

taneous events, both of which are necessary for the phenomenon to occur. These two events are adrenal insufficiency (markedly reduced circulating concentrations of corticosteroids) and reflex sympathetic hyperactivity. Prevention of either event from occurring will protect against circulatory collapse.

Summary. Bilateral splanchnic neurectomy prevented the occurrence of circulatory collapse in dogs following acute bilateral adrenalectomy. Sham splanchnic neurectomy was not effective in this regard. The mechanism of this protective effect is not by delaying the disappearance of the corticosteroids, but rather by preventing hyperactivity of the sympathetic nervous system in the face of adrenal insufficiency.

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Effect of Coconut Oil on Serum Lipids of Normal and of Thyroidectomized Dogs.* (30978)

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The occurrence of elevated serum cholesterol levels in human hypothyroidism has long been known. Thyroidectomy has been repeatedly reported to cause elevation of the serum lipids in the dog(1-4), but there is no information about the effect of dietary fat on the serum lipids of thyroidectomized dogs.

In the course of studies on the effects of dietary fat on the serum lipids of the dog it was observed that thyroidectomized dogs responded to the addition of saturated fat to the diet, in the form of coconut oil, with

greater increases of serum cholesterol concentration than normal animals. These observations are described here.

Methods. Male adult mongrel dogs were kept on a commercial low-fat dog food[†] which by analysis had a fat content of 1.6% (approximately 4% of the total caloric value), for at least one month before the beginning of the experiments.

The experimental diet consisted of a mixture of 80% of the low-fat diet and 20% of coconut oil. Approximately 40% of the total caloric value of this diet was provided

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[†] Kibbies, Morton Dog Food Co., Minneapolis, Minn.

TABLE I. Effect of 20% Coconut Oil for 2 Weeks on Serum Cholesterol in 12 Normal and in 12 Thyroidectomized Dogs.

Serum cholesterol, mg/100 ml, means and standard errors					
Normal dogs			Thyroidectomized dogs		
Low-fat diet	Coconut oil diet	Difference	Low-fat diet	Coconut oil diet	Difference
145 ± 13.7	248 ± 20.3	103 ± 11.8	231 ± 18.0	441 ± 38.3	210 ± 25.4
		p < .0001			p < .0001

by fat. The fatty acid composition of the coconut oil used has been previously reported (5).

Fasting blood samples were taken on 3 non-consecutive days during the last week on the low-fat diet and twice at the end of each week thereafter. Body weight was measured weekly throughout the experiment.

Serum cholesterol and lipid phosphorus were determined as previously reported (5). Serum triglycerides were measured by determination of glycerol after removal of the phospholipids on a column of floril as described by Pantulu *et al* (6).

Thyroidectomy was performed under Nembutal anesthesia on the dogs kept on the low-fat diet. The 2 superior (external) parathyroid glands were carefully dissected preserving their blood supply, and left attached to the capsula. The dogs were used between 3 and 18 months after thyroidectomy. Autopsy of the thyroidectomized dogs revealed no visible rest of thyroid gland.

Results. The first experiment offers a comparison of the effects of coconut oil in 12 normal and 12 thyroidectomized dogs. Mean serum cholesterol values on the low-fat diet and at the end of 2 weeks on coconut oil are reported in Table I.

Both groups of animals showed a significant increase of serum cholesterol concentration after 2 weeks on coconut oil. The mean increase of the thyroidectomized dogs was 107 mg/100 ml (SE ± 28.0) higher than that of the normal dogs, and this difference was statistically significant ($p = 0.0015$). No significant changes of body weight were observed during the experiment.

In the second experiment 6 normal and 6 thyroidectomized dogs were compared. After the initial low-fat period the animals were fed the coconut oil diet for 3 weeks, and returned for 2 weeks to the low-fat diet.

The serum cholesterol changes are described in Fig. 1, which also gives the body weight of the animals.

The statistical analysis of the results is presented in Table II. The increase of serum cholesterol concentration of the thyroidectomized dogs in this experiment, was 124 mg/100 ml higher than that observed in the normal animals. However this difference had a probability of chance occurrence of only $p = 0.025$ due to the great variability of the responses of the thyroidectomized animals and to the smaller number of dogs in this experiment.

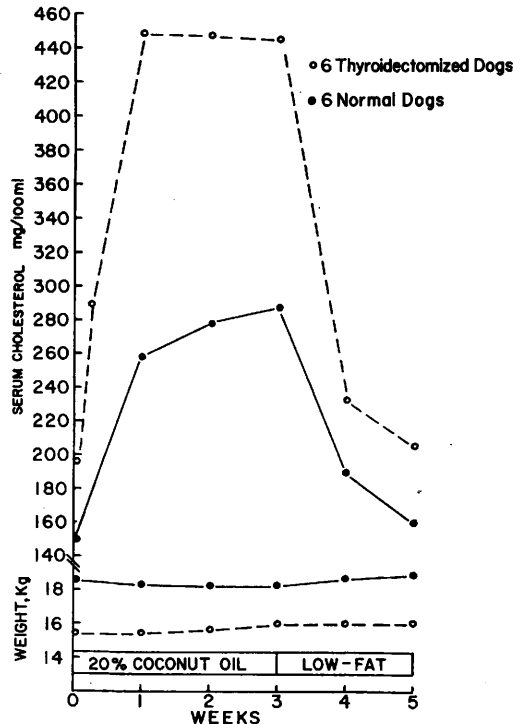


FIG. 1. Mean serum cholesterol (mg/100 ml) and mean weight (kg) of 6 normal and 6 thyroidectomized dogs. Values at 0 time are means of 3 blood samples taken from each dog in the last week on the low-fat diet preceding the coconut oil diet.

Serum phospholipids were elevated on the coconut oil diet in both groups of animals but there was no significant difference between the absolute values of the responses.

Coconut oil increased the serum triglycerides in the thyroidectomized dogs but the difference between normal and thyroidectomized animals in this respect did not reach

statistical significance ($p = 0.07$).

Because the changes of serum cholesterol concentration caused by dietary fat in man are related to the "intrinsic" serum cholesterol level(7,8) it is pertinent to ask if the greater cholesterol elevation observed in the thyroidectomized dogs is explained by their higher serum cholesterol level on the low-fat diet. The coefficient of correlation between cholesterol level on the low-fat diet and the serum cholesterol increase after 2 weeks on coconut oil was $r = +0.62$ for 48 normal dogs, including the 18 used in the present experiments. This correlation coefficient is significantly different from zero ($p < 0.0001$). The change in serum cholesterol concentration associated with the administration of coconut oil in the normal dog can be predicted by the regression equation

$$\Delta \text{Chol.} = 0.76 \text{ Chol.} + 6.7 \quad (1)$$

where $\Delta \text{Chol.}$ represents the increase of serum cholesterol after 2 weeks on the 20% coconut oil diet and Chol. the serum cholesterol level on the low-fat diet (both in mg/100 ml). This equation, when applied to the 18 thyroidectomized dogs, predicts increases of serum cholesterol with a mean of 174 mg/100 ml instead of the observed 222 mg. The mean of the differences between observed and predicted cholesterol elevations for the 18 dogs was 48 mg ($SE \pm 19.9$, $p = 0.02$).

The correlation coefficient between serum cholesterol level on the low-fat diet and cholesterol increase after 2 weeks on the coconut oil diet, for the 18 thyroidectomized dogs, was $r = +0.48$ ($p = 0.032$). The corresponding regression equation is

$$\Delta \text{Chol.} = 0.74 \text{ Chol.} + 58.1 \quad (2)$$

The slopes of equations 1 and 2 are practically equal, but the intercept for the thyroidectomized dogs is almost 9 times greater than that for the normal dogs, and the 2 intercepts are significantly different from each other ($p < 0.0005$).

Discussion. Each of the thyroidectomized dogs used in the present experiments had on the low-fat diet higher serum cholesterol concentration than before the thyroidectomy, but

TABLE II. Effect of 20% Coconut Oil on Serum Lipids of 6 Normal and 6 Thyroidectomized Dogs. Means and Standard Errors.

	Normal dogs			Thyroidectomized dogs		
	Low-fat diet*	Coconut oil diet†	Difference	Low-fat diet	Coconut oil diet	Difference
Total cholesterol, mg/100 ml	156 ± 15.8	278 ± 33.1	122 ± 18.0	201 ± 22.7	447 ± 59.7	246 ± 43.3
Total phospholipids, mg/100 ml†	341 ± 31.2	570 ± 30.9	229 ± 7.0	448 ± 48.2	645 ± 49.8	197 ± 30.3
Triglycerides, mg/100 ml	63 ± 5.0	91 ± 6.7	28 ± 6.4	99 ± 13.2	220 ± 54.4	121 ± 43.8

* Mean values for the low-fat periods before and 2 weeks after discontinuing coconut oil.

† Mean values at the end of 2 weeks on coconut oil diet.

‡ Total phospholipids = Lipid phosphorus (mg/100 ml) × 25.

.0025

.0016

.038

there was great variability in the individual elevations, as reported by Chaikoff *et al*(3).

Addition of 20% of coconut oil to the low-fat diet caused a marked rise of serum cholesterol in all the animals. The elevations in normal dogs were of the same order of magnitude as previously reported(5). The mean elevation for the 18 normal dogs was 109 mg/100 ml (SD \pm 41.8) and 222 mg/100 ml (SD \pm 93.0) for the 18 thyroidectomized dogs. The difference between these two mean elevations (222-109) is 113 mg/100 ml with a standard error of \pm 24.0 and is highly significant ($p < 0.0001$).

The regression analysis indicates that the thyroidectomized dog responds to administration of coconut oil with a greater elevation of serum cholesterol than does the normal dog. This is not explained by the higher serum cholesterol level of the former when on the low-fat diet.

The thyroidectomized dogs had higher serum phospholipid levels than the normal dogs, when on the low-fat diet (Table II), but the difference between the mean levels is not significant ($p = 0.08$). This agrees with the observations by Chaikoff *et al*(3). Administration of coconut oil was associated with an increase of the serum phospholipids in both groups of dogs, but since the responses of normal and of thyroidectomized animals were practically equal we conclude that thyroidectomy increases the serum cholesterol response to coconut oil but not that of the phospholipids. Thyroidectomy caused some increase of the serum triglycerides as well as an increase of the triglyceride response to coconut oil, but the data are not conclusive because of their great variability.

Summary. Thyroidectomized dogs respond to the addition of coconut oil to the diet with greater elevations of serum cholesterol concentration than do normal dogs. This greater elevation is not explained by the higher serum cholesterol level of the thyroidectomized dogs on the low-fat diet. Serum phospholipids are elevated by administration of coconut oil but there is no difference between the responses of normal and thyroidectomized dogs. Serum triglycerides are elevated in both groups of animals by coconut oil. The elevation tends to be greater in the thyroidectomized animals but the difference between normal and thyroidectomized dogs was not statistically significant.

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