papilledema was found in twenty-three of the eighty-eight patients. In seventeen it disappeared completely, in five partially and in one remained unchanged. Hemorrhages were found in fifty-five of the eighty-eight patients. In thirty-nine they disappeared completely, in fifteen partially and in one remained unchanged. Exudates were found in seventy of the eighty-eight patients. In forty-two they disappeared completely, in twenty-three partially and in five remained unchanged. In one of the patients in whom the exudates cleared up partially small hemorrhages occurred after a period of twelve

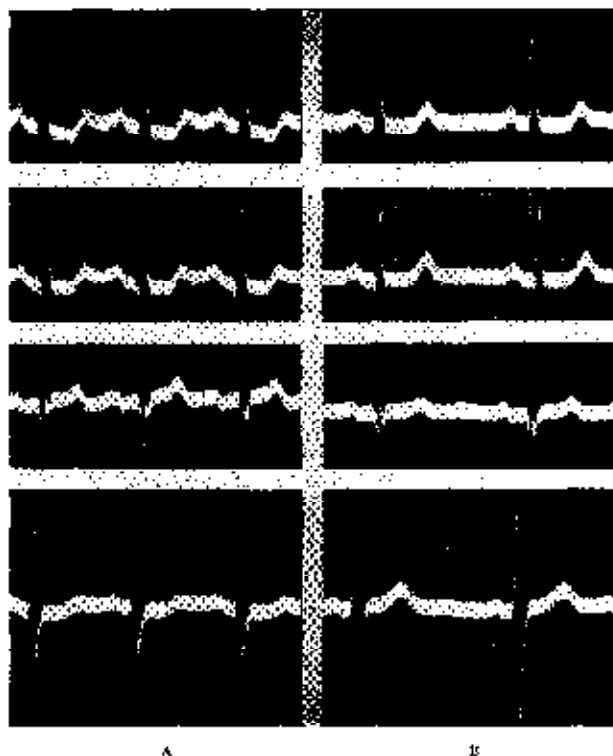


FIG. 25, A and B. F. G., a female, fifty-two years of age, had hypertensive vascular disease of twelve years' duration which began in toxemia of pregnancy. There were severe headaches. She had a stroke in May, 1946. She had previous treatment in a hospital with bedrest and a reduction diet. She had been given sedatives for the last three years. No digitalis was given. August 8, 1946: blood pressure was 238/128; total PSP excretion in two hours: 57 per cent. Rice diet was started August 10, 1946; it was strictly followed for six weeks (5 mg. Cl per 100 cc. of urine). September 20, 1946 to September 26, 1946: blood pressure, average, was 150/100. There was a decrease in blood pressure. . . . The diphasic T_1 has become upright.

months on the diet (which had not been strictly followed).

Those patients in whom the retinopathy remained unchanged had been on the diet from one to three and one-half months except for one patient with exudative stippling who was on the rice diet for nineteen months. The patients in whom the

retinopathy cleared up only partially had been on the rice diet from one to seventeen months, an average of five months. The period of time in which the retinal changes disappeared completely ranged from two to thirty months, an average of fourteen months.

Figures 26 to 30 show typical eyeground photographs before and after the diet.

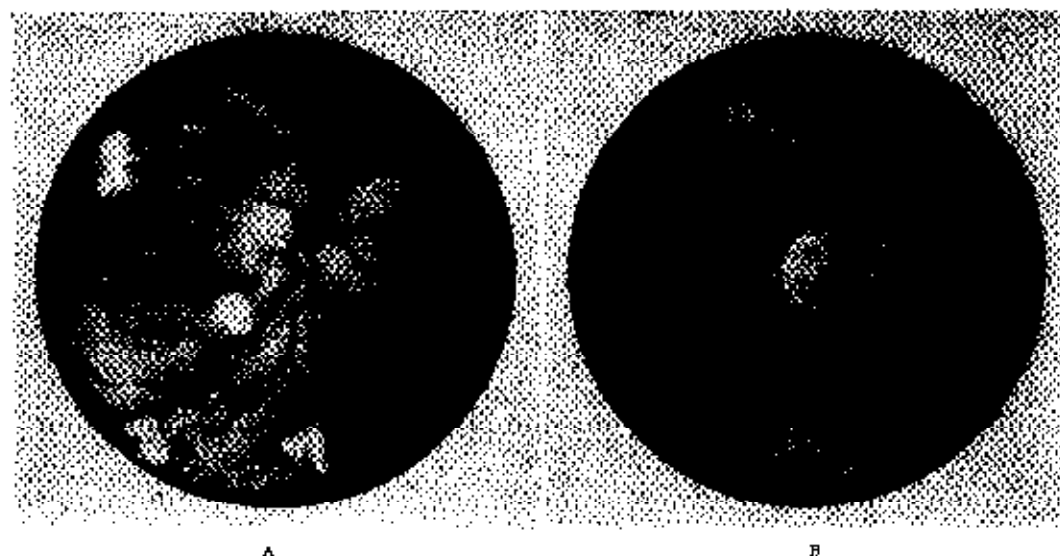


FIG. 26. A and B. D. L., a male, fifty-four years of age, had hypertensive vascular disease of at least six months' duration. His previous treatment consisted of low-fat, low-protein diet and sedatives. April 19, 1946 to May 6, 1946: blood pressure average was 221/144; EKG T₁ inverted; total PSP excretion in two hours: 35 per cent. Rice diet was started April 26, 1946; it was strictly followed (5-13 mg. Cl per 100 cc. of urine). March 25 to March 26, 1947: blood pressure, average, was 177/112; EKG T₁ was upright. September 22 to September 24, 1947: blood pressure, average, was 149/106; EKG T₁ upright. There was a disappearance of papilledema and exudates before lowest blood pressure level was reached.

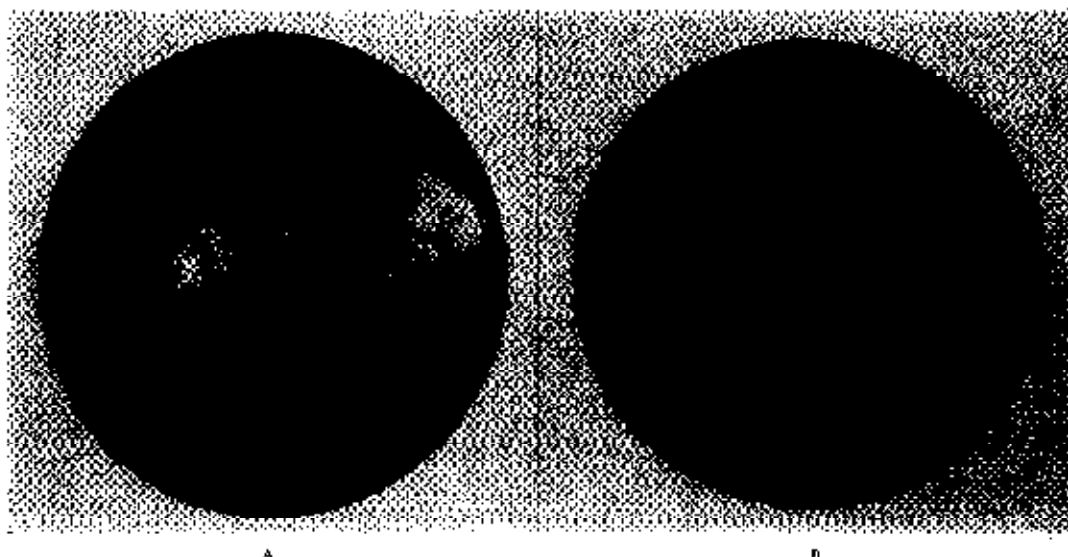
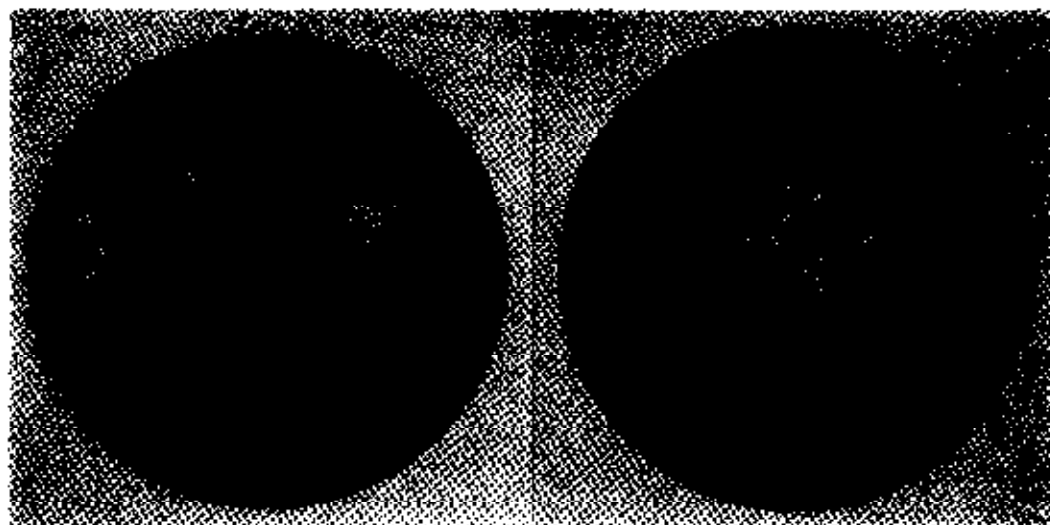
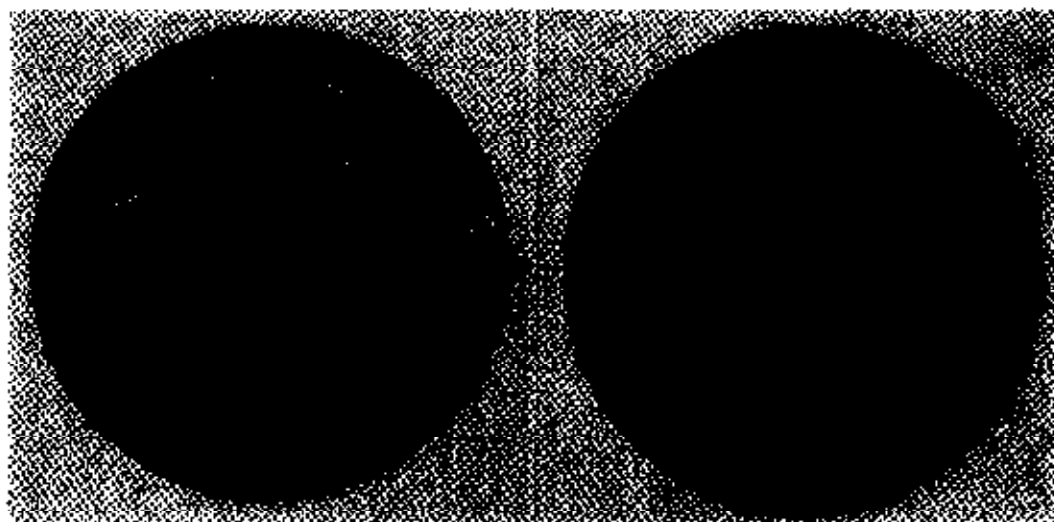


FIG. 27. A and B. W. A., a male, thirty-two years of age, had hypertensive vascular disease of eighteen years' duration. Sympathectomy was performed in the Mayo Clinic in 1945. Since July, 1946, there had been progressive impairment of vision in the left eye. February 19 to February 21, 1947: blood pressure average was 255/158; total PSP excretion in two hours: 40 per cent. Rice diet was started February 21, 1947; it was moderately well followed (12-51 mg. Cl per 100 cc. of urine). September 22 to September 26, 1947 blood pressure, average 230/138. There was marked improvement of vision. There was a disappearance of papilledema, almost complete disappearance of hemorrhages and exudates in spite of persistence of high blood pressure.



A



B

FIG. 28. A and B, L. W., a female, forty-five years of age, had hypertensive vascular disease of at least four months' duration, July 16 to August 5, 1944: blood pressure, average, 225/153; total PSP excretion in two hours, 59 per cent. Rice diet was started July 23, 1944 and strictly followed (4-24 mg. Cl per 100 cc. of urine). August 8 to August 13, 1945: blood pressure, average, 215/138. There was a disappearance of papilledema, hemorrhages and exudates in spite of persistence of high blood pressure.

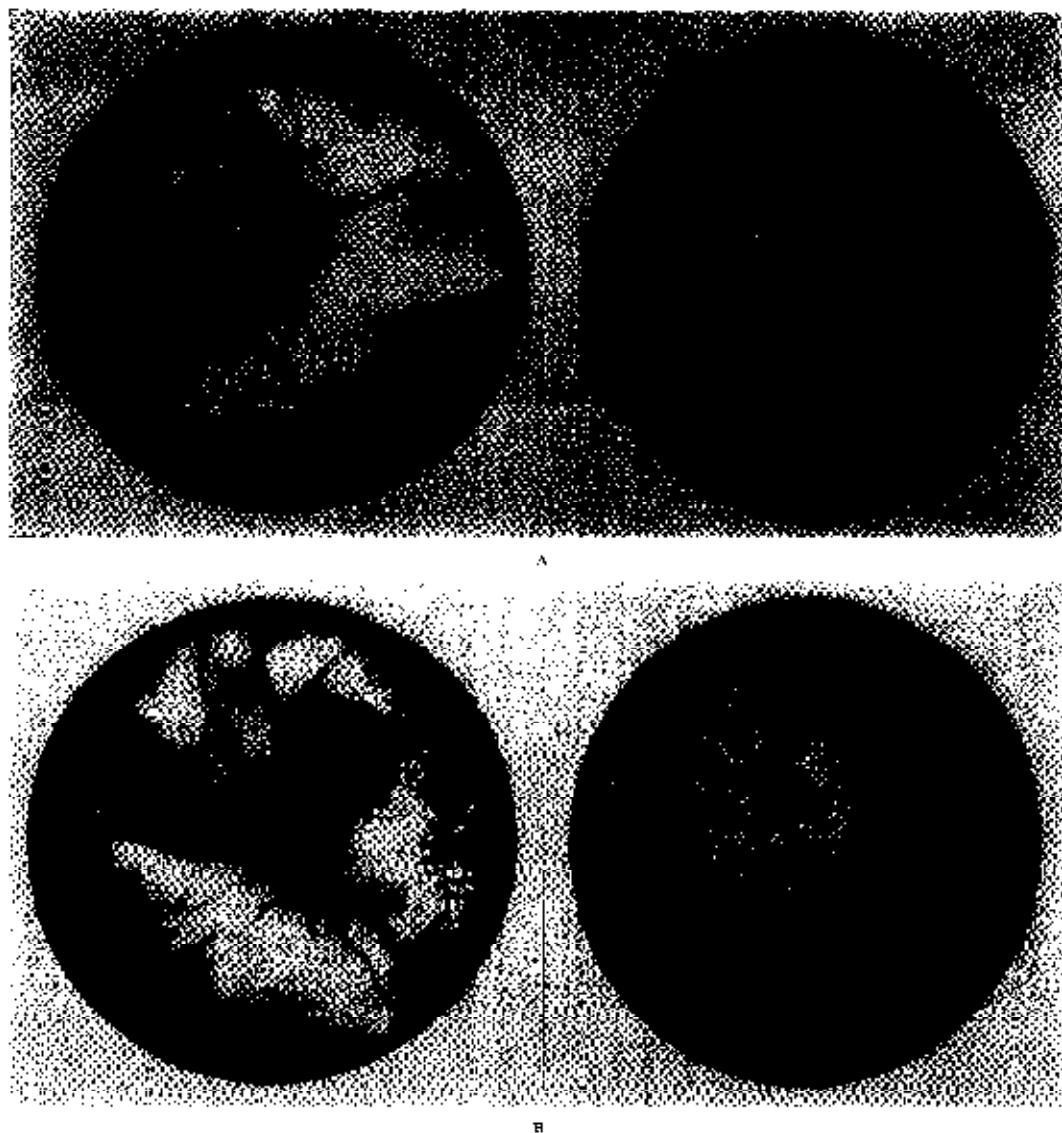


FIG. 29. A and B, A. McA., a male, thirty-eight years of age, had hypertensive vascular disease of at least one years' duration. He was previously treated with sedatives and low-salt diet. December 8 to 20, 1945: blood pressure, average, 216/132; EKG T₁ inverted; total PSP excretion in two hours, 58 per cent. Rice diet was started, December 13, 1945 but was not strictly followed (28-55 mg. Cl per 100 cc. of urine). May 5 to 8, 1947: blood pressure, average, 208/123; EKG T₁ upright. — Papilledema, hemorrhages, exudates disappeared in spite of persistence of high blood pressure.

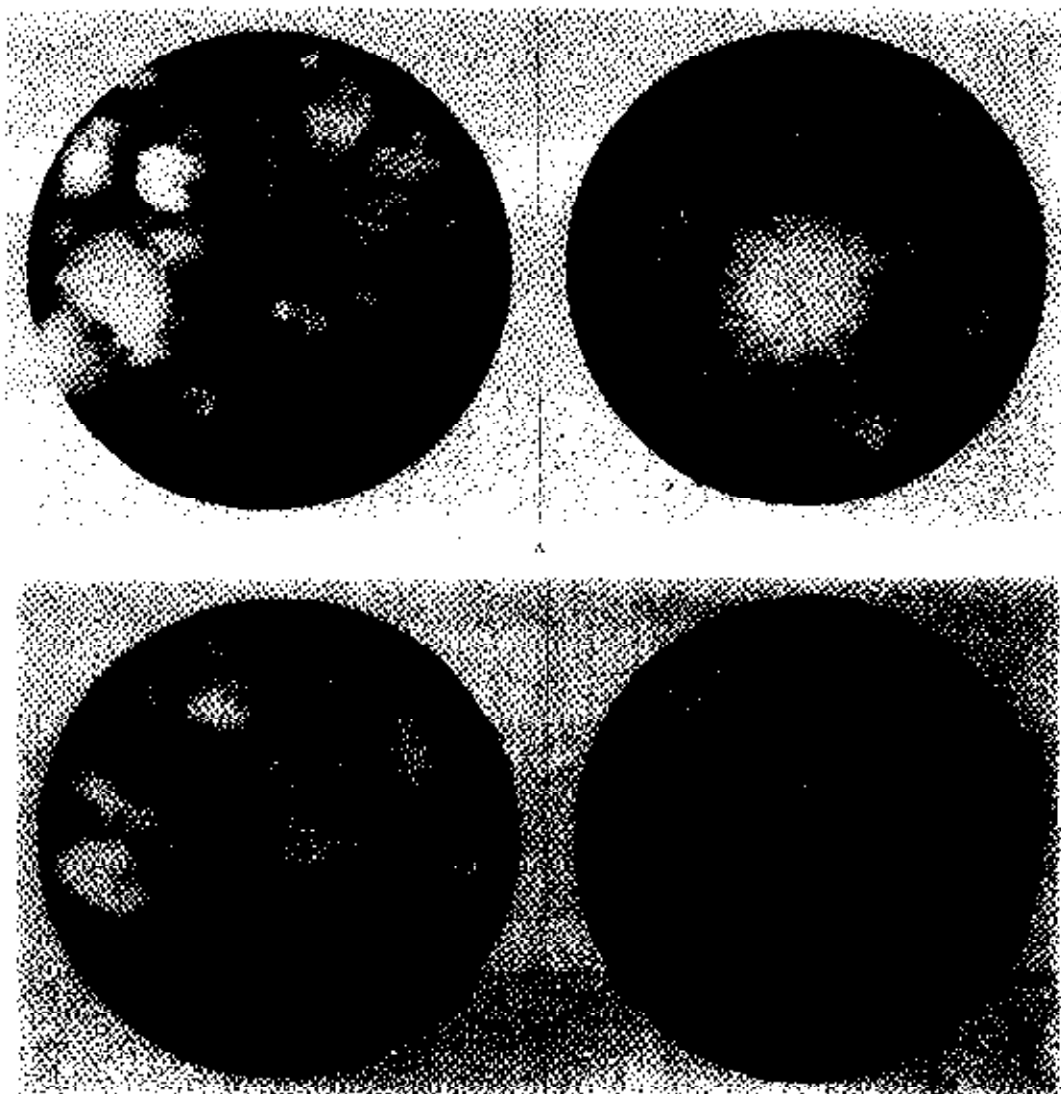


FIG. 30. A and B, R. L., a male, twenty-three years of age, had hypertensive vascular disease of three years' duration. Previous treatment consisted of a "modified rice diet." December 18 to December 24, 1945: blood pressure, average, 222/148; EKG T_1 inverted; total PSP excretion in two hours, 2.5 per cent; NPN 79 mg. per 100 cc. blood; cholesterol 340 mg. per 100 cc. serum. Rice diet was started December 18, 1945 and strictly followed for three months (8-21 mg. Cl per 100 cc. of urine). March 11 to 22, 1946: blood pressure, average 134/94; EKG T_1 upright. After March, diet was poorly followed (192-255 mg. Cl per 100 cc. of urine). August 15 to 21, 1946 and October 2 to 5, 1946: blood pressure, average, 194/133; EKG T_1 upright; NPN 60 mg. per 100 cc. blood; cholesterol 173 mg. per 100 cc. serum. There was a disappearance of papilledema, hemorrhages, exudates and no recurrence of retinopathy although diet was broken and hypertension recurred.

REFERENCES

1. KEMPNER, W. Treatment of kidney disease and hypertensive vascular disease with rice diet. *North Carolina M. J.*, 5: 125-133, 1944.
2. KEMPNER, W. Treatment of kidney disease and hypertensive vascular disease with rice diet. II. *North Carolina M. J.*, 5: 273-274, 1944.
3. KEMPNER, W. Treatment of kidney disease and hypertensive vascular disease with rice diet. *J. A. M. A.*, 125: 48, 1944.
4. KEMPNER, W. Treatment of kidney disease and hypertensive vascular disease with rice diet. *J. A. M. A.*, 125: 60, 1944.
5. KEMPNER, W. Treatment of kidney disease and hypertensive vascular disease with rice diet. III. *North Carolina M. J.*, 6: 61-87; 117-161, 1945.
6. KEMPNER, W. Anoxemia of the kidney as a cause of uremic acidosis: inhibitory effect of low oxygen tension on the deamination of amino acids in kidney tissue. *Am. J. Physiol.*, 123: 117-118, 1938.
7. LOHMANN, R. Biologie der Entzündung. *Ztschr. f. klin. Med.*, 135: 316-346, 1938.
8. KEMPNER, W. Inhibitory effect of low oxygen tension on the deamination of amino acids in the kidney. *J. Biol. Chem.*, 124: 229-235, 1938.
9. KEMPNER, W. Verminderter Sauerstoffdruck in der Niere als Ursache der reversiblen urämischen Acidose. *Klin. Wchnschr.*, 12: 971-973, 1938.
10. KEMPNER, W. The role of oxygen tension in biological oxidations. Cold Spring Harbor Symposia on Quantitative Biology. 7: 269-289, 1939.
11. KEMPNER, W. Some effects of the rice diet treatment of kidney disease and hypertension. *Bull. New York Acad. Med.*, 22: 350-370, 1946.
12. GOLDRING, W. and CHASSIN, H. Hypertension and Hypertensive Disease. P. 169. New York, 1944. Commonwealth Fund.
13. FISHER, A. M. Hypertension and Nephritis. 4th ed. Philadelphia, 1939. Lea & Febiger.
14. FOLIN, O. Laws governing the chemical composition of urine. *Am. J. Physiol.*, 13: 66, 1905.
15. BRUNEDICT, F. G. A Study of Prolonged Fasting. Washington, 1915. Carnegie Institution of Washington.
16. STARKE, H. Unpublished data.
17. ALLEN, F. M. and SHERILL, J. W. The treatment of arterial hypertension. *J. Metab. Research*, 2: 429, 1922.
18. VOLLMER, F. Die Behandlung der Nephrosklerosen, Handbuch der Inneren Medizin. Edited by von Bergmann and Staehelin, 2nd ed., pp. 1753-1782. Berlin, 1931. Julius Springer.
19. PAGE, I. H. and GORDON, A. C. Arterial Hypertension. P. 79. Chicago, 1945. Year Book Publishers.
20. KEMPNER, W., LESGNE, J., NEWBORG, B. and WHICKER, C., The sulfate and phosphate excretion in the urine of patients on the rice diet. (Unpublished.)
21. GROLLMAN, A. and HARRISON, T. R. Effect of rigid sodium restriction on blood pressure and survival of hypertensive rats. *Proc. Soc. Exper. Biol. & Med.*, 60: 52, 1945.
22. SELYE, H. and STONE, H. Effect of the diet upon the renotropic, nephrosclerotic, cardiotoxic and adrenotropic actions of crude anterior pituitary preparations. *Endocrinol. Proc.*, 5: 93, 1946.
23. DOCK, W. The predilection of atherosclerosis for the coronary arteries. *J. A. M. A.*, 131: 875, 1946.
24. DOCK, W. Coronary disease. *J. A. M. A.*, 134: 1177, 1947.
25. DIET, G. F. and SCHWARTZ, W. B. Response of experimental hypertension to rice and fruit juice diet. *Proc. Soc. Exper. Biol. & Med.*, 65: 22, 1947.
26. KEMPNER, W. Treatment of cardiac failure with the rice diet. *North Carolina M. J.*, 8: 128-131, 1947.
27. RABENOWITZ, I. M. Experiences with a high carbohydrate-low caloric diet for the treatment of diabetes mellitus. *Canad. M. A. J.*, 23: 489-498, 1930.
28. KEMPNER, W. and PRUCHET, E. Stoffwechsel der Entzündung. *Ztschr. f. klin. Med.*, 114: 430-455, 1930.
29. KAPLAN, L. G. and KATZ, L. N. The characteristic electrocardiograms in left ventricular strain with and without axis deviation. *Am. J. M. Sc.*, 201: 676-693, 1941.
30. RUCKERT, H. E. and HERRON, J. Electrocardiographic abnormalities characteristic of certain cases of arterial hypertension. *Am. Heart J.*, 10: 942, 1935.
31. CECIL, R. L. A Textbook of Medicine. 7th ed., p. 1156. Philadelphia, 1947. W. B. Saunders Co.