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The Effect of a Low-Refined-Carbohydrate Diet upon the Nonfasting Hematocrit Level*

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1. Introduction

Previous reports have attempted to analyze the effect of a low-refined-carbohydrate high-protein diet upon a number of *biochemical* phenomena including nonfasting blood sugar[1], calcium[2], phosphorus[3], calcium-phosphorus relationships[4], cholesterol[5], and protein[6]. A second series of reports has dealt with the relationship of *physiologic* processes (blood pressure[7]) and this same diet. In a third group of studies, the relationship of this diet to the *hematologic* picture has been introduced with attention directed to the erythrocyte count[8] and hemoglobin[9]. This report will consider the effect of a *low-refined-carbohydrate relatively high-protein diet* upon the *hematocrit*.

2. Review of the Literature

In order to appreciate the design and results of this study, brief consideration will be given to: (1) *the relationship of diet to hematocrit*, (2) *hematocrit homeostasis*, and (3) *hematocrit normality*.

2.1 *Diet and Hematocrit*

Smith[10] demonstrated that dogs maintained on an adequate diet throughout life showed higher hematocrit levels than the commonly accepted normal scores. Josephson and his associates[11] reported subnormal hematocrit values for prisoners of war maintained on calorically inadequate diets.

Orten and Orten[12] have shown in rats that a low protein diet (high in calories and adequate in minerals and vitamins) produces a chronic anemia in rats because of a decrease in both hemoglobin and red blood cells which can be prevented or cured by the addition of adequate protein. Weech and his group[13] have demonstrated that dogs on a low protein intake exhibit a steady decrease in the number of circulating erythrocytes.

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2.2 *Hematocrit Homeostasis*

The following factors have been reported as having a direct relationship to the hematocrit: (1) age, (2) sex, (3) physical activity, (4) altitude, (5) season, and (6) time of day.

JOSEPHSON[11] has found the adult hematocrit to be higher than the values obtained in adolescent subjects. NEWMAN and GITLOW[14] and FOWLER *et al.*[15] have carried out studies which show a decrease in the hematocrit with age. FOWLER and his co-workers[15] and JOSEPHSON and his group[11] have reported lower normal values for females as compared with males of comparable age. Seasonal variations of the hematocrit have been observed by JOSEPHSON *et al.*[11].

2.3 *Hematocrit Normality*

A random sampling of hematocrit normality studies by five investigators of 1,081 male subjects shows the range of the means to vary from 44.2 to 49.9 percent. A calculation of the mean of these reported means was found to be 47.0 percent. Five investigators of the normal adult female hematocrit (derived from 621 subjects) revealed the range of the reported means to vary from 39.4 to 42.0 percent. The mean of the means was found to be 41.1 percent.

3. METHOD OF INVESTIGATION

Ninety ambulatory subjects were studied with regard to hematocrit level before and after dietary change. The 90 persons were divided into three groups. Group I (35 ambulatory male and female dental patients) included subjects from 13 to 80 with a mean age of 40.0 years. Group II comprised 35 male dental students. The ages ranged from 21 to 33 with a mean age of 25.7. Group III constituted 20 laboratory personnel. The ages ranged from 19 to 48 with a mean age of 33.1.

Each subject presented in the clinic at approximately 10.00 a.m. after a customary breakfast meal. At that time a hematocrit was performed. The hematocrit scores so obtained will hereafter be referred to as based on a *regular* diet.

Each Group I and Group II subject was then given dietary instructions to follow for the next three days. Protein intake was encouraged. Specific instructions were given not to eat sugar and refined sugar products as well as white flour foods. Thus, principal attention was directed to the elimination of refined carbohydrates from the diet. Hereafter, this regime will be referred to as a *basic* or *preparatory* diet (preparatory to hematocrit determinations). Group III received no instructions.

Finally, each subject was instructed to return on the fourth day at10.00 a.m. after breakfast based on the above recommendations. At this second visit the hematocrit was again measured.

At the first visit, the Group III (control) subjects' hematocrits were performed twice by each of two technicians. This was done to establish the experimental error in measuring hematocrit. Fig. 1 shows the first hematocrit value plotted on the abscissa against the repeat tests shown on the ordinate. The determinations for the observations of the two technicians are indicated by black and open dots respectively. The great con-

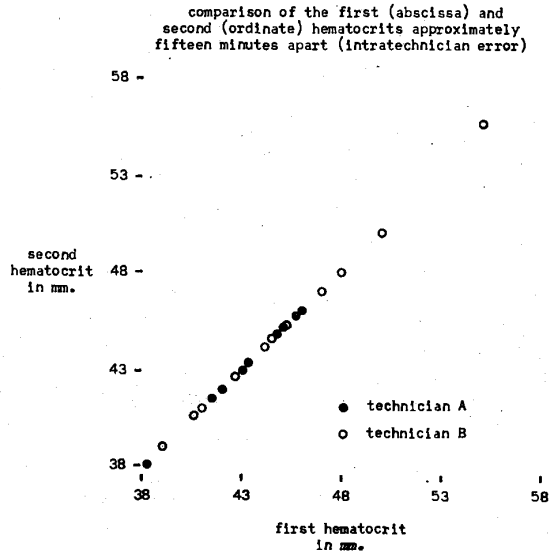

Fig. 1

Table 1 Intratechnician and intertechnician error in the hematocrit

Intratechnician		*Intertechnician*	
Difference between consecutive hematocrits in mm	*Percentage of cases*	*Difference between two technicians in mm*	*Percentage of cases*
0	100	0	90
		1	10

stancy of the values is underlined by the dramatic line of regression. The reproducibility of these observations is heightened by the coefficient of correlation of $r = +1.000$ and a $P < 0.001$. Table 1 summarizes the actual differences between the results obtained by one technician against herself (intratechnician error) and one versus the other technician (intertechnician error). It can be observed that, at the intratechnician level, 100 percent of the samples were found to be exactly alike. With regard to the intertechnician error, the difference is approximately the same ($r = +0.998$, $P < 0.001$). In 90 percent of the instances, both technicians agreed precisely. In 10 percent of the cases, the difference was not more than 1 mm. Hence, it would appear that the experimental error is quite small at both the intra- and intertechnician levels.

4. Results

The findings will be considered independently for the dental patients, dental students, and laboratory personnel.

4.1 *Group I (Dental Patients)*

The mean initial hematocrit for the 35 dental patients proved to be 43.1 ± 6.1. Hence, two-thirds of the group ranged from 37.0 to 49.2. Three days after subsisting on the preparatory diet, the hematocrit increased to 43.4 ± 5.7. Thus, at the end of the three-day experimental period, 68 percent of the group ranged from 37.7 to 49.1. The mean scores obtained for the 35 patients initially and after the three-day dietary

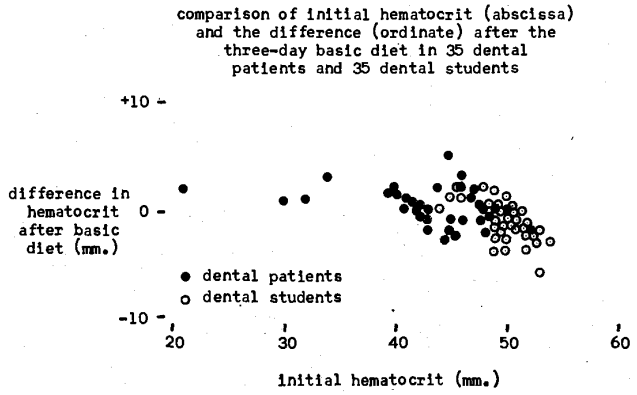

Fig. 2

regime are pictorially represented in fig. 2 as the black dots. Shown along the abscissa are the initial findings. The difference between the initial scores and the findings three days later are charted on the ordinate. It is very clear from this graph that there is a definite line of regression. The coefficient of correlation for the entire group was found to be —0.354 with a $P < 0.050$.

Thus, the evidence seems reasonable that, under this dietary program, the range of hematocrit shrinks. However, it is well-known that the phys-

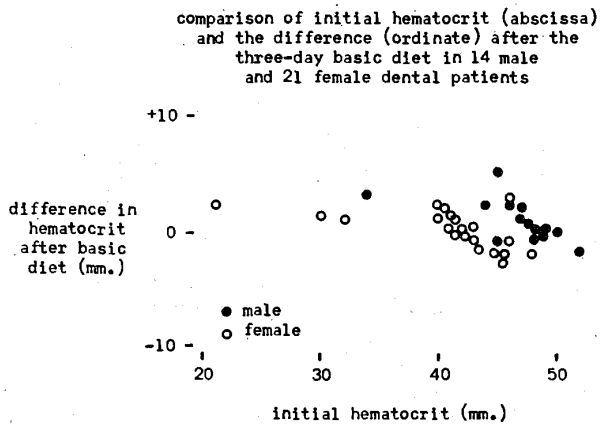

Fig. 3

iologic range of the hematocrit differs in the two sexes. Accordingly, the data were restudied in this connection. A study of the initial findings in the 14 male patients shows an original score of 46.6 ± 4.2. This changed to 47.4 ± 3.4. Thus, the male picture increased during the three-day experimental period. A study of the 21 female subjects revealed initial values of 40.8 ± 6.2. At the end of the study, the values were 40.8 ± 5.6. It is noteworthy that there are rather significant differences between the male and female findings.

The mean scores obtained for the 14 male and 21 female subjects initially and after the three-day dietary regime are pictorially represented in fig. 3. Black dots have been employed for the male group and open dots for the female subjects. Shown along the abscissa are the initial findings. The difference between the initial scores and the findings three days later are charted on the ordinate. One may observe on the graph a line of

regression for each sex. The coefficient of correlation for the male and female groups was found to be —0.607 and —0.522 respectively with probability values of < 0.05 and < 0.05.

Thus, the evidence seems reasonable that, under this dietary program, male patients with hematocrits below approximately 48 rise to or about that value while those above it decline to 48. For the female, the leveling off point appears to be approximately 42.

4.2 *Group II (Dental Students)*

The mean hematocrit for the 35 dental students initially proved to be 49.9 ± 2.2. Thus, at the start of the study, two-thirds of the group ranged from 47.7 to 52.1. Three days after subsisting on the preparatory diet, the hematocrit decreased to 48.6 ± 2.0. Thus, at the end of the three-day experimental period, 68 percent ranged from 46.6 to 50.6. It should be noted that the overall pattern for the dental students is very similar to that previously observed for the entire dental patient group and particularly for the male dental patients.

The hematocrit scores obtained for the 35 dental students initially and after the dietary regime are pictorially represented in fig. 2 as the open dots. Shown along the abscissa are the initial hematocrit scores. The differences between the initial scores and the findings three days later are charted on the ordinate. It is very clear from this graph that there is a definite line of regression. The coefficient of correlation for the dental students was found to be -0.556 with $P < 0.05$.

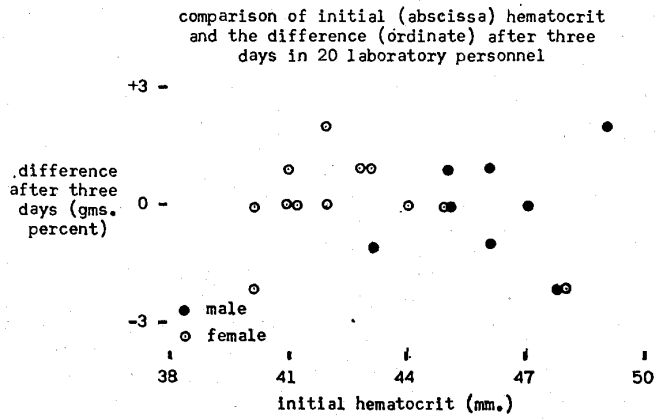

Fig. 4

4.3 *Group III (Control Subjects)*

The mean initial hematocrit levels for the 20 laboratory personnel proved to be 44.0 ± 2.8. Three days after subsisting on a regular diet, the mean values were found to be 44.0 ± 2.9. Thus, during the three-day interval, the mean hematocrit remained essentially unchanged.

The hematocrit scores obtained for the 20 laboratory personnel (8 males, 12 females) initially and after the dietary regime are pictorially reported in fig. 4. Shown along the abscissa are the initial findings. The differences between the initial scores and the observations three days later are charted on the ordinate. It is very clear from this graph that there is no definite line of regression for either the males or females. The coefficient of correlation ($r = +0.079$) was found not significant ($P = 0.500$).

5. Discussion

The evidence from these 90 subjects grouped in three categories indicates that there is a tendency for the hematocrit to approach a more narrow limit under the conditions of a low-refined-carbohydrate regime. This is underscored by the corrections in the dental patients (Group I) and the dental students (Group II), and the lack of change in the control subjects (Group III). That the overall alteration, even when small, is significant is further shown by the fact that the experimental error in doing the test is even smaller.

Mention has already been made that there is no general agreement in the literature as to the effects of dietary carbohydrates and proteins upon the hematocrit. In contrast, this report seems to suggest a correlation between these factors. Two points in experimental design may account for the unusual results in this project. Firstly, major attention has been focused here upon the *quality* rather than the *quantity* of carbohydrate intake. It should be underlined that only *refined* carbohydrates have been eliminated in this study. In contrast, attention in other reports has been largely directed to quantity (caloric) intake. A second unique feature of this investigation is that consideration has been given to *both* the elimination of refined carbohydrates and the encouragement of greater protein intake.

This report should be viewed in the light of a number of limitations. Firstly, it would be interesting to repeat the project with a larger group and, secondly, by other investigators. Thirdly, it might prove helpful if the diet were continued for a longer period. Fourthly, the validity of the findings would be enhanced if the study could be conducted under conditions where the diet could be more rigidly supervised (metabolic ward).

SUMMARY

(1) Nonfasting hematocrit levels were performed three days apart in a control group (20) that was given no dietary instructions. Hematocrit levels were also taken in student (35) and patient (35) samples initially (following their regular diet) and subsequent to a three-day low-refined-carbohydrate relatively high-protein diet.

(2) The data presented indicates that, during the prescribed dietary program, hematocrits tend to seek a more narrow range than during the regular dietary period.

(3) It appears that, during the low-refined-carbohydrate diet, hematocrits (both high and low) migrate toward 48 mm in males and 42 mm in females. The significant coefficients of correlation in the patient (males: $r = -0.607$, $P < 0.05$; females: $r = -0.522$, $P < 0.05$) and student ($r = -0.556$, $P < 0.05$) groups and the lack of correlation in the controls ($r = +0.079$, $P = 0.500$) provide evidence of this physiologic change.

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RÉSUMÉ

L'hématocrite a été enregistré chez 20 individus n'ayant pas été soumis à un régime alimentaire spécial, en comparaison avec 35 étudiants et 35 autres sujets ayant reçu pendant trois jours un régime pauvre en hydrates de carbone raffinés, mais riche en protéines. Ces observations ont démontré que l'hématocrite tend à se modifier dans une marge plus restreinte avec ce dernier régime qu'avec une alimentation normale.

ZUSAMMENFASSUNG

Messungen des Verhältnisses der soliden Elemente des Blutplasmas wurden während 3 Tagen in einer Kontrollgruppe durchgeführt, welche keine besonderen Diätvorschriften erhielt. Dieselben Messungen wurden an einer Studentengruppe und einer gleich grossen Patientengruppe vorgenommen, welche zu Beginn ihre reguläre Diät und nachfolgend für 3 Tage eine reine Kohlenhydrat- und relativ hohe Eiweissdiät erhielten.

Die Resultate zeigten, dass während des vorgeschriebenen Diätprogrammes die obigen Messungen eher niedrigere Werte ergaben als bei der regulären Diät. HESS