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ALTERATIONS IN STRUCTURE AND FUNCTION OF ADRENAL GLAND DUE TO BILATERAL VAGOTOMY IN DOMESTIC PIGEONS

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ABSTRACT

Histomorphological studies carried out on adrenal glands of bilaterally vagotomized pigeons showed that adrenals, to some extent, are dependent on vagal nerve for structural and functional integrity. Vagotomy resulted in an increase of adrenal weights. This increase was seen in both absolute and relative weights of the gland. Histochemical preparations revealed a hypertrophy of cortical tissue and a regression of medullary tissue. Activity of acetylcholinesterase as well as ascorbic acid content showed a decrease in the adrenal gland of vagotomized pigeons. However, there was an increased accumulation of lipid droplets in the cortical cells. The results indicate that in pigeons, the vagal transection leads to cortical hypertrophy but a slight reduction in steroidogenic activities.

INTRODUCTION

ADRENOCORTICOSTEROIDS and catecholamines secreted by adrenal gland are involved in metabolic, thermoregulatory, reproductive and many other physiological changes taking place in birds[1,2]. Some of these are long term changes and hence seasonal or related to environmental conditions. Several adrenal functions are related to short term regulation and are mostly metabolic. While long term regulations are mediated by hormones such as ACTH[1], the short-term regulations are modulated by autonomous nervous sytem.

In mammals, the nerves of both parasympathetic and sympathetic systems have regulatory influence on the adrenal. Subdiaphragmatic splanchnotomy in male rats resulted in a reduction of catecholamine content of adrenal medullary cells[3] and an activation of adrenal cortical cells[4], indicating that sympathetic nerves have an inhibitory effect on cortical cells and stimulatory effect on medullary cells. On the other hand bilateral subdiaphragmatic vagotomy resulted in a decrease in functional activities of adrenal cortical cells [5–8]. Avian adrenal gland is different from mammalian adrenal by the absence of zonation of cortical and medullary cells, although both splanchnic and vagal innervations are same as in mammals[9]. However, the functional relationship between autonomous nerve fibres and adrenal activity has not been clearly established in birds as in mammals. In the present report, an attempt to understand the influence of vagal fibres on the adrenal gland is made by subjecting pigeons to bilateral vagotomy.

MATERIALS AND METHODS

Adult domestic pigeons (*Columba livia*) of both sexes weighing 250 to 300 g and acclimated to laboratory conditions were used in the experiments. The birds were divided into four groups of five birds each. Two groups of pigeons, injected with sodium phenobarbitone (40 mg/kg body weight) as anaesthetic agent, were bilaterally vagotomized from cervical region and

sacrificed at 48 or 72 hr. The birds of third group were subjected to sham operation under anaesthesia and sacrificed after 48 hr. The birds of fourth group, referred as normal, were sacrificed after overnight starvation. The experimental and sham-operated birds were not provided with food in the post-operative period. Both operation and autopsy were carried out around 10.00 am. All birds were sacrificed by decapitation under mild anaesthesia and the adrenals of both sides were removed, weighted and processed for histochemical observations.

Ascorbic acid was histochemically demonstrated using the method as described by Chinoy[10, 11]. Frozen sections of calcium formol fixed adrenals were stained with Sudan black B or Fettrot 7B for demonstration of lipids[12] The relative percentage of cortical and medullary cells was determined from Sudan black stained frozen sections. Localization of acetylcholinesterase (AChE) in frozen sections of calcium formol fixed adrenals was done by the direct colouring method of Karnovsky and Roots[13] using acetylthiocholine iodide as substrate. All histochemical studies were carried out on adrenals of 72 hr vagotomized pigeons.

OBSERVATIONS

Average weight of adrenals of normal pigeons was found to be 21.20 ± 5.25 mg which was relatively 8.42 mg/100 g body weight. Adrenals of sham-operated pigeons exhibited a slight reduction in the weight. On the other hand, the adrenals of vagotomized pigeons showed a significant increase in both absolute and relative weights (table 1).

When the relative proportions of cortical and medullary cells were calculated (table 2), it was found that cortical cells were more than medullary cells in the adrenals of the pigeons. Vagotomy resulted in a further increase in the percentage of cortical cells (table 2).

Table 1 *Changes in the weight of adrenal gland in vagotomized and sham-operated domestic pigeons*

Experimental conditions	Body weight gms	Adrenal weight	
		Absolute mg	Relative mg/100 gm
Normal	254.0 ±35.7	21.20 ±5.25	8.42 ±0.93
Sham operated	283.3 ±40.4	16.40 ±4.02	5.72 ±0.97
48 hr vagotomized	282.5 ±25.5	34.15* ±3.32	12.08** ±1.16
72 hr vagotomized	260.0 ±15.4	35.28* ±2.80	12.47** ±0.99

Values (Mean ± S.E.M.) are significant at $^*P < 0.05$; $^{**}P < 0.02$

Table 2 *Percentage changes in the relative proportions of cortical and medullary cells in the adrenals of vagotomized pigeons*

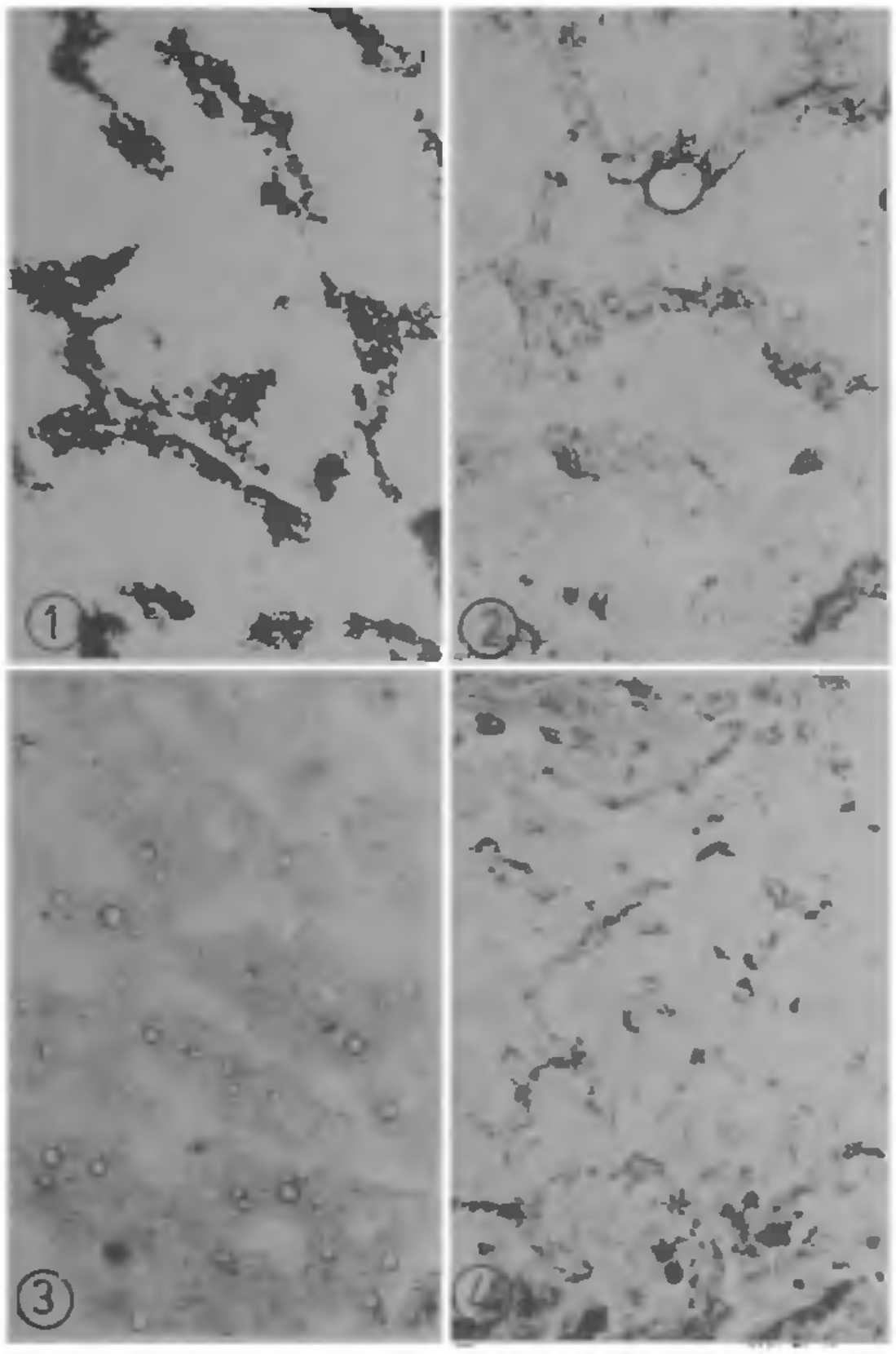
Experimental conditions	Cortical cells	Medullary cells
Normal	66.99 ± 3.34	33 01 ± 3.34
72 hr vagotomized	73.98 ± 0.77	26 02 ± 1 51

Acetylcholinesterase activity was localized more in cortical cells than in medullary cells (figure 1). Bilateral vagotomy caused a slight reduction in AChE activity in both the areas (figure 2). Lipid droplets were also seen more in cortical cells (figure 3). Distribution of these lipid droplets was found to increase in the cortical cells after vagotomy (figure 4). Ascorbic acid could be seen as fine granules in the histochemical preparations. The medullary cells were found to have slightly bigger granules than the cortical cells (figure 5). A general reduction of ascorbic acid was seen in adrenals of vagotomized pigeons (figure 6).

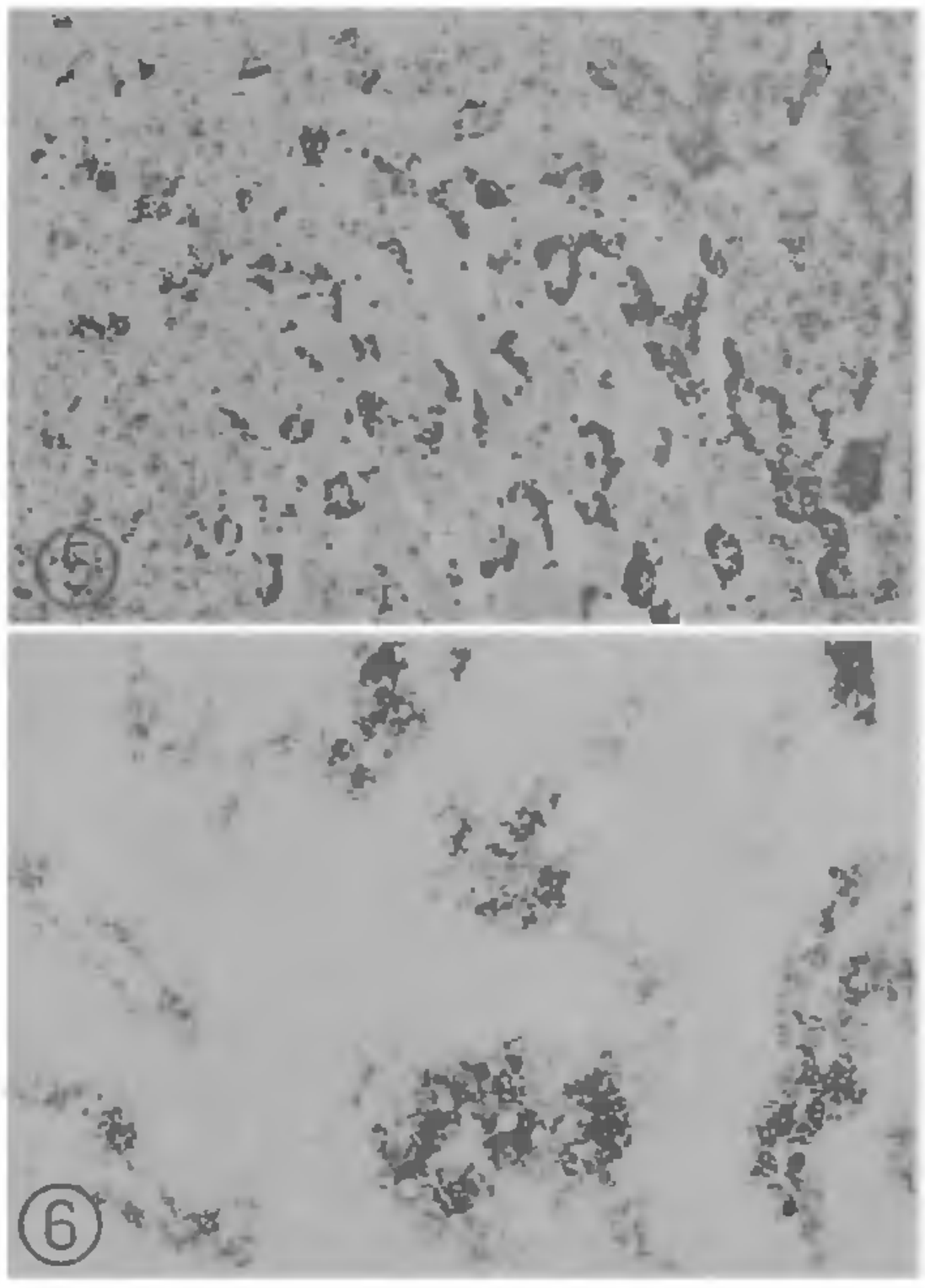
DISCUSSION

The reduced activity of AChE in the adrenal gland of vagotomized pigeons indicated the absence of acetyl choline secretion by the cholinergic vagal fibres. But the vagotomized pigeon adrenal also showed an increase in absolute as well as relative weight. This increase in weight was mainly due to the hypertrophy of adrenocortical cells which could be judged from the fact that the percentage of cortical cells showed an increase. Such increase in the adrenal weight was also seen in mammals after subphrenic vagotomy[14]. The increase in weight was seen due to the enlargement of fascicular and reticular zones[5, 9].

However, the hypertrophy of the cortical cells seen in the adrenals of the vagotomized pigeons was not probably accompanied by a corresponding increase in the functional activity. The ascorbic acid content was found to decrease in the adrenals after vagotomy. Since ascorbic acid is known to stimulate catecholamine and corticosteroid synthesis in pigeons[2, 15], the reduced content of ascorbic acid indicate a reduced cortical functional activity. The reduction in steroidogenesis could also be deduced from the fact that the lipid



Figures 1–4. Photomicrographs of sections of adrenal glands of normal and vagotomized pigeons showing histochemical distribution of AChE, lipids and ascorbic acid. **1.** AChE in the adrenal of normal pigeon **2.** AChE in the adrenal of vagotomized pigeon **3.** Lipids in the adrenal of normal pigeon **4.** Lipids in the adrenal of vagotomized pigeon.



Figures 5 & 6. Ascorbic acid in the adrenal of normal pigeon **6.** Ascorbic acid in the adrenal of vagotomized pigeon

droplets were found to be more in cortical cells after vagotomy. In fact, enlargement of fascicular and reticular zones of adrenal cortex was accompanied by a greater content of cellular unsaturated phospholipids in the vagotomized rats also[6]. Moreover, acetylcholine has an acute and direct stimulative effect on steroidogenesis in isolated calf adrenals perfused with an artificial medium, while atropine, a muscarinic blocking agent, blocked the acceleration of steroidogenesis by aceylcholine[16].

Although the stimulatory effect of vagal fibres on steroidogenesis thus can be explained, it is difficult to find reason for the observed hypertrophy of cortical cells in vagotomized pigeons. Perhaps the reduction in steroid synthesis could lead to a lowered plasma concentrations of corticosteroids which in turn could trigger an elevated release of ACTH from adenohypophysis.

The parasympathetic nerve fibres also have an influence on the medullary cells. In pigeon, vagotomy resulted in the reduction in the proportion of medullary cells. Thus it could be stated that, as in mammals, in birds too vagotomy causes a hypertrophy of cortical tissues and an atrophy of chromaffin cells.

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GRAVIMETRIC AND HISTOLOGICAL STUDY OF THE ADRENAL GLANDS OF THE INDIAN GRAY MONGOOSE, *HERPESTES EDWARDSII EDWARDSII* GEOFFROY

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ABSTRACT

The adrenals of the Indian gray mongoose grow isometrically with the body weight. The relative weights (mg %) of the glands remained more or less constant in juvenile as well as adults of both sexes. The right gland was uniformly smaller than the left in all the groups. Histologically, an outer cortex of three zones and a central medulla of chromaffin cells were seen. There was no sexual dimorphism in respect of either the histological structure or weight variations in juvenile or the adult mongoose.

INTRODUCTION

INFORMATION on the adrenal glands of wild carnivores from the Indian subcontinent is very limited. There has been, in fact, no report on the adrenals of mongooses (Family: Viveridae) though a number of species are fairly widely distributed in India. As the adrenal glands are known to play an important role both at the individual and the population level the present work was undertaken. This report deals with the gravimetric and histological aspects.

MATERIAL AND METHODS

The Indian gray mongoose, *Herpestes edwardsii edwardsii* Geoffroy trapped over a period of one year around the city of Mysore comprising juvenile and adult animals of both sexes numbering to a total of 19 have been used. During autopsy the adrenals were removed, trimmed off adherent tissue and weighed separately. Glands fixed in Bouin's fluid were sectioned at 7 μ thickness, stained in Harris haematoxylin-eosin and Mallory's tripple for histological observations.

OBSERVATIONS

Weights of left and right adrenal glands have been expressed in mg/100 g of body weight in different groups (table 1) separately. Absolute weights of the paired glands of all the 19 animals have been plotted against the body weight in figure 1. Two adrenal glands