possibility. Our results were similar whether the spinal cord was intact or not.

Others do not express their results with the nasal plethysmograph in cc of blood displaced, probably because of the danger of leaks, influence of temperature changes, secretion of mucus and changes in tissue fluid content. There are advantages in quantitation and the likelihood of the other factors being important seems small in short runs of a few minutes. Studies of this nature, whereby changes in blood content of the nasal mucosa are followed under different experimental conditions, can be of great interest to the clinician who often encounters stuffiness of the nose as a prevalent symptom.

Summary. The origin of the vasoconstrictor fibers to the nasal mucosa of the dog was investigated by nasal plethysmography and anterior root stimulation. T_2 stimulation, more often gave the greatest vasoconstrictor effect, T_1 and T_3 gave good vasoconstriction, T_4 and T_5 progressively less, T_6 doubtful, and T_7 and T_8 no constriction. In exceptional instances C_8 might give some constriction.

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Effect of Scurvy on Serum Proteins of Rhesus Monkeys.* (29694)

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Banerjee and Rohatgi(1) reported changes in the electrophoretic patterns of serum proteins in scorbutic guinea pigs. In studies with monkeys, Greenberg *et al*(2) did not observe any significant change in the different fractions of serum proteins during the early stages of scurvy. Salmon and May(3), however, reported diminished total serum proteins and an increase in plasma fibrogen in scorbutic monkeys. An increase in plasma fibrogen has also been reported in scorbutic guinea pigs(1,4). A detailed study of the various fractions of serum proteins in scorbutic monkeys has not been reported The present report deals with studies on the serum total proteins and different fractions of serum proteins in normal and scorbutic rhesus monkeys and also in monkeys recovered from scurvy after supplementation with ascorbic acid.

Materials and methods. Fifteen rhesus monkeys weighing on the average 4 kg were maintained in the laboratory on a scorbutogenic diet(5). In addition 50 mg of ascorbic acid per animal per day and 2 drops of a concentrate of vit. A and D twice a week were given to the animals. The animals were housed in individual cages.

After the animals were on the above dietary regimen for one month, they were fasted overnight and fasting blood samples were collected in centrifuge tubes from the femoral vein. Serum was analyzed for the different fractions of protein.

After the initial studies were completed, ascorbic acid was withdrawn from 10 of the monkeys. The remaining 5 monkeys which continued to receive ascorbic acid supplement were designated as "pair-fed controls." The amount of food consumed daily by each of the 5 monkeys from whom ascorbic acid supplement was withdrawn was noted and the same amount of food was given to the corresponding pair of the monkey in the "pair-fed control" group on the next day. Food consumption of the monkeys not re-

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TABLE I. Serum Proteins of Monkeys Under Different Treatments.

	Normal monkeys when fed *ad lib* (15)	Normal monkeys pair-fed with scorbutic (5)	Scorbutic monkeys (8)	Scorbutic monkeys when recovered from scurvy (6)
Total proteins, %	7.24 ± .21	4.90 ± .53	4.77 ± .74	7.64 ± .82
Albumin, % of total protein	39 ± 1	40 ± 2	25 ± 2	40 ± 1
Globulins, % of total protein				
α_1	10 ± 1	10 ± 1	19 ± 1	10 ± 1
α_2	19 ± 1	21 ± 3	22 ± 1	15 ± 2
β	24 ± 1	21 ± 1	27 ± 2	24 ± 1
γ	8 ± 1	8 ± 2	7 ± 1	11 ± 1
Glycoproteins, mg hexose/100 ml	149 ± 5	100 ± 3	297 ±20	144 ± 7
Mucoproteins, mg hexose/100 ml	24 ± 2	16 ± 1	122 ±17	19 ± 2

Values = Mean ± S.E. Figures in parentheses indicate number of animals.

ceiving ascorbic acid was appreciably diminished from the third month of withdrawal of ascorbic acid. These animals developed cardinal signs of scurvy, *e.g.*, bleeding gums, swollen and stiff joints restricting their movements, diminution of body weight, etc., in the fourth month of withdrawal of ascorbic acid. When the monkeys developed scurvy, they as well as the pair-fed control monkeys were allowed to fast overnight and blood was withdrawn for serum studies.

Six of the 10 monkeys which developed scurvy were treated with ascorbic acid so that they could recover from the disease. Each of the monkeys received 500 mg ascorbic acid daily by intravenous injection for 3 days. They were then fed 100 mg ascorbic acid per day for 7 days and 50 mg ascorbic acid for another 2 months. They ate the diet *ad lib*. The animals completely recovered from scurvy and regained their initial weights. Food consumption of the animals also returned to normal. Blood was withdrawn for serum studies after the animals were fasted overnight.

Total serum protein was estimated by the micro-Kjeldahl procedure. Serum glycoprotein and mucoprotein were determined by the method of Weimer and Moshin(6). Different fractions of serum proteins were separated by paper electrophoresis(7).

Results. Five components of serum proteins were clearly separated by paper electrophoresis of serum of rhesus monkeys. When the food intake of the normal monkeys was restricted (pair-fed control), serum levels of total protein, glycoprotein and mucoprotein diminished significantly as compared to normal animals fed *ad lib*. The percentage distribution of serum albumin and globulins did not change. When the animals developed scurvy, there was no change in the serum total proteins, α_2-globulin, and γ-globulin; serum albumin diminished; and there was increase in percent distribution of serum α_1-globulin and β-globulin. Serum glycoprotein and mucoprotein were also increased in these animals. When the scorbutic monkeys recovered from scurvy after treatment with ascorbic acid, all the observed changes in serum proteins were found to be reversed to normal with the exception of serum α_2-globulin which diminished significantly. The results are given in Table I.

Discussion. Restriction of food intake induced a diminution in serum levels of total protein in the pair-fed normal monkeys. Serum total protein of the scorbutic monkeys although significantly diminished as compared to the value in *ad lib* fed normal monkeys, was comparable with the value obtained in the pair-fed normal monkey. The diminution in serum total protein in the scorbutic monkey was, therefore, due to inanition. Diminished serum glycoprotein and mucoprotein in pair-fed normal animals as

compared to normal monkeys fed *ad lib* was due to diminished serum total proteins as a result of inanition. Increased serum glycoprotein and mucoprotein of scorbutic monkeys might be due to increased release of mucopolysaccharides from ground substances. Increased percentage of serum α_1-globulin could be related to increased serum glycoprotein and mucoprotein which are carried in this fraction. It might be also due to wasting of tissues usually observed in scorbutic animals. Increase in serum β-globulin percentage of scorbutic monkeys was possibly due to associated accumulation of lipid in this fraction. We(8) have observed increased serum β-lipoprotein percentage and serum triglycerides in scorbutic monkeys. The changes in the patterns of serum proteins were reversed when the scorbutic monkeys were cured of the disease by treatment with ascorbic acid. Ascorbic acid, therefore, plays a part in maintenance of the normal levels of different fractions of serum proteins. Insulin is necessary in the biosynthesis of proteins (9). Scorbutic animals suffer from hypoinsulinism(10,11). Plasma insulin-like activity which is greatly diminished in scorbutic monkeys returned to normal when the animals recovered from scurvy(8). The changes in serum proteins of scorbutic monkeys might, therefore, be either due to a direct effect of ascorbic acid deficiency or mediated through the associated insulin lack.

Summary. Serum total proteins, glycoproteins, mucoproteins, albumin and different fractions of globulins were determined in normal monkeys fed *ad lib,* in scorbutic monkeys, in normal monkeys pair-fed with the scorbutic, and in monkeys which recovered from scurvy after treatment with ascorbic acid. Following changes from pair-fed normal were observed in scorbutic monkeys: Serum total proteins, α_2-globulin and γ-globulin did not change. Serum albumin diminished. Glycoproteins, mucoproteins, α_1-globulin and β-globulin expressed as percent of total protein of serum increased. The changes in serum proteins were reversed to normal when the scorbutic monkeys recovered after supplementation with ascorbic acid with the exception of serum α_2-globulin which diminished significantly. The changes in serum proteins of scorbutic monkeys seems to be a specific effect of ascorbic acid deficiency.

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