

Mortality, Hemodynamics, and Aortic Properties among Male and Female Turkeys Fed β -Aminopropionitrile (41541)

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Abstract. Broad-Breasted White turkeys were randomized into four treatment groups at 4 weeks of age in each of three trials. Group 1, males, and Group 2, females, were fed an unsupplemented (control) diet from 4 to 10 weeks of age. Group 3, males, and Group 4, females, were fed the control diet supplemented with 0.07% β -aminopropionitrile (BAPN). The experiments were terminated at 10 weeks of age. There was no mortality among male and female turkeys fed the control diet or significant differences in blood pressure, heart rate, aortic tensile strength, or aortic hydroxyproline between these males and females. Sixty-five percent of the males and 21% of the females fed BAPN died of dissecting aneurysms; blood pressure, heart rate, and dp/dt max were not altered as a result of feeding BAPN. Aortic tensile strength was higher in control turkeys than those fed BAPN, but males fed BAPN had the lowest value. Males fed BAPN also had the lowest aortic hydroxyproline content. Ultrastructural alterations of aortic elastic and collagen fibers were more severe in males than females fed BAPN. Aortic changes did not occur in control turkeys.

Feeding of *Lathyrus odoratus* seeds (1) or β -aminopropionitrile (2-4), the toxic principle of the sweet pea plant (5), to rats leads to the development of aortic dissecting aneurysms. Likewise, feeding of β -aminopropionitrile to turkey poult also results in the formation of aneurysms (6). Mortality due to aneurysms among male, Broad-Breasted White turkeys (BBW) fed β -aminopropionitrile varies from experiment to experiment, but generally is in the range of 50% (7). Apparently, experiments have not been formulated to specifically ascertain whether male and female turkeys are equally susceptible to the angiopathy induced by the consumption of β -aminopropionitrile. Therefore, the present paper describes the results of feeding the chemical to immature male and female turkeys as pertains to mortality, hemodynamics, aortic tensile strength, aortic ultrastructure, and aortic hydroxyproline content.

Materials and Methods. Three experiments were conducted. Since the results of all three were similar, the data were combined for this presentation. Male and female BBW turkeys, purchased from a commercial hatchery, were fed an unsupplemented diet (con-

trol) until 4 weeks of age. At this time the turkeys were randomized into four treatment groups, each group consisting of 20 turkeys. Group 1 (males) and Group 2 (females) were continued on the control diet. Group 3 (males) and Group 4 (females) were fed the control diet supplemented with 0.07% β -aminopropionitrile fumarate (BAPN). Turkeys that died during the course of the experiment were necropsied. The experiment terminated at 10 weeks of age, at which time all surviving turkeys also were necropsied. Twenty-four hours prior to sacrifice, the following parameters were determined from cannulation of the carotid artery (8) following injection of the operative site with lidocaine hydrochloride: arterial blood pressure, heart rate, and dp/dt max (maximum rate of blood pressure rise per second). At necropsy of surviving turkeys, a 2.9-mm ring of abdominal aorta, 1 cm cephalad to the sciatic arteries, was procured for determination of aortic tensile strength (8). A small segment of aorta immediately proximal to this area was processed for electron microscopy by fixing the tissue in 3.5% buffered glutaraldehyde, postfixing in 1% OsO₄, embedding in Araldite, and examining lead citrate- and uranyl acetate-stained thin sections with an electron microscope. The abdominal aorta remaining after procurement

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TABLE I. HEMODYNAMICS OF MALE AND FEMALE TURKEYS FED BAPN

Diet-sex	Blood pressure, systolic/diastolic (mm Hg)		Heart rate (beats/min)	dp/dt max (mm Hg/sec)	Mortality (%)
Control-male	205 ± 4.9 ^a	154 ± 10.1 ^a	276 ± 5.0 ^a	1856 ± 146 ^a	0.0 ± 0.0 ^a
Control-female	207 ± 8.7 ^a	144 ± 8.0 ^a	270 ± 8.2 ^a	1426 ± 72 ^b	0.0 ± 0.0 ^a
BAPN-male	209 ± 8.2 ^a	143 ± 7.9 ^a	267 ± 6.0 ^a	1632 ± 85 ^{a,b}	64.0 ± 7.3 ^b
BAPN-female	201 ± 9.0 ^a	148 ± 11.5 ^a	275 ± 3.8 ^a	1586 ± 157 ^{a,b}	21.0 ± 8.3 ^c

Note. Values with different superscripts are significantly different ($P < 0.05$) from each other.

of sections for tensile strength and electron microscopy was stripped of adventitia, chopped to a fine consistency, dried to a constant weight, extracted with chloroform-methanol (2:1), dried under vacuum, hydrolyzed with 6 N HCl, and hydroxyproline determined by the method of Neuman and Logan (9).

Results. There was no mortality among either male or female turkeys fed the control diet, and there was not a sex-related difference in arterial blood pressure, heart rate, aortic tensile strength, or aortic hydroxyproline. However, dp/dt max was higher in males than control females. In contrast, 64% of the males and 21% of the females fed BAPN died of aortic ruptures. When compared to controls, BAPN did not influence heart rate, arterial blood pressure, or dp/dt max (Table I). Aortic tensile strength was lowest in males and intermediate in females fed BAPN; it was highest in males and females fed the control diet (Table II). Aortic hydroxyproline was highest in control males and females and also females fed BAPN, as compared to males fed BAPN, indicating that collagen content was higher in the first three groups than in males fed BAPN.

TABLE II. AORTIC TENSILE STRENGTH AND AORTIC HYDROXYPROLINE AMONG MALE AND FEMALE TURKEYS FED BAPN

Diet-sex	Aortic tensile strength (g/mm ²)	Aortic hydroxyproline (μg/mg dry weight)
Control-male	129.4 ± 6.9 ^a	20.1 ± 1.2 ^a
Control-female	130.2 ± 3.6 ^a	18.0 ± 1.1 ^a
BAPN-male	64.6 ± 2.8 ^b	16.3 ± 0.8 ^b
BAPN-female	85.7 ± 5.9 ^c	19.0 ± 0.7 ^a

Note. Values with different superscripts are significantly different ($P < 0.05$) from each other.

The ultrastructural appearance of the aortic media varied among two of the four treatment groups. The media of males and females fed the control diet was similar. In these specimens the elastic fibers between smooth muscle cells had smooth surfaces and compact bundles of collagen fibers generally were closely associated with the elastic fibers (Fig. 1). Elastic fibers between smooth muscle cells in the media of males fed BAPN were greatly swollen and severely fragmented; collagenous fibers in the vicinity were dispersed and appeared swollen (Fig. 2). In the media of females fed BAPN, elastic fibers were slightly swollen and fragmented; collagen fibers were not dispersed (Fig. 3).

Discussion. Barnett *et al.* (6) reported that feeding of BAPN to young turkeys caused mortality due to dissecting aneurysms, and also noted the gross and microscopic resemblance of this experimentally induced condition to spontaneous aneurysms seen in field flocks of turkeys. Subsequently, it was found that the first step in the crosslinking of collagen and elastin was oxidative deamination of lysine and hydroxylysine by the enzyme lysyloxidase (10). Since BAPN inhibits the activity of this enzyme, the chemical decreases the deposition of mature collagen and elastic fibers in the aorta, and, therefore, reduces aortic tensile strength.

In deoxycorticosterone acetate salt (DOCA)-induced hypertensive male rats, administration of BAPN reduced aortic lysyloxidase and the collagen content of the vessel wall (11, 12). Decreased lysyloxidase activity was noted in the skin of aneurysm-prone mottled mice (13), a condition characterized by abnormal crosslinking of collagen and elastin.

Important to the present study was the report that tom turkeys had lower aortic levels

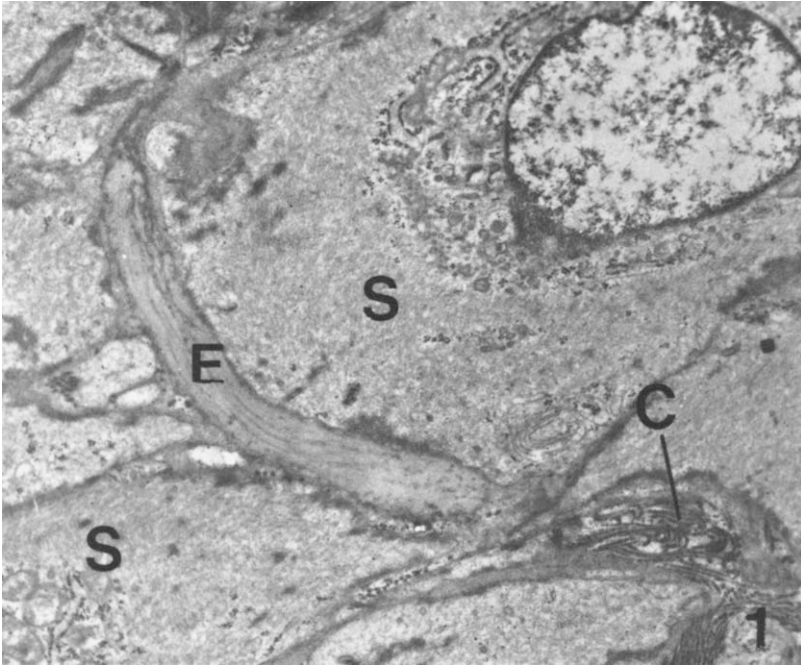


FIG. 1. The aortic media of a control male or female turkey contains elastic fibers with smooth surfaces (E) and compact bundles of collagen fibers (C) between smooth muscle cells (S). (9000 \times).

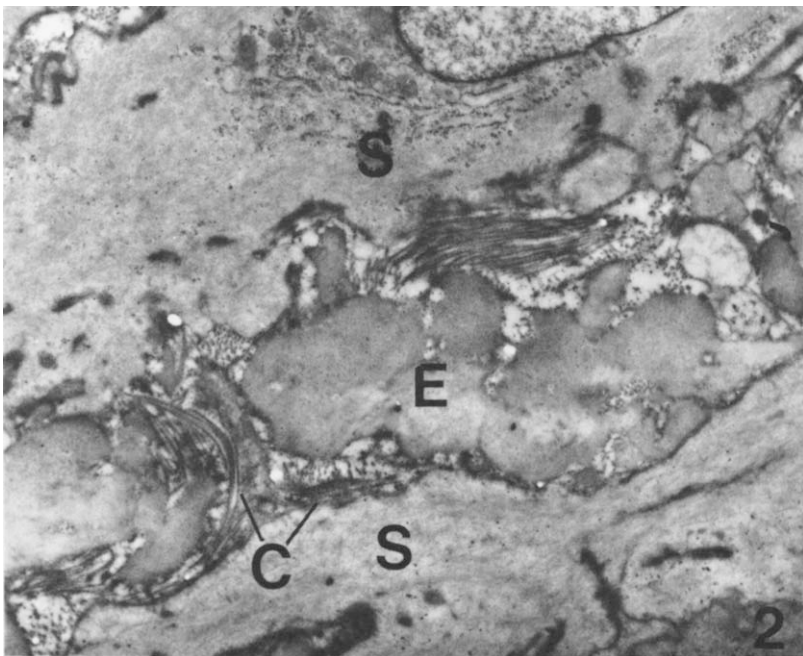


FIG. 2. In the aortic media of a male fed BAPN, an elastic fiber between smooth muscle cells (S) is greatly swollen and fragmented (E). Collagen fibers (C) are dispersed. (9000 \times).

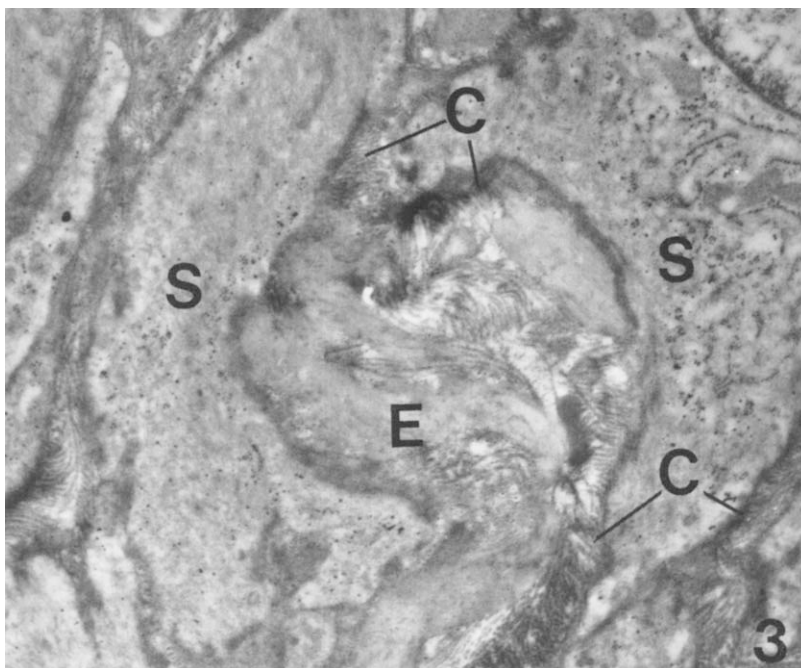


FIG. 3. An elastic fiber between smooth muscle cells (S) in the aortic media of a female fed BAPN is mildly swollen and slightly fragmented (E). Bundles of collagen fibers (C) are compact. (9000 \times).

of lxyloxidase activity than hen turkeys (14). These results were, in the opinion of the authors, an explanation for the increased incidence of spontaneous aneurysms noted among male turkeys.

The results of the present paper indicate that the higher mortality rate from aneurysms among male turkeys fed BAPN is not associated with elevated arterial blood pressure, heart rate or dp/dt max since these parameters were not significantly different between males and females. Thus, the explanation for this phenomenon is probably explainable by the work of Narayanan *et al.* (14) relating to lower aortic lxyloxidase activity among male than female turkeys. This factor in addition to the lxyloxidase inhibitory activity of BAPN caused a greater accumulation of uncross-linked collagen and elastin in the male turkey aorta, and therefore, greater mortality from BAPN-induced aneurysms. This biochemical explanation is confirmed by the ultrastructural observations of the aorta reported in the present paper.

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