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Effect of Rice Diet on Diabetes Mellitus Associated With Vascular Disease

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BECAUSE of a high incidence of advanced vascular disease among our patients with diabetes mellitus, we have for the past 15 years treated numerous diabetic patients with the rice diet. Since more than 90 per cent of the calories in this diet are derived from carbohydrates, it was anticipated that increased amounts of insulin would be necessary to keep the blood sugar at its previous level. However, the opposite proved to be true. As previously reported,[1-5] not only is the rice diet well tolerated but in many instances the blood sugar and the insulin requirements decrease.

This paper deals with the effect of the rice diet on some vascular complications, particularly diabetic retinopathy, as well as with its effect on blood and urine chemical findings, especially blood sugar and insulin levels. Findings are given for 100 consecutive patients who were first examined by us between May 1944 and September 1955 and who followed the rice diet more or less strictly for at least three months. The period of observation in these 100 cases ranged from three months to 11 years and averaged 22 months. Nine patients died during the period reported here.

Clinical and Laboratory Data

Table 1 gives the average figures before and after treatment for blood sugar, urine sugar, insulin dosage, serum cholesterol, weight, blood pressure, heart size, blood nonprotein nitrogen, phenolsulfonphthalein excretion and urine protein, as well as averages for duration of diabetes, period of observation, age and sex, and incidence of vascular calcifications on x-rays.

Blood sugar—In 22 cases the fasting blood sugar remained relatively unchanged. In 78 cases a change of 20 mg. or more per 100 cc. was found. In 15 the blood sugar increased, the average levels being 140 mg. before treatment and 241 mg. after treatment. In the remaining 63 of the 78 cases the blood sugar level decreased, with averages of 236 mg. before treatment and 135 mg. after treatment.

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This paper was written for Dr. Otto Warburg in honor of his seventy-fifth birthday.

TABLE 1

EFFECT OF RICE DIET ON 100 PATIENTS WITH DIABETES MELLITUS; CLINICAL AND LABORATORY DATA (AVERAGES)

Average age of patients, 51 years (19 to 71)
Sex distribution, 46 men and 54 women
Average known duration of diabetes, nine years (0 to 33)
Average period of observation, 22 months (3 to 137)

	Before diet	*After diet*
Fasting blood sugar (mg. per 100 cc.)	202	155
Insulin (units)	25	17
Urine sugar (gm. in 24 hours)	21.1	4.2
Cholesterol (mg. per 100 cc. of serum)	297	239
Weight (kg.)	71.3	64.0
Blood pressure (mm. Hg)	179/97	151/85
Heart size (heart-chest ratio)	0.48	0.45
Incidence of arteriosclerosis (x-rays) (per cent)	66	
Nonprotein nitrogen (mg. per 100 cc. of blood)	42	37
Phenolsulfonphthalein excretion (per cent in two hours)	55	49
Proteinuria (gm. per 1000 cc. of urine)	0.36	0.19

Insulin—Twenty-eight patients did not take insulin either at the beginning or at the end of treatment. In 21 of the 72 cases in which the patients did take insulin the dosage was not changed; in 51 it was changed. Insulin dosage was increased in nine cases, including four in which the patients started without insulin (averages, 22 units before and 44 units after treatment). It was decreased in 42 cases. The average dosages in these cases were 39 units before treatment and 16 units after treatment; in 18 cases with an average initial insulin requirement of 26 units, insulin could be completely discontinued.

Glycosuria—Sixty-six of the 100 patients did not have glycosuria either at the beginning or at the end of treatment. In three of the 34 cases in which the patients had glycosuria, there was an increase in the amount excreted; in two of these three cases the average increase was from zero to 11.2 gm. in 24 hours, and in the third case the amount increased from 4 to 14.6 gm. in 24 hours. In 31 of the 34 cases in which the patients had glycosuria, there was a decrease in the amount excreted: from 28.1 to 8.1 gm. in 24 hours (averages), nine cases; from 4 plus to 3 plus, three cases; from 4 plus to 1 plus, one case; from 22.1 gm. in 24 hours (average) to zero, eight cases; from 4 plus to zero, four cases; from 2 plus to zero, three cases; and from 1 plus to zero, three cases.

Serum cholesterol—Twenty of the 100 patients had a serum cholesterol concentration of 220 mg. or less per 100 cc. at the beginning of treatment. In 13 of these cases the concentration increased, the averages being 191 mg. before treatment and 232 mg. after treatment. In two cases the cholesterol concentration remained unchanged. In five it decreased (average, 201 mg. to 174 mg.).

Eighty patients had a serum cholesterol concentration of 221 mg. or more per 100 cc. at the beginning of treatment. The concentration increased in 12 of these cases (averages, 303 mg. before treatment and 352 mg. after treatment). In the other 68 cases the cholesterol concentration decreased, the average values being 325 mg. before treatment and 227 mg. after treatment.

Blood pressure—Ten patients had blood pressures of 129/88 or less at the beginning of treatment; the average readings in these 10 cases were 122/77 before treatment and 129/82 after treatment.

Ninety patients had blood pressure readings of 135/82 or more (average, 185/99) at the beginning of treatment. Their average blood pressure after treatment was 153/85. In 19 cases the blood pressure returned to normal (118/75, average).

Heart size—Chest films of 87 patients are available for comparison before and after treatment (no digitalis after beginning of rice diet). In 59 cases the heart-chest ratio was less than 0.50 before treatment; it decreased from 0.44 to 0.43 (averages). In 28 cases the heart-chest ratio was 0.50 or more before treatment. It decreased from 0.56 to 0.50 (averages). In no case did the heart become larger in size.

Electrocardiogram—Electrocardiograms of 86 patients are available for comparison before and after treatment (no digitalis). Fifty of the 86 patients had a normal electrocardiogram at the beginning of treatment. In 46 cases it remained normal, and in four cases

abnormal findings were observed: infarct, one case; T_1 inverted, two cases; and diphasic T_1, one case.

Thirty-six of the 86 patients had an abnormal electrocardiogram at the beginning of treatment; four had previous infarction, five had bundle-branch block, and 27 abnormal T_1. In 15 of these cases the abnormal findings persisted (four previous infarction, five bundle-branch block, six inverted or diphasic T_1). In five cases the electrocardiographic findings became worse; in three the diphasic T_1 became inverted, and in two with inverted T_1 a bundle-branch block and an infarction developed, respectively. In 16 cases the electrocardiogram improved; the T_1, which had been inverted in six, diphasic in five, and flat in five, became upright.

Nonprotein nitrogen—Sixty of the 100 patients had a nonprotein nitrogen level of 40 mg. or less per 100 cc. of blood at the beginning of treatment. In 20 of these cases the nonprotein nitrogen increased, the averages being 31.1 mg. before treatment and 39.6 mg. after treatment. In three cases the level remained unchanged. In 37 there was a decrease in the nonprotein nitrogen, from 35.2 mg. before to 30 mg. after treatment (averages).

Forty patients had a nonprotein nitrogen level of more than 40 mg. per 100 cc. of blood at the beginning of treatment. In six of these cases the level increased from an average of 52 mg. before treatment to an average of 64 mg. after treatment. In two the level remained unchanged, and in 32 there was a decrease, from an average of 83 mg. before treatment to an average of 38 mg. after treatment.

Phenolsulfonphthalein excretion—Data on phenolsulfonphthalein excretion before and after treatment are available for 77 of the 100 patients. In only 11 cases was the initial phenolsulfonphthalein excretion 75 per cent or more in two hours. Including these, in 59 cases there was an initial phenolsulfonphthalein excretion of 40 per cent or more in two hours. In 39 of these 59 cases the percentage of phenolsulfonphthalein excreted decreased from an average of 64.7 before treatment to 50.7 after treatment. In two cases the excretion remained unchanged. In 18 it increased, the averages being 60.9 per cent before treatment and 70.1 per cent after treatment.

Eighteen patients had an initial phenolsulfonphthalein excretion of less than 40 per cent in two hours (range, zero to 39 per cent). Of these, nine showed a decrease, from an average of 33 per cent before to an average of 25 per cent after treatment. In one case the excretion remained unchanged. In eight cases it increased, the average before treatment being 20 per cent and the average after treatment 35 per cent.

Proteinuria—Thirty-three patients did not have proteinuria either at the beginning or at the end of treatment. In 10 of the 67 cases with proteinuria, the amount increased from an average of 0.20 gm. per 1000 cc. before treatment to an average of 0.40 gm. per 1000 cc. after treatment. In four cases the amount of protein in the urine did not change, and in 53 it decreased (in 32 from an average of 0.88 gm. before to an average of 0.41 gm. after treatment; in 21 from an average initial level of 0.24 gm. to zero).

Retinopathy—Tables 2 and 3 show the incidence and course of retinopathy, the frequency of renal disease, and duration of diabetes. Of the 100 patients, 68 had advanced retinal involvement.

In 48 cases (44 with comparable photographs) there was specific diabetic retinopathy manifested by capillary aneurysms, punctate, preretinal or vitreous hemorrhages, waxy exudates, neovascularization and retinitis proliferans, with or without other changes in the retina (renal, hypertensive, arteriosclerotic). Thirty of the 48 patients had the most severe form of diabetic retinopathy, retinitis proliferans. Diabetic retinopathy was considered improved if the eyeground photographs after treatment showed marked regression of "diabetic" hemorrhages, exudates, aneurysms or retinitis proliferans.

In 13 of the 44 cases in which photographs are available for comparison, these showed marked improvement. In one case "diabetic" hemorrhages and aneurysms disappeared completely and have not recurred during three years of observation. In eight cases these changes disappeared to a large extent. In four

TABLE 2

INCIDENCE OF RETINOPATHY IN 100 DIABETIC PATIENTS TREATED WITH RICE DIET, AND ITS RELATION TO RENAL DISEASE

	NUMBER OF PATIENTS	AGE* *(Years)*	KNOWN DURATION OF DIABETES* *(Years)*	PERIOD OF OBSERVATION* *(Months)*
Specific diabetic retinopathy	48	48	14	19
(Without renal disease)	(19)	(53)	(15)	(19)
(With renal disease)	(29)	(44)	(14)	(19)
Nonspecific vascular retinopathy	20	53	5	33
(Without renal disease)	(13)	(53)	(5)	(41)
(With renal disease)	(7)	(54)	(5)	(18)
No retinopathy	32	55	4	19
(Without renal disease)	(29)	(54)	(3)	(19)
(With renal disease)	(3)	(61)	(11)	(23)

*Averages.

cases, in addition to improvement of hemorrhages, there was a considerable clearing of retinitis proliferans; the patients in these four cases have been observed for periods of four months, 10 months, five years and five years, respectively.

Twenty patients (19 with comparable photographs) did not have specific diabetic retinopathy as defined in the foregoing discussion but had other forms of retinopathy (renal, hypertensive, arteriosclerotic) manifested by vascular thromboses, hemorrhages, exudates, and papilledema. This retinopathy was considered improved if the eyeground photographs after treatment showed either complete disappearance or considerable clearing of the hemorrhages or exudates or complete disappearance of the papilledema. Eleven of the 19 patients of whom comparable photographs are available showed marked improvement.

In only one of the 32 cases in this series in which the patients did not have retinopathy at the beginning of treatment did it develop during the period of observation (exudates).

TABLE 3

EFFECT OF RICE DIET ON RETINOPATHY IN 63 PATIENTS WITH DIABETES

	NUMBER OF PATIENTS	PERIOD OF OBSERVATION *(Months) (Average and Range)*
*Specific diabetic retinopathy**		
Eyeground photographs available for comparison	44	19 (4-102)
Progression of lesions	9	28 (4-102)
Lesion improved in one eye, progressed in other	7	19 (4-76)
No change	15	8 (4-48)
Improved	13	25 (4-60)
*Nonspecific vascular retinopathy**		
Eyeground photographs available for comparison	19	33 (4-137)
Progression of lesions	3	8 (5-13)
No change	5	10 (4-21)
Improved	11	52 (8-137)

*Comparable photographs are not available of four patients with specific diabetic retinopathy and one with nonspecific vascular retinopathy.

Representative Case Histories

Figures 1 through 6 are eyeground photographs taken before treatment and after 3½ to 60 months of treatment with the rice diet.

Case 1—The patient in figure 1, a 54 year old woman, was first seen in March 1949. She had had known diabetes mellitus for 10 years. For the first few years there was good control of the disease by diet, and she did not take insulin. Since 1947 she had taken 25 units of insulin daily. Three months before we saw her, she noted the beginning of impairment of vision. One month before we saw her, she suddenly was unable to read headlines with her left eye. At the time we examined her, her vision was somewhat improved, and she could

pick out a few words of smaller headlines with her left eye. Blood pressure had increased for the past 10 years.

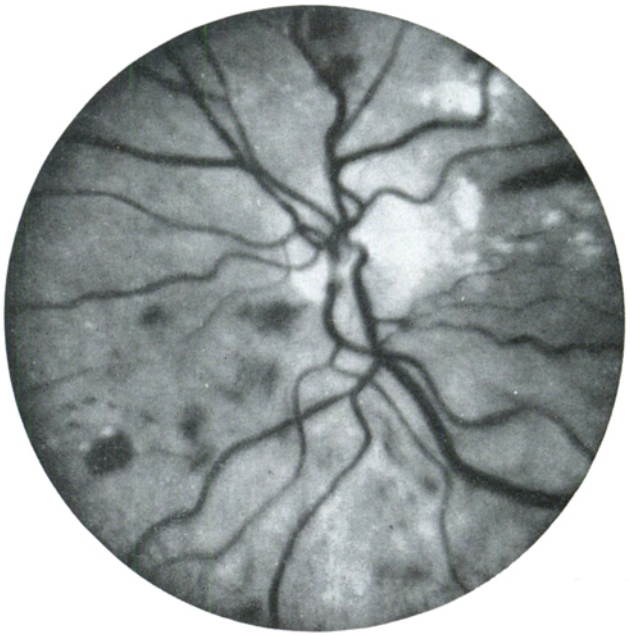
The rice diet was started in March 1949.

Laboratory data—Findings at the first examination in March 1949 and in September 1952 were as follows:

	1949	*1952*
Blood pressure (average)	234/108	180/90
Insulin (units)	25	18
Blood sugar, fasting (mg. per 100 cc.)	189	166
Urine sugar	0	0
Cholesterol (mg. per 100 cc. of serum)	225	224
Phenolsulfonphthalein excretion (per cent in two hours)	52	
Albuminuria (gm. per 1000 cc.)	0	0.16
Nonprotein nitrogen (mg. per 100 cc. of blood)	44	50

Vision—In 1949 the patient could see well with the right eye, and with the left she could read small headlines with difficulty. There were hemorrhages (large and pinpoint), aneurysms and numerous cottony and hard exudates throughout both fundi, the left macula being more involved than the right. In 1952 vision was normal. Both fundi showed a few sprinkles of exudates, without hemorrhages or aneurysms.

Case 2—The patient represented in figure 2 was a 24 year old man first seen in August 1950. He had a nine year history of diabetes mellitus. There was good control with diet and insulin; he had not had coma, but acidosis had occurred at the ages of 14, 17 and 21 years. He was asymptomatic until January 1949, when the glare of the sun caused difficulty in vision. There were carbuncles on both arms at the sites of insulin injections. Insulin dosage had increased to 85 units. Hemorrhages were found in the eyes. In February 1950 he experienced difficulty in reading because the lines blurred. When driving, the lights were out of focus. His vision was dim,



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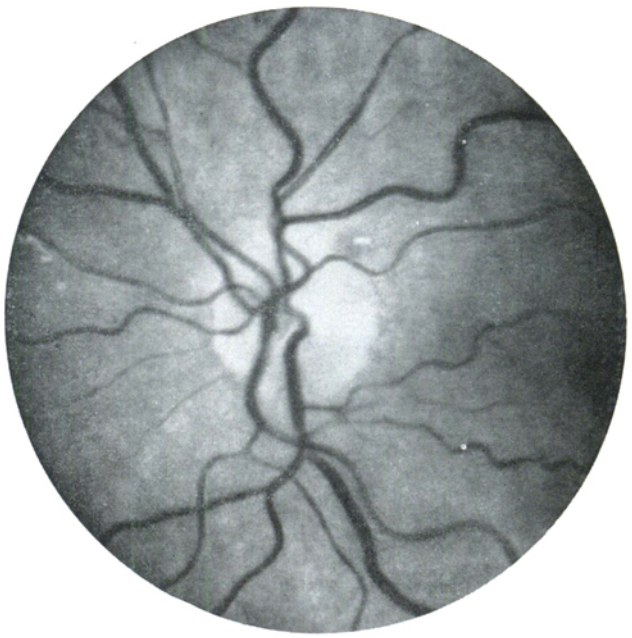

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FIGURE 1. Case 1.

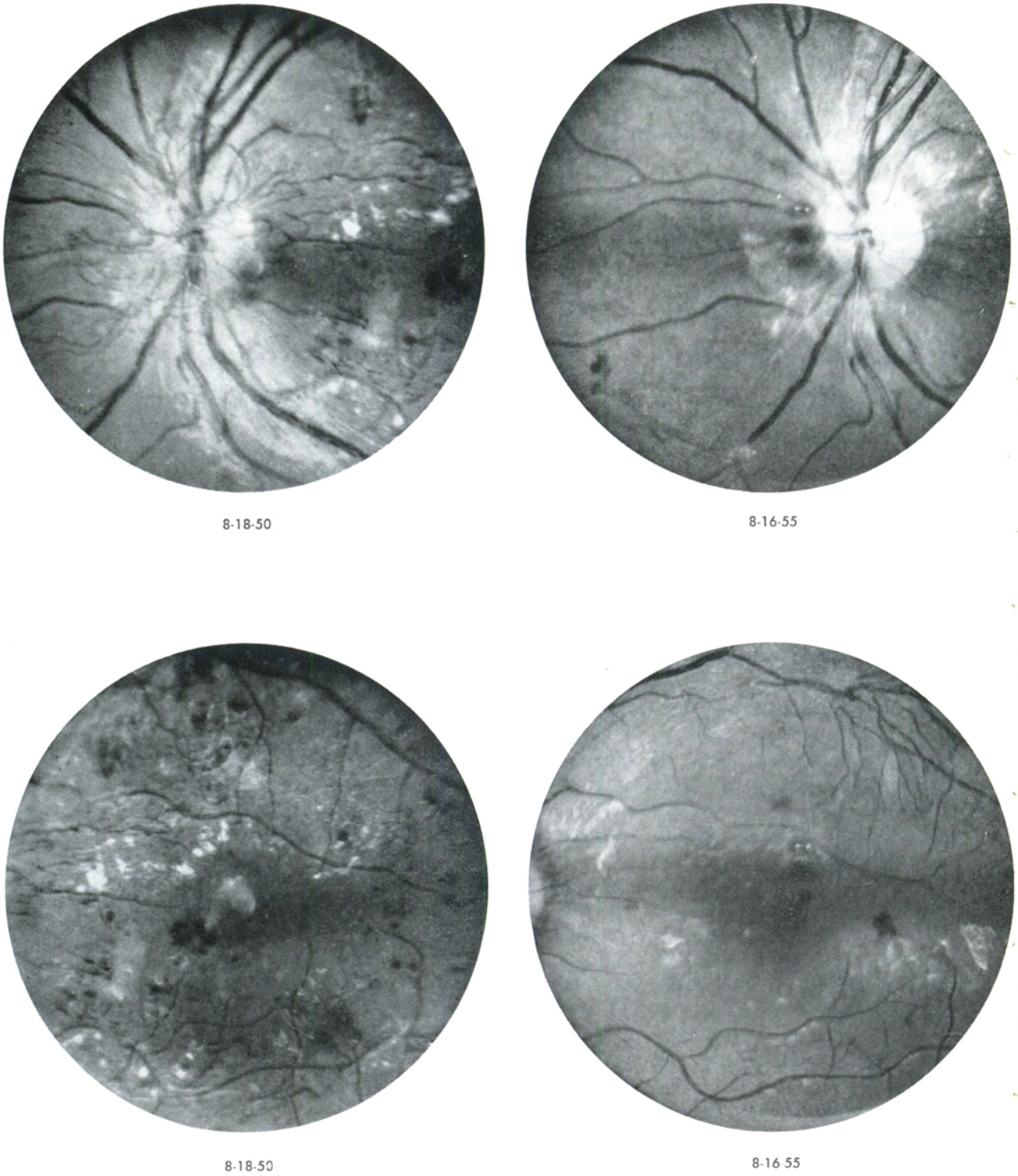
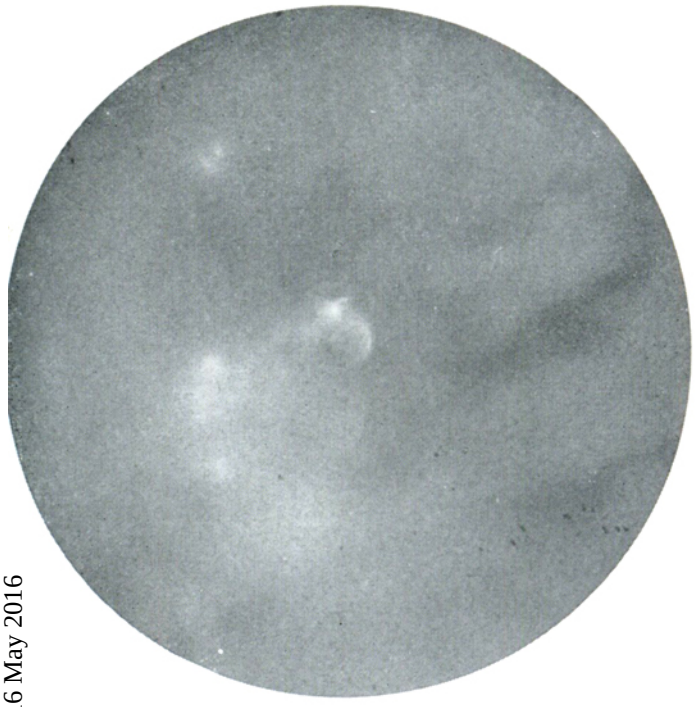
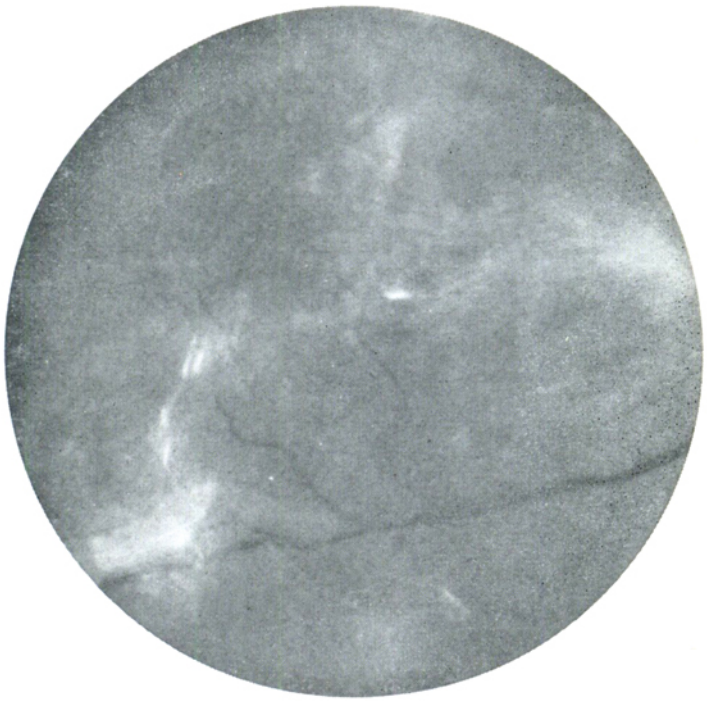


FIGURE 2. Case 2.



10-20-50



10-12-55

FIGURE 3. Case 3.

and he could not read the signs on buses.

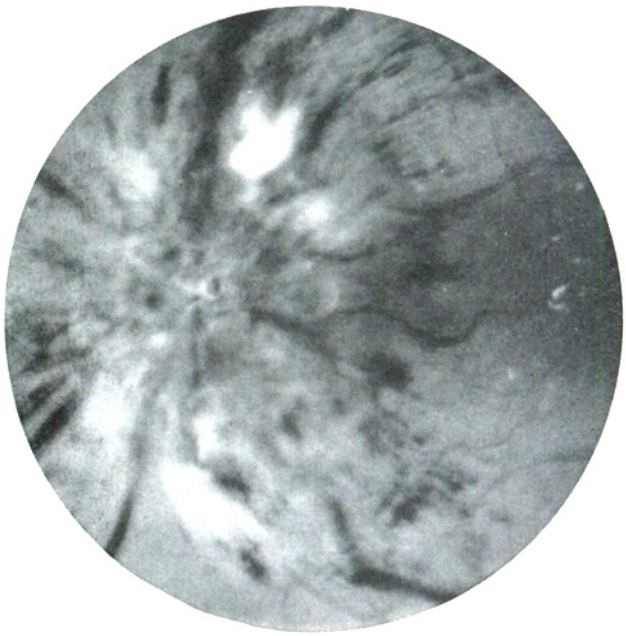
The rice diet was started in August 1950.

Laboratory data—Findings at the first examination in August 1950 and in August 1955 were as follows.

	1950	*1955*
Blood pressure (average)	126/80	135/90
Insulin (units)	75	42
Blood sugar, fasting (mg. per 100 cc.)	91	272
Urine sugar (gm. in 24 hours)	0	1 plus
Cholesterol (mg. per 100 cc. of serum)	165	156
Phenolsulfonphthalein excretion (per cent in two hours)	73	65
Albuminuria (gm. per 1000 cc.)	0.32	0.28
Nonprotein nitrogen (mg. per 100 cc. of blood)	33	43

Vision—In 1950 the patient could read ⅜ in. print. The disks were obscured by marked neovascularization and beginning retinitis proliferans. There were numerous round and flame-shaped hemorrhages, capillary aneurysms, and hard and cottony exudates bilaterally. In 1955 the patient could read small print with his left eye and ½ in. print with the right eye. The right disk was obscured by a hazy veil, but the largest part of the retina, especially the macular region, was almost clear. There were no hemorrhages or exudates. The disk on the left was well outlined. Neovascularization had disappeared, and hemorrhages, exudates and aneurysms had almost completely disappeared.

Case 3—A 60 year old woman was first seen in October 1950 (figure 3). Her past history included diabetes mellitus for two years, and weight loss for 16 years although she ate well. In 1948 urinalysis showed 2 plus sugar. A diabetic diet was prescribed but she did not take insulin. One and a half years before we saw her she had visual difficulty. Hemorrhages were found in the right eye. Treatment consisted of RUTORBIN® and 10 units of insulin.



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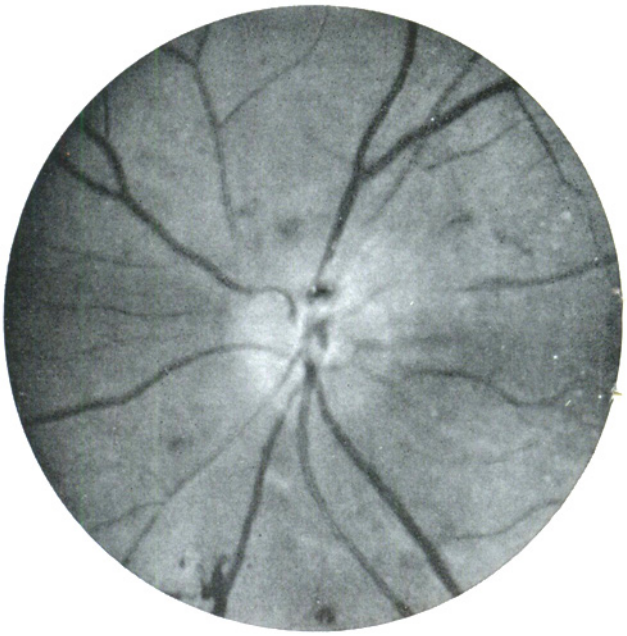
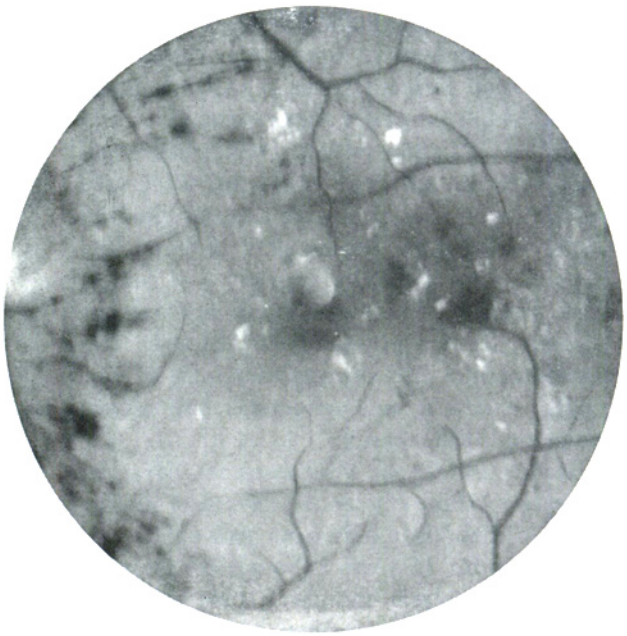


7-25-51



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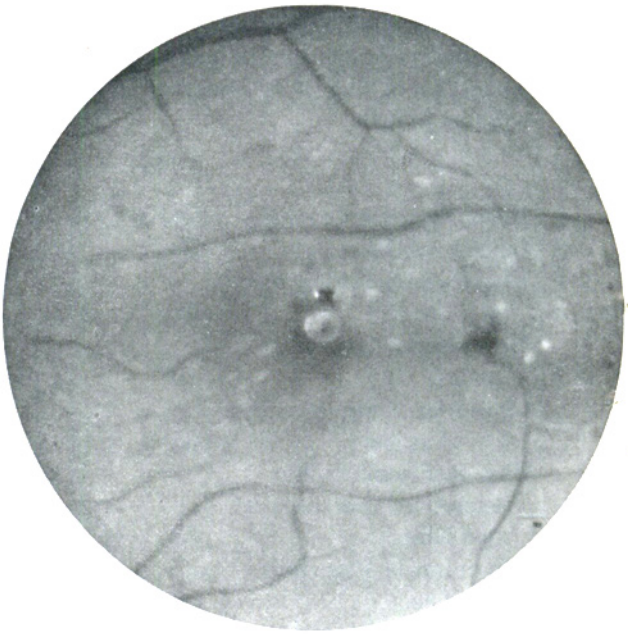

7-25-51

FIGURE 4. Case 4.

Visual impairment in the right eye persisted. Five weeks before we saw the patient she had sudden impairment of vision in the left eye.

The rice diet was started in October 1950.

Laboratory data—The findings in October 1950 compared with those in October 1955 were as follows.

	1950	*1955*
Blood pressure (average)	186/90	170/80
Insulin (units)	14	0
Blood sugar, fasting (mg. per 100 cc.)	161	95
Urine sugar	0	0
Cholesterol (mg. per 100 cc. of serum)	335	228
Phenolsulfonphthalein excretion (per cent in two hours)	64	40
Albuminuria (gm. per 1000 cc.)	0	0.16
Nonprotein nitrogen (mg. per 100 cc. of blood)	39	37

Vision—In 1950 the patient could see contours of large objects with the right eye. With the left eye there was light perception only. There were fundal hemorrhages bilaterally, especially extensive in the left macular region. Marked proliferative changes were noted in both fundi. In 1955 the vision in the right eye had improved. The patient could make out faces and read signs and large newspaper print. With the left eye there was light perception only. There were no fundal hemorrhages or exudates in the right eye; except for proliferative changes around the disk, the retina, especially the macular region, was considerably clearer. Examination of the left eye showed extensive retinitis proliferans, with no hemorrhages.

Case 4—The patient whose eyeground photographs are shown in figure 4 was a 42 year old man first seen in April 1951. Diabetes mellitus had been diagnosed three and a half years previously. He had lost 30 lb., and the blood sugar level at that time was 157 mg. per 100 cc. Treatment consisted of restriction of sweets, and 15 units of insulin. Blood pressure was elevated. Two months before we saw the patient he had blurred vision in his right eye. Blood pressure was 230 systolic, albuminuria was noted, and a hemorrhage was found in the right eye. He was given a salt-poor diet. The vision in the right eye cleared; however, that in the left became cloudy.

The rice diet was started in April 1951.

Laboratory data—Comparative findings in April 1951 and in July 1951 were as follows.

	April	*July*
Blood pressure (average)	220/120	143/80
Insulin (units)	15	0
Blood sugar, fasting (mg. per 100 cc.)	85	142
Urine sugar	0	0
Cholesterol (mg. per 100 cc. of serum)	289	183
Phenolsulfonphthalein excretion (per cent in two hours)	26	
Albuminuria (gm. per 1000 cc.)	2.8	0.22
Nonprotein nitrogen (mg. per 100 cc. of blood)	81	70

Vision—In April the patient could see well with the right eye, but had blurred vision with the left. Bilateral papilledema was noted, and numerous hemorrhages and exudates in both eyes. There were capillary aneurysms. In July the patient's vision was normal. The left disk was clearly outlined. The right disk was still slightly hazy but greatly improved. There were a few hemorrhages and small hard exudates, and fewer aneurysms.

Case 5—A 29 year old man (figure 5) first seen in May 1952 had had known diabetes mellitus for 19 years. The diabetes was under good control with 60 to 80 units of insulin daily, and later the dosage was 48 units. There was no history of coma or acidosis, and the urine was almost always sugar-free. For five years before we saw him the patient had albuminuria and hypertension. Blood pressure at a recent examination prior to May 1952 was 180/110. In November 1951 he had an episode of blurring of vision and spots before the eyes. Small hemorrhages were found, and

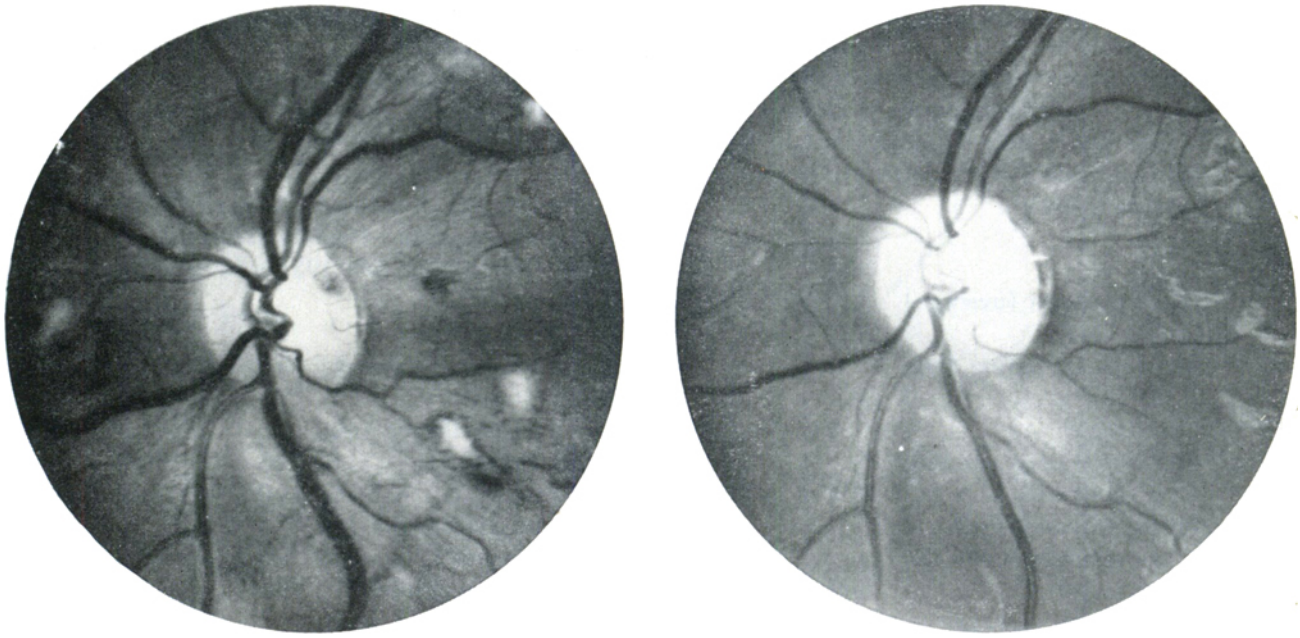

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FIGURE 5. Case 5.

subsequently he had repeated episodes of blurred vision.

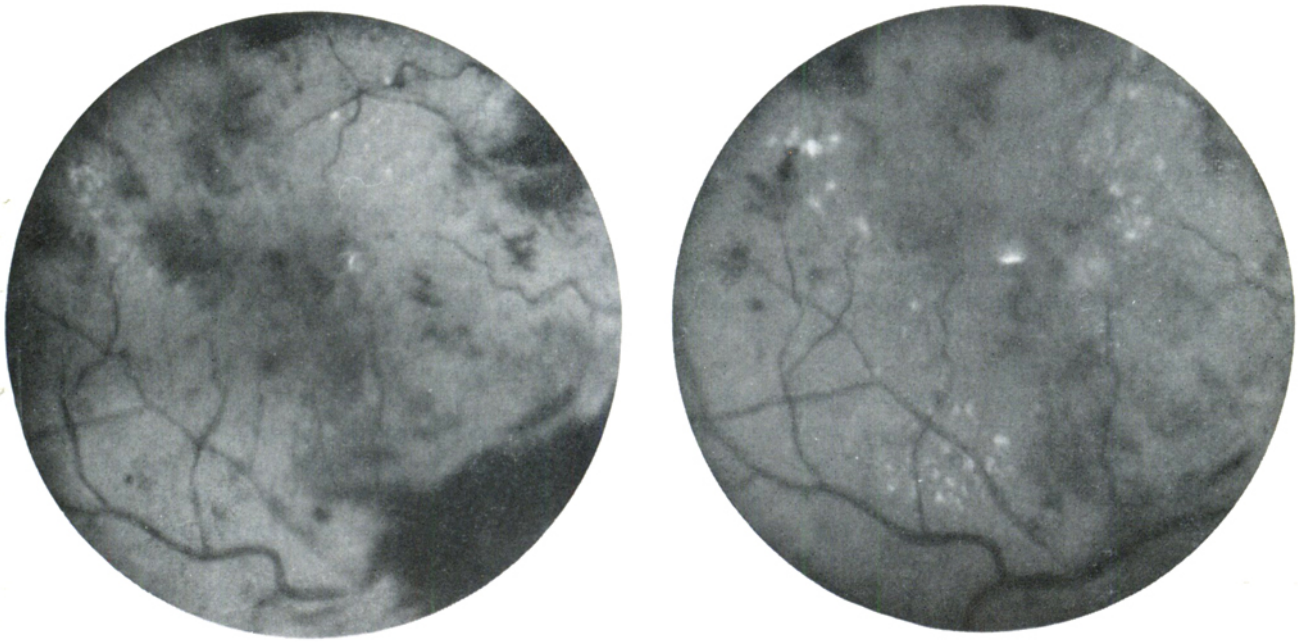
The rice diet was started in May 1952.

Laboratory data—Examinations in May 1952 and in November 1955 gave the following findings.

	1952	*1955*
Blood pressure (average)	214/130	141/89
Insulin (units)	62	42
Blood sugar, fasting (mg. per 100 cc.)	58	78
Before lunch	225	177
Before dinner	78	61
Urine sugar (gm. in 24 hours)	8	0
Cholesterol (mg. per 100 cc. of serum)	346	209
Phenolsulfonphthalein excretion (per cent in two hours)	34	25
Albuminuria (gm. per 1000 cc.)	1.3	0.62
Nonprotein nitrogen (mg. per 100 cc. of blood)	38	45

Vision—In May 1952 vision was blurred. There were numerous hemorrhages and cottony exudates scattered throughout both fundi. Capillary aneurysms were noted. In November 1952 there was improvement of vision and regression of hemorrhages and exudates. In March 1953, examination showed complete disappearance of hemorrhages, exudates and aneurysms. Between March 1953 and November 1955, the patient had seven checkups, each including eyeground photographs. There was no recurrence of diabetic or other retinopathy. In November 1955 visual acuity was normal; disks were well outlined, and there were no hemorrhages, exudates or aneurysms.

Case 6—The patient represented in figure 6 was a 65 year old woman first seen in August 1955 with a 15 year history of diabetes mellitus. When the disease was diagnosed, the blood sugar was 200 mg. per 100 cc., and the blood pressure was elevated. A general diet was prescribed, restricting carbohydrates, and 40 units of insulin was given daily. The diabetes was fairly well controlled. Over a period of 10 to 15 years before we saw her, the patient had failing vision in the left eye, and had



8-17-55 12-9-55

FIGURE 6. Case 6.

noticed failing vision in the right eye for one and a half years. The patient was said to have "bleedings and scars" in the eyes. Rapid impairment of vision occurred in the two month period before we saw her. She could still see objects and read big headlines.

The rice diet was started in August 1955.

Laboratory data—Findings in August 1955 and in December 1955 were as follows.

	Aug.	*Dec.*
Blood pressure (average)	190/100	146/74
Insulin (units)	40	20
Blood sugar, fasting (mg. per 100 cc.)	161	136
Urine sugar	0	0
Cholesterol (mg. per 100 cc. serum)	226	191
Phenolsulfonphthalein excretion (per cent in two hours)	68	
Albuminuria (gm. per 1000 cc.)	0.1	0
Nonprotein nitrogen (mg. per 100 cc. of blood)	40	30

Vision—In August 1955 the patient could read large print with either eye. The disks were well outlined, and there were numerous hemorrhages and hard exudates in both fundi. In the right eye there was inferior temporal vein thrombosis with massive hemorrhage. Capillary aneurysms were noted. In December 1955 the patient could read newspaper print. Disks were well outlined, and marked regression of hemorrhages and exudates was noted. Capillary aneurysms were still present.

Discussion

It has been known since 1943[1-5] that patients with diabetes mellitus not only tolerate the rice diet well but also are often benefited by it. (The rice diet contains 565 to 570 gm. carbohydrate, 20 to 25 gm. protein, less than 5 gm. fat, and 70 to 120 mg. sodium per 2400 calories.) The present survey of 100 patients shows again that the average blood sugar levels and average insulin requirements decrease. Although this group included many patients with severe diabetes, ketosis occurred only once. Acidosis did not occur; on the contrary, the plasma carbon dioxide-combining power

increased in the majority of cases and moved away from the acid toward the alkaline side.

Patients who were obese were urged to reduce. However, changes in blood sugar levels, insulin requirements, cholesterol levels, blood pressure, and so on occurred both in patients who lost weight and in those who did not have a significant weight change.

In view of the frequency of the development of arteriosclerosis in diabetic patients, the decrease in the serum cholesterol level may be of importance.

The reduction in blood pressure and heart size and the improvement in abnormal electrocardiographic patterns in diabetic patients treated by the rice diet are the same as those found in nondiabetic patients with cardiovascular disease who are treated with the rice diet. This is also true for the decrease in azotemia in cases in which there is renal involvement. An increase in the average phenolsulfonphthalein excretion was not found, and we cannot yet state whether this is because a much longer treatment period may be necessary for this change to occur.[6]

Of particular interest was the effect of the rice diet on diabetic retinopathy. The ophthalmoscopic picture of "specific" diabetic retinopathy differs from that of renal, arteriosclerotic or hypertensive vascular retinopathy. All forms of vascular retinopathy may occur together with the "specific" diabetic retinopathy, as was also found in this series.

Table 2 shows again that diabetic retinopathy develops more commonly in patients who have had diabetes for a long time. In the 52 cases without evidence of diabetic retinopathy the known duration of diabetes prior to the first examination at our institution averaged 4.4 years; the known duration of diabetes in the 48 patients with "specific" diabetic retinopathy averaged 14 years. The table confirms further the frequent coincidence of renal disease and diabetic retinopathy (60 per cent). Table 3 indicates that at least during the period of observation covered by this study the renal, arteriosclerotic and hypertensive changes improved in a significantly higher percentage of cases than did the "specific" retinal changes; the percentages were 55 and 27 per cent, respectively. Hemorrhages, exudates and papilledema heal as well in diabetic patients as they do in nondiabetic patients treated with the rice diet.

Diabetic retinopathy has been considered a sign of irreversible destruction. "The retinal complications of long-standing diabetes are grave and have an unfavorable prognostic significance. Any observation, therefore, is valuable which indicates a favorable influence in at least some patients."[7]

In our group of 48 patients with diabetic retinopathy the incidence of retinitis proliferans, the severest form of diabetic retinopathy, was very high, 63 per cent. Thirteen patients with diabetic retinopathy, four of them with retinitis proliferans, showed marked improvement. In the 26 of the 30 cases of retinitis proliferans in which this lesion did not improve the patients were observed for 3 to 102 months (average, 17 months), compared with observation periods of 4 to 60 months (average, 34 months) in the four cases in which the lesion did improve.

The effect of the rice diet on diabetes mellitus with or without retinopathy has been explained as "due to a reversible inactivation of the pituitary and/or adrenal gland achieving in a conservative and unbloody way what has been tried by hypophysectomy and adrenalectomy."[8] In this connection the report[9] of a case of improvement in diabetic retinopathy after pituitary necrosis might be interesting. This is one of the few instances reported in the literature in which severe diabetic retinopathy disappeared.

The observations of Handler and Georgiade[10] of our department of biochemistry are also interesting along these lines. They studied the effect of proteins on blood sugar in two groups of rats, the first of which received a low protein diet and the second a high protein diet. They found that the rats receiving a low protein diet were much more sensitive to insulin than were the rats receiving a high protein diet, and also that their fasting blood sugar concentrations were lower. This difference in the blood sugar concentrations disappeared when the animals who were on a low protein diet were treated with ACTH. The in-

vestigators concluded from these results that prolonged low protein diet causes the pituitary to secrete less ACTH.

No matter which single factor may cause the effects of the rice diet on diabetes mellitus and its vascular complications, the rice diet contains less sodium, protein and fat than any other diet for treating diabetes mellitus.

Summary

A report is given on 100 consecutive patients with diabetes mellitus associated with vascular disease who were treated with the rice diet. They were followed for from three months to 11 years, and the average period of observation was 22 months. Nine patients died.

The rice diet, which is a high carbohydrate, low protein, low fat, low sodium diet containing 565 to 570 gm. carbohydrate, 20 to 25 gm. protein, less than 5 gm. fat, and 70 to 120 mg. sodium per 2400 calories, was well tolerated. Average insulin requirements as well as average blood sugar levels decreased.

Manifestations of cardiovascular and renal disease such as hypertension, enlargement of the heart, electrocardiographic abnormalities, azotemia and proteinuria improved significantly in the majority of cases. Hypercholesteremia, present in 80 of the 100 cases, decreased in 85 per cent from an average level of 325 mg. to an average level of 227 mg. per 100 cc.

The effect of the rice diet on "specific" diabetic retinopathy (aneurysms; punctate, preretinal, vitreous hemorrhages; waxy exudates; retinitis proliferans) in 44 patients was as follows: progression of lesions, nine cases; improvement in one eye but progression of lesion in other eye, seven; no change, 15; improved, 13. In 19 cases in which the patients had hypertensive, arteriosclerotic or renal retinopathy (papilledema, hemorrhages, exudates, venous thrombosis), the lesions progressed in three, did not change in five, and improved in 11 cases.

Our experience leads us to conclude that an attitude of resignation with regard to the prognosis in diabetes mellitus with vascular complications including diabetic retinopathy is no longer necessary. The course of the disease can be favorably changed by intensive treatment with the rice diet.

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