

Effect of Caecectomy on Hematology and Serum Clinical Biochemistry Values in White Roman Goslings

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ABSTRACT

The aim of this study was to investigate the effect of caecectomy on hematology and serum clinical biochemistry in White Roman goslings. Forty eight 2-wk-old female goslings with similar body weight were randomly divided into four treatments: sham, left side caecum removed, right side caecum removed and both caeca removed. Feed and water were supplied ad libitum during the experimental period (3-6 wks of age). The blood samples from 4 and 6 weeks of age were collected by wing vein puncture to determine hematology and serum clinical biochemistry values. The results indicated that there were no significant difference for serum sodium, chloride, calcium, blood total red cell number and hemoglobin concentration, packed cell volume, mean corpuscular hemoglobin concentration, and mean corpuscular hemoglobin levels of goslings among the treatments. However, caecectomy did affect serum potassium, magnesium, uric acid, and total cholesterol concentrations of goslings ($P < 0.05$). Therefore, this suggests that the role of caeca in goslings for digestive tract nutrient absorption, transport and metabolism may be retarded after caecectomized.

Key words: *Caecectomy, Clinical biochemistry, Goslings, Hematology*

INTRODUCTION

The caecum is the major organ for dietary fiber digestion in poultry intestine, and it can ferment carbohydrate into volatile fatty acid (Chen et al., 1992; Clemens et al., 1975; McBee, 1969), the other function of caecum include protein digestion (Nitsan and Alumot, 1980), no protein nitrogen absorption and metabolism (Karasawa, 1991), a role in the transport of water, sodium, potassium and chloride (Thomas and Skadhauge, 1988), and microbial synthesis of vitamins and their absorption (Couch et al., 1950; McNab, 1973). Geese have a pair of well-developed caeca and possess fine villi structure in histological specimens and scanning elec-

tron micrograph at the proximal zone of caecum (Chen et al., 2002a). Moreover, Chen et al. (2002b) indicated that caecum have the absorptive function in geese. Turkey (Dziuk et al., 1970) and desert quail (Anderson and Braun, 1984) minor increased water intake following caecectomy. The surgical operation affect blood characteristics in bird. e.g. erythrocyte numbers were the highest in the male, intermediate in the capons, and the lowest in the female birds (Sturkie and Textor, 1960) and erythrocyte sedimentation rate in the capon bird was faster than that of the male bird in 60 min (Sturkie and Textor, 1958). Serum cholesterol levels of caecectomized laying hens were higher than that of normal birds (Tortuero et al., 1975). However, no information is available on the effect of caecum removed on the blood characteristics in goslings. It is necessary to process caecum ligation when we study caecum functions in poultry and caecectomy provide a tool to study the role of caecum in absorption and transportation. The purpose of this study was to

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investigate the effects of caecectomy on hematology and serum clinical biochemistry values in White Roman goslings.

MATERIALS AND METHODS

Animals and diets

Sixty 1-day-old female White Roman goslings were obtained from the Taiwan Livestock Research Institute, Changhua Animal Propagation Station. Goslings were brooded in an electric brooder from 0 to 2 wks of age. Forty eight 14-day-old goslings with similar body weight were randomly divided into four treatments, including sham, left side caecum removed, right side caecum removed and both caeca removed. Goslings of each treatment were allocated to three cages (90 cm × 56 cm × 60 cm) of 4 goslings each. Caecectomy was conducted according to the method of Chen et al. (2002). The diets used at 0-4 wks of age and 5-6 wks of age were pelleted diets containing CP(%) / ME(kcal/kg) as 20.6/2826 and

18.07/2800, respectively (Table 1). Feed and water were supplied ad libitum during the experimental period (3 -6 wks of age).

Sampling

The blood samples of all birds at 4 and 6 weeks of age were collected by wing vein puncture after feed was deprived of for 8 hours. One part of blood samples was put into serum bottle with ethylene diaminetetraacetic acid-2K (EDTA-2K) to anticoagulate and the other part of blood samples was centrifuged at 1500 g, 10 min to separate plasma after coagulated blood. The serum samples were stored in refrigerator under -30°C to supply the analysis of clinical biochemistry values.

Analysis of hematology

Total red cell number, hemoglobin (Hb) packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), and mean corpuscular hemoglobin (MCH) concentration were

Table 1. Composition of experimental diets

Ingredients	starter (0-4 wk)	grower (5-6 wk)
	-----%-----	
Yellow corn	51.60	54.55
Wheat bran	3.00	6.00
Soybean meal, 44%	29.10	20.20
Fish meal, 60%	3.00	3.00
Alfalfa meal, 17%	7.00	11.00
Tallow	3.50	2.90
Dicalcium phosphate	1.32	1.02
Calcium carbonate, pulverized	0.50	0.35
Salt	0.40	0.40
DL-Methionine	0.20	0.20
Choline chloride, 50%	0.08	0.08
Premix*	0.30	0.30
Total	100	100
Calculated composition, %		
Crude protein	20.60	18.07
Crude fat	6.55	6.43
Crude fiber	5.39	6.22
ME, kcal/kg	2826	2800
Calcium	0.83	0.73
Available phosphorus	0.45	0.38

*Supplied per kilogram of diet: vitamin A, 15,000 IU; vitamin D., 3,000 IU; vitamin E, 30 mg; vitamin K.,

determined using the blood cell counter (Sysmex F-800, Sysmex Co., Japan) Erythrocyte absolute indexes were calculated according to the method of Schalm (1961) and $Hb \times 100/PCV$; $MCH = Hb \times 10/RBC$ ($106/\mu L$).

Analysis of clinical biochemistry values of serum samples

Serum triglyceride, total cholesterol, uric acid, total protein, albumin, calcium, phosphorous and magnesium levels were determined by clinical analyzer (Express Plus, Ciba Corning Co., England). Sodium, potassium and chloride concentrations in the serum were assayed by 644 $Na^+/K^+/Cl^-$ electrolytes analyzer (Ciba Corning Co., England).

Statistical analysis

All data were subject to analysis of variance using the General Linear Model (GLM) of SAS (Statistical Analysis System, 1996). The Least Squares Means were used to compare and estimate the differences among the treatments.

RESULTS

Serum electrolytes

The effect of caecectomy on serum electrolytes in

White Roman goslings at 4 and 6 wks age is shown in Table 2. The data indicated that caecectomy did not affect sodium, chloride, and calcium concentrations. However, the whole experimental period; meanwhile, compared the serum potassium concentration were the lowest in both caeca removed goslings at 4 or 6 wks of age and with sham treatment, there was significant difference ($P < 0.05$). The serum magnesium concentrations in both caeca removed birds at 4 wks of age were significantly lower than sham treatment. On the contrary, caecetomized birds at 6 wks of age had the highest serum magnesium concentrations among the treatments.

Clinical biochemistry

The effect of both caeca removed on serum triglyceride, total cholesterol, uric acid, total protein and albumin values in White Roman goslings at 4 and 6 wks of age is shown in Table 3. There was not significant difference for serum triglyceride, total protein and albumin concentrations among the treatments. Both caeca removed birds at 4 wks of age and the whole experimental period had the highest for serum total cholesterol; however, goslings at 6 wks of age, there was not significant difference for total cholesterol concentrations among the treatments. Both caeca removed goslings at 6 wks of age and the whole experimental period were the lowest for serum uric acid

Table 2. Effect of caecectomy on serum electrolyte in White Roman goslings at 4 and 6 wks age

Items	Treatments			
	Control (sham)	Left side caecum removed	Right side caecum removed	Both caeca removed
Sodium		----- mmol/L -----		
4 wks	141.58±4.66	142.50±3.87	143.08±3.90	139.75±4.07
6 wks	141.83±4.09	141.92±5.58	143.25±3.08	141.66±4.68
mean	141.71±4.29	142.21±4.71	143.17±3.43	140.71±4.40
Potassium		----- mmol/L -----		
4 wks	3.07±0.73 ^b	2.66±0.49 ^a	2.50±0.27 ^a	2.39±0.34 ^a
6 wks	2.94±0.43 ^b	2.73±0.23 ^{ab}	2.77±0.19 ^{ab}	2.55±0.35 ^a
mean	3.00±0.59 ^b	2.70±0.39 ^a	2.63±0.27 ^a	2.47±0.34 ^a
Chloride		----- mmol/L -----		
4 wks	98.25±3.65	98.83±3.61	97.42±3.94	99.58±2.11
6 wks	98.33±2.50	97.42±3.92	98.17±3.01	96.33±3.47
mean	98.29±3.06	98.13±3.86	97.79±3.45	97.96±3.26
Calcium		----- mg/dL -----		
4 wks	11.39±0.51	11.43±0.49	11.61±0.49	11.43±0.47
6 wks	11.08±0.35	10.88±0.53	10.98±0.45	11.03±0.57
mean	11.24±0.46	11.16±0.57	11.30±0.56	11.23±0.50
Phosphorous		----- mg/dL -----		
4 wks	7.09±0.45	7.18±0.56	7.13±0.57	7.16±0.48
6 wks	7.32±0.51	7.30±0.45	7.71±0.79	7.52±0.43
mean	7.20±0.49	7.24±0.50	7.42±0.73	7.34±0.48
Magnesium		----- mg/dL -----		
4 wks	3.53±0.21 ^b	3.20±0.20 ^{ab}	2.93±0.76 ^a	2.88±0.74 ^a
6 wks	2.43±0.79 ^a	2.73±0.84 ^{ab}	2.75±0.34 ^{ab}	2.96±0.31 ^b
mean	2.98±0.80	3.06±0.74	2.84±0.59	2.93±0.56

^{a,b} Means within the same row without the same superscripts differ significantly ($P < 0.05$).

Table 3. Effect of caecetomy on serum triglyceride, total cholesterol, uric acid, total protein and albumin values in White Roman goslings at 4 and 6 wks age

Items	Treatments			
	Control (sham)	Left side caecum removed	Right side caecum removed	Both side caeca removed
-----mg/dL-----				
Triglyceride				
4 wks	52.83±11.99	64.42±19.05	59.08±20.35	50.58±14.20
6 wks	71.33±16.10	77.00±18.03	74.17±26.88	75.50±27.43
mean	62.08±16.80	69.71±19.61	66.63±24.56	63.04±24.86
-----mg/dL-----				
Total cholesterol				
4 wks	190.91±16.31 ^a	182.88±12.67 ^a	197.83±24.48 ^{ab}	212.75±19.25 ^b
6 wks	176.36±18.42	166.78±16.35	188.83±29.58	194.50±25.60
mean	183.64±18.54 ^a	174.86±16.51 ^a	193.33±26.95 ^{ab}	203.63±24.03 ^b
-----mg/dL-----				
Uric acid				
4 wks	2.02±0.68	2.07±0.52	1.87±0.38	1.83±0.47
6 wks	1.43±0.29 ^b	1.35±0.41 ^{ab}	1.32±0.30 ^{ab}	1.14±0.21 ^a
mean	1.73±0.59 ^b	1.71±0.59 ^b	1.59±0.44 ^{ab}	1.41±0.44 ^a
-----g/dL-----				
Total protein				
4 wks	3.23±0.25	3.25±0.09	3.29±0.19	3.26±0.22
6 wks	3.75±0.29	3.87±0.23	3.97±0.60	3.90±0.30
mean	3.49±0.38	3.56±0.36	3.63±0.59	3.58±0.42
-----g/dL-----				
Albumin				
4 wks	1.56±0.12	1.51±0.07	1.55±0.08	1.52±0.11
6 wks	1.82±0.14	1.81±0.16	1.78±0.10	1.78±0.09
mean	1.69±0.19	1.66±0.20	1.66±0.15	1.65±0.17

concentration; however, goslings at 4 wks of age, there were not significant difference for uric acid concentrations among the treatments.

Hematology

The effect of caecetomy on hematological pictures in White Roman goslings at 4 and 6 wks age is shown in Table 4. The data indicated that there was no significant difference for Hb, RBC, PCV, MCHC and MCH among the treatments. However, the value of MCV in caecetomised birds were significantly higher than that of the sham goslings during the whole experimental period ($P < 0.05$).

DISCUSSIONS

Serum electrolytes

The phenomenon of the lowest potassium concentration in both caeca removed birds may be related to the urine retrogradation from rectum and colon. Bjornhag et al. (1989) pointed that when the ground was covered with deep snow, herbivorous birds were then obliged to resort to arboreal food such as buds, needles and twigs and the backflow of urine will then allow the bird to reabsorb and reutilize electrolytes and minerals that were limited in the food. In this study, the feed of goslings was deprived of before blood sampling. Therefore, the digestive tract of both caeca removed goslings decreased potassium absorption and then blood

potassium concentration descended. The serum magnesium concentration of both caeca removed goslings at 4 wks of age was the lowest among the treatments. This finding whether extracaecal organ (small intestine and/or kidney) fully compensated for the lost function of the caeca or had another physiological phenomenon is unknown. This study suggests that further research is required to resolve this problem.

Clinical biochemistry

Caecetomized birds had the highest serum total cholesterol concentration at 4 wks of age. This result agreed with the finding that caecetomized laying hens had a higher serum cholesterol levels than that of normal birds; and the reason may be the role of caeca flora as the mechanism of cholesterol degradation (Tortuero et al., 1975). However, the serum total cholesterol concentrations of 6-wks-old goslings in both caeca removed treatment was similar to the other treatments. It indicated that the caecetomized goslings maybe adjust serum total cholesterol concentrations to suitable values when its level is high. i.e. the synthesis of endogenous cholesterol in goslings decrease to maintain homeostatic regulation in body. Both the caeca removed goslings at 6 wks of age had the highest serum uric acid values among the treatments, and the reason may be related to that avian caecum which has the function of absorption water because of the antiperistaltic transportation of the urine from rectum and colon to the caecum. Bjornhag and

Table 4. Effect of caecetomy on hematological parameters in White Roman goslings at 4 and 6 wks age

Items	Treatments			
	Control(sham)	Left side caecum removed	Right side caecum removed	Both caeca removed
Hb	----- g/dL -----			
4 wks	11.29±0.74	11.49±0.41	11.68±0.84	11.59±0.63
6 wks	11.47±0.76	11.58±0.52	11.83±0.59	11.52±0.49
mean	11.38±0.74	11.53±0.46	11.75±0.71	11.55±0.55
RBC	----- 10 ⁶ /μL -----			
4 wks	2.13±0.18	2.12±0.13	2.19±0.23	2.10±0.19
6 wks	2.09±0.15	2.11±0.13	2.17±0.18	2.09±0.13
mean	2.11±0.16	2.11±0.13	2.18±0.20	2.10±0.16
PCV	----- % -----			
4 wks	31.623±2.53	31.85±1.61	32.58±2.92	31.56±2.15
6 wks	30.74±1.86	28.79±8.20	31.90±1.88	31.33±1.96
mean	1.18±2.21	30.32±5.99	32.24±2.42	31.44±2.01
MCV	----- fL -----			
4 wks	148.30±4.74	150.68±4.55	149.19±4.95	150.64±4.84
6 wks	146.95±3.40	147.90±3.87	147.33±4.91	149.76±2.95
mean	147.63±4.09 ^a	149.29±4.36 ^{ab}	148.26±4.91 ^{ab}	150.20±3.95 ^b
MCHC	----- g/dL -----			
4 wks	35.78±1.31	36.13±1.40	35.97±2.07	36.78±1.45
6 wks	37.32±1.31	37.16±0.95	37.11±1.23	36.83±1.30
mean	36.55±1.51	36.64±1.29	36.54±1.76	36.80±1.35
MCH	----- pg -----			
4 wks	53.07±3.01	52.64±4.99	53.74±4.69	55.46±3.64
6 wks	54.86±3.08	54.98±2.50	54.71±3.39	55.17±2.51
mean	53.96±3.11	53.81±4.04	54.23±4.03	55.31±3.07

^{ab} Means within the same row without the same superscripts differ significantly (*P* < 0.05). RBC: red blood cell; Hb: hemoglobin; PCV: packed cell volume; MCV: mean corpuscular volume; MCHC: mean cor-

Seperber (1977) pointed out that 20% and 34% of the urine flow was transported into the caeca and 87-97% water of urine was absorbed in caeca. Chicks with no caecum, that were fed raw soybean to gain less weight, showed lower nitrogen retention than sham-operated chicks (Nitsan and Alumot, 1980). Therefore, the reabsorption of urine fluid in caecetomized goslings was retarded, meanwhile the serum uric acid concentrations decreased. It is interesting that caecetomy did not affect serum uric acid in caecetomized birds at 4 wks of age. This study suggested that further research should be required to resolve this problem whether the antiperistaltic transportation in gosling was more frequently at 6 wks of age than that of gosling at 4 wks of age.

Hematology

The caecetomized goslings had higher the mean value of MCV than that of sham birds during the whole experimental period. Microbial in poultry caecum could synthesis and absorb vitamin, e.g. thiamine, riboflavine, pantothenic acid, nicotinic acid, folic acid, biotin as well as vitamin B12 (Coates et al., 1968; Couch et al., 1950;

McNab, 1973), and the reason of the higher mean MCV value during the whole experimental period in caecetomized bird may be macrocyte and it caused the megaloblastic anemia due to vitamin B12 and folic acid deficiency (Tsang, 1994). However, there were not significant difference for Hb, RBC, PCV, MCHC MCH and MCV at 4 and 6 weeks of age among the treatments. Therefore, it indicated that the both caeca removed goslings may be in normal condition.

Based on caecetomy affecting serum potassium, magnesium, total cholesterol, uric acid concentration of goslings in this study, therefore, the role of caeca in goslings for digestive tract nutrient absorption, transportation and metabolism may be retarded after caecetomized.

A C K N O W L E D G M E N T S

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