Effects of High Carbohydrate or Protein Diets on Blood Pressure of Normotensive and Hypertensive Dogs

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The effects of diets high in carbohydrate or protein were studied on four dogs when nonno-
tensive and later when hypertensive. The results suggest that under certain conditions a
cardiovascular homeostatic relationship may exist between diet, VEM-VDM and the sympath-
icoadrenal system.

PREVIOUS studies showed that when
normal dogs were subjected to a prolong-
ed fast and realimented with diets high in car-
bohydrate fed at the luxus consumption level
of 120 cal./M.²/hour they developed a high
eytolic pressure and a rapid pulse with a low
diastolic pressure. This systolic hyperten-
sion would usually persist as long as the diet
was eaten. When normal fasted dogs were
realimented with luxus consumption diets
high in protein, the blood pressure and pulse
rate rose moderately above the low fasting
level but finally stabilized below the control
values. Isocaloric luxus consumption diets
high in carbohydrate or protein appeared to
have antagonistic actions on the blood pres-
sure of normal dogs.

We have been able to produce a prolonged
diastolic hypertension in 4 dogs by the use
of diets containing from 50 to 70 per cent
of the calories from animal fat and con-
comitant dietary stresses. Previous publica-
tions have dealt with: the experimental de-
sign and the first circulatory abnormality to
appear;² a nosographical study of the genesis
and development of the hypertension;³ and a
statistical study of the fully developed condi-
tion;⁴ and this material will not be repeated
here. The purpose of the present paper is to
show the effects of luxus consumption diets
high in carbohydrate on the blood pressure
and heart rate of these dogs when normoten-
sive and later when hypertensive and to show
the effect of substituting an isocaloric high
protein diet for the high carbohydrate diet
during the hypertensive state.

MATERIALS AND METHODS

The 4 dogs (2 males and 2 females) used in
the present studies had been used in blood pressure
studies for over 5 years and during this period
blood pressure and heart rate had been determined
5 to 6 days each week with almost no interrup-
tions; consequently the animals were well trained
and the control values were well established. The
diastolic hypertension of dietary origin had been
present for approximately 3 years and was highly
significant both statistically and physiologically⁵.

In the present studies, blood pressure was de-
determined 5 to 6 days each week by the auscula-
tory method of Allen with certain modifications
and improvements.¹⁷ The daily values were the
mean of from 10 to 15 consecutive determinations.

Diets: Boiled white rice or cracker meal mois-
tened and flavored with Difco beef extract and fed
at the luxus consumption level of 120 cal./M.²/hour
were used as the high carbohydrate diets. A table-
spoon of brewers yeast was added to the diet and
one multivitamin tablet was given daily. Ground
raw horse meat fed at the level of 120 cal./M.²/hour
was used as the high protein diet. No brewers
yeast or vitamin pills were given when on the
meat diet.

In the present studies, the hypertensive animals
were subjected to a preliminary fast of 23 days
during which there was no decline in blood pres-
sure.⁷ They were then realimented with the high

*Multicebrin (Lilly) contains the daily human re-
quirement of the most important vitamins.
The data on the 4 dogs are shown in figure 1. For each dog, period 1 shows the control blood pressure and heart rate on the standard kennel diet of Nutrena. The controls were done at frequent intervals over a period of several years and the total number of days on which control blood pressure and pulse rate were determined were 124, 113, 89, and 168 for dogs 1-4 respectively. The individual daily values were combined statistically to give a single mean for each dog. The pressures during the various control periods were all similar and there was no evidence that a spontaneous elevation was occurring.

Period 2 shows the hemodynamic effects of a luxus consumption diet of rice or cracker meal fed for 90 days after a prolonged fast, before the production of the diastolic hypertension. Each dog shows the typical elevation of the systolic pressure and pulse rate with either no change or a minimal elevation of diastolic pressure.

Period 3 shows the diastolic hypertension produced by dietary stresses and diets high in animal fats. In each dog the systolic and diastolic pressures were elevated above the control levels and the probability of the elevations were <0.01 when calculated from t.4

In dogs 1, 2 and 4 the heart rate during the period of hypertension was significantly lower than the control (p <0.01) but it was significantly higher (p <0.01) in dog 3.

Period 4 shows the effect of the luxus consumption diets of cracker meal or rice during the entire period of 35 days after the production of the diastolic hypertension. In each dog these diets caused a decrease of both the systolic and diastolic pressures, the decrease of the diastolic always being greater than that of the systolic. As shown in the table, the probabilities of the decreases in pressure ranged from <0.05 to <0.01. In each dog the heart rate was higher than during the hypertensive period (p <0.01).

In dogs 1, 3, and 4 the pressures were lower during the last 5 days than during the entire 35 day period on the carbohydrate diet. This is illustrated in period 5. In dog 1 the systolic and diastolic pressures reached the original control values during these last 5 days.

Period 6 shows the effect of the luxus consumption diet of protein for the entire period of 70 days, while period 7 shows the last 28 days of the 70 day period. In each dog the high protein diets antagonized the effect of the high carbohydrate diets and the systolic and diastolic pressures rose to or above the
TABLE 1.—Effect of High Carbohydrate Diet after Preliminary Fast during Hypertension

<table>
<thead>
<tr>
<th>Dog</th>
<th>Hypertensive period</th>
<th>Entire period on high carbohydrate diet</th>
<th>Difference</th>
<th>Probability of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>D</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>1</td>
<td>133</td>
<td>79</td>
<td>56</td>
<td>124</td>
</tr>
<tr>
<td>2</td>
<td>166</td>
<td>102</td>
<td>31</td>
<td>145</td>
</tr>
<tr>
<td>3</td>
<td>133</td>
<td>100</td>
<td>82</td>
<td>126</td>
</tr>
<tr>
<td>4</td>
<td>153</td>
<td>105</td>
<td>71</td>
<td>145</td>
</tr>
</tbody>
</table>

S, systolic; D, diastolic; P, pulse pressure.

Original hypertensive level while the pulse rates decreased.

The effect of the high protein diet in annulling the hypotensive effect of the high carbohydrate diet occurred very promptly as shown in figure 2 (dog 1).

**DISCUSSION**

The etiology of the diastolic hypertension produced by high fat diets and dietary stresses (fasting, marked obesity, and drastic reduction diets) is unknown but one important negative finding has been established, namely that the plasma level of 17 hydroxycorticosterone is well within the normal level for dogs (1.4 μg./100 ml.).

Assays kindly made by the late Professor Ephraim Shorr showed that samples of blood from dogs 2 and 3, when on the high carbohydrate diet during the normotensive period, had high VEM activity in the unfractionated specimens. On fractionation, VDM activity was also demonstrated and shown to be due to the presence of ferritin. Blood from control dogs or the same dogs on the standard kennel diet were negative for VEM and VDM.

The important aspect of the present investigations is that when the effect of the high carbohydrate diet was annulled by the high protein diet, the systolic and diastolic pressures of dogs 1, 3 and 4 rose above the original hypertensive levels. This suggests that when hypertensive levels of blood pressure are lowered without removing the cause, there is a stimulation of the blood pressure elevating mechanisms with a resulting rebound of the pressure when the hypotensive agent is removed. This hypothesis possibly explains the following observations: (1) During the development of the diastolic hypertension of dietary origin it was noted that when the pressure fell spontaneously to low or normal levels, or when it was artificially lowered by an intravenous injection of histamine, the period of low pressure was nearly always followed by a sharp rise to levels higher than those before the fall; (2) during drug therapy of human hypertension, discontinuance of therapy after a low or normotensive level has been attained is often followed by a marked rebound of pressure with disastrous results. As previously reported, the systolic hypertension with rapid pulse and a low or normal diastolic pressure will be maintained for prolonged periods of time only when the luxus consumption high carbohydrate diet is given after a prolonged preliminary fast. Recently we have shown that the specific hemodynamic effects of fasting and of the high carbohydrate diet were annulled by the high protein diet.
Drate diets are dependent on the sympathico-adrenal medullary system since neither occur in dogs after a bilateral para vertebral gang lione ctomy with denervation of the adrenal glands. These facts plus the results reported in the present paper suggest that under certain conditions diet, the sympathico-adrenal medullary system and VEM-VDM may constitute an integrated cardiovascular homeostatic system.

SUMMARY

Four dogs were studied when normotensive and later when hypertensive. During the normotensive period they were subjected to a preliminary fast and realimented with high carbohydrate diets fed at the level of 120 cal. M.2/hour. As a result they developed a high systolic pressure and a rapid pulse with a low diastolic pressure. VEM and VDM were demonstrated in the blood plasma. It was previously shown that substitution of an isocaloric high protein diet antagonizes the effect of the high carbohydrate diet.

During the hypertensive period they were fasted and realimented with the high carbohydrate diet. This caused a lowering of both the systolic and diastolic pressure. An isocaloric high protein diet antagonized the carbohydrate effect and caused the pressure to rise above the original hypertensive levels. These studies plus other recent findings suggest an integrated hemodynamic homeostatic relationship between diet, the sympathetic-adrenal system and VEM-VDM.

SUMMARY IN INTERLINGUA

Quatro canes esseva studiate in stato de normotensivitate e plus tarde quando illos esseva hypertensive. Durante le periodo normotensive le canes esseva subjecite a un jejuno preliminari sequite per realimentation con dietas ric in hydrates de carbon che esseva administrate al mesura de 120 cal. per m² per hora. Le resultato esseva que le canes dis veloppava un alte pression systolic e un pulso rapide con basse pression diastolic. Materiales vaso-excitatori e vaso-depressori esseva demons tratare in le plasma del sanguine. Il esseva monstare previemente que le substitution de un isocaloric dieta ric in proteina antagonisa le effecto del dieta ric in hydratos de carbon.

Durante le periodo de hypertension, le canes esseva de novo subjecite a un jejuno preliminari e realimentate con le dietas ric in hydratos de carbon. Isto resultava in un reduction del pression systolic e etiam del pression diastolic. Un dieta isocaloric ric in proteina antagonisava le effecto del hydratos de carbon e faceva le pressiones montar a supra le nivellos hypertensive original. Iste studios, insimul con altere constatationes recente, sug gere le existentia de un integrate relation homeostatic hemodynamic inter le dieta, le systema sympathico-adrenal, e le materiales vaso-excitatori e vaso-depressori.

REFERENCES

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