

## A Study on the Back Flow of Urine into the Ceca in Chicken

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### 닭에서 맹장으로 역류하는 뇨(尿)에 관한 연구

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**ABSTRACT** : A cecostomy technique (surgery for inserted tube into ceca) was developed to quantify urine backflow into the ceca of fed and feed-deprived chickens. Two days post-surgery, cecostomised chickens were flushed with 20 ml of warm saline solution every other day for 10 days. Excreta were collected daily from cecal tubing and cloaca by surgical attachment of polyethylene collection vessels to the chickens. Uric acid excretion was significantly increased in fed compared to feed-deprived chickens ( $P<0.05$ ). Amount of determined uric acid from the ceca was 7.74 % and 5.31% of total excretion for fed and feed-deprived chickens, respectively. Post-mortem examinations ascertained that the caeca were intact around the Latex tubing.

The results of the study indicated that at least 5% of daily urine production flow retrograde into the ceca of roosters.  
(Key words : chickens, urine, backflow, ceca, cecostomy)

## INTRODUCTION

The ceca of birds consist of prominent and structurally distinct diverticula (McLelland, 1989) which open from the junction of the ileum and colon (Clark, 1978). In birds, ureteral urine drains into a posterior compartment of the cloaca, usually the urodeum, then moves anteriorly into the coprodeum, colon, and to a certain extent into the ceca and even the ileum (Akester et al., 1967). This retrograde urine transport towards the ceca in several species of birds has been demonstrated by a number of researchers (Domestic fowl, Akester et al., 1967; Japanese quail, Fenna and Boag, 1974; Rock ptarmigan, Gasaway et al., 1975; Domestic turkey, Bjornhag and Sperber, 1977; Guinea fowl, Bjornhag and Sperber, 1977; Domestic geese, Clemes et al., 1975).

While antiperistalsis from the cloaca to the colon and ceca

has been documented for a number of poultry species, it is not clear how much retrograde urine flow into the ceca occurs in the chicken.

Therefore, in the present study the amount of urine back flow into the ceca of roosters was quantified by inserting Latex tubing into the ceca. This paper describes the surgical procedure and post-operative management, and reports quantitative estimates of retrograde flow of urine into the ceca.

## MATERIALS AND METHODS

### 1. Animals and Presurgery

Male White Leghorn roosters 24 months of age and 2.5 kg body weight, were housed in individual wire cages in an environmentally controlled room at approximately 25°C. Food

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and water were supplied *ad libitum*. A 12-h light, 12-h dark schedule was maintained. Food was withheld for 12 h and water for 2 h prior to surgery. The roosters were restrained in dorsal recumbency for the surgical procedure (cecostomy). General anaesthesia was administered using Halothane gas (Halocarbon Laboratories, River Edge, NJ 07661). Roosters were induced and maintained under gas anesthesia using an anesthetic mask fabricated in our laboratory specifically for chickens. A slow anaesthetic induction was employed using 2.0 % anesthetic gas and an oxygen flow rate of 2 L/min. Upon achieving a surgical plane of anaesthesia, the oxygen flow rate remained constant at 2 L/min, and the anesthetic gas was maintained between 1.75 and 2.00 %. Systemic preoperative and postoperative antibiotic therapy was used to prevent infection and eliminate the need for daily injections of antibiotics postsurgery. Prior to preparation of the roosters for surgery, 300,000 IU of penicillin G procaine (Vedco Inc., St. Joseph, MO 64504) was administered subcutaneously. Feathers were removed from the surgical site and the skin scrubbed with betadine scrub (The Purdue Frederick Co., Norwalk, CT 06850). The chickens were then covered with a disposable surgical drape and a defect created in the drape to access the surgical site. Principles of aseptic surgery were observed to prevent complications of infection postsurgery, thus, surgical caps, surgical masks and sterile gloves were worn during the procedures by all individuals present.

## 2. A Surgical Process

A 5 cm paramedian skin incision was made on the left side of the abdomen, caudal to the costal arch. The incision was continued down through the muscle layers and peritoneum, exposing the distal ends of the ceca. The ends of the ceca were isolated and incised. Tygon tubing attached to a 20 ml syringe was inserted into the ceca, and the ceca flushed with 20 ml of saline solution (Son and Karasawa, 2000a) to remove the caecal contents. Approximately 2.5 cm of 10 cm length of Latex tubing (4.6 mm I.D., VWR Scientific West Chester, PA 19380) were inserted into the ceca, and secured in place by transfixing the tubing to the ceca with 2 simple interrupted stay sutures (Fig. 1). The body wall was closed in three layers; peritoneum, muscle and skin. During closure of the incision, the exposed tubing was transfixed to the body wall by 2 simple interrupted

stay sutures (Fig. 2). Immediately after completion of the procedure, 450,000 IU of Dual-Cillin (penicillin G and penicillin G benzathine; Phoenix Pharmaceutical, Inc., Loveland, CO 80538) was administered subcutaneously to maintain postoperative antibiotic blood levels. Two days after surgery, the tubing was flushed with 20 ml of warm saline solution every other day for 10 days.

## 3. Diets, Sample Collection and Analysis

Roosters were allowed two weeks for recovery and used in experiment. All chickens had free access to feed and water. The percentage composition of diet is as follows: 87.5 % corn, 9.6 % SBM, 1.5 % DCP, 0.7 % limestone, 0.4 % salt, 0.2 % vitamin and mineral premix, 0.05 % mold inhibitor, 82 g/kg crude protein and 3,740 kcal gross energy/kg.

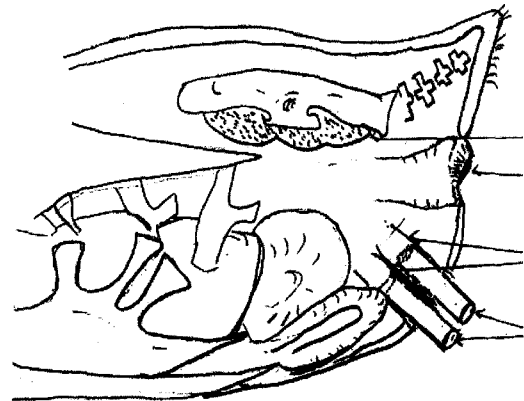


Fig. 1. Side view of the posterior half of the cecostomised rooster.

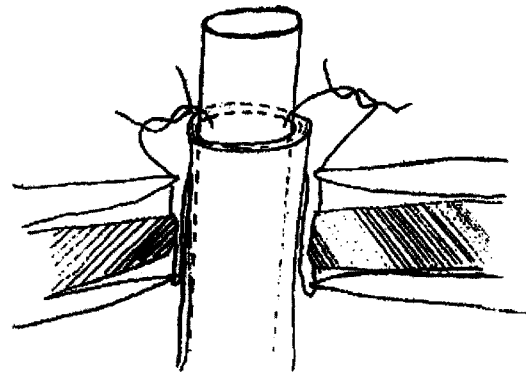


Fig. 2. Schematic diagram showing the procedure for fixation of Latex tubing.

Excreta were collected daily from the cloaca and cecal tubing by surgical attachment of plastic bags (Adeola et al., 1997) and polyethylene collection (Son et al., 2002) vessels to the roosters (Fig. 3). The plastic bags and polyethylene collection vessels were presprayed with 2 ml of 5 % HCl to prevent fermentation of the excreta and a change in nitrogen composition. The collected excreta were immediately sprayed with 5 % HCl and stored in a 80°C freezer. For analysis, the collected excreta was dried at 55°C for 48 h in a forced-air electric oven. The uric acid in excreta was determined by an enzymatic spectrophotometric method (Pudelkiewicz et al., 1968). Post-mortem examinations ascertained that Latex tubes are appropriately inserted into each caeca and the ceca were intact around the Latex tubing (Fig. 4).



Fig. 3. Picture of the bag and bottle attached to rooster for collecting cloacal and cecal contents.

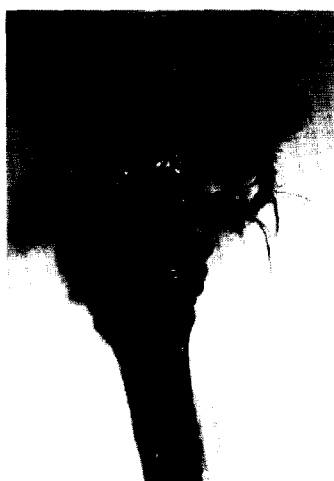


Fig. 4. Post-mortem examinations of cecal wall around latex tubings from cecostomised roosters.

#### 4. Statistical Analysis

Data were statistically analyzed by one-way analysis of variance and Tukey's test was used as the mean separation procedure (Steel and Torrie, 1960).

The surgery procedure, feeding and collection protocols were approved by the Purdue University Animal Care and Use Committee.

## RESULTS

In 6 of 12 roosters, the cecal tubing functioned well for 4 weeks after surgery with few complications. The new method described in this study required minimal maintenance post-surgery to keep birds healthy and in suitable condition. In 2 of 12 cecostomised roosters were euthanised because the skin surrounding the cecal tubing gradually encroached on the cecostomy site after surgery. Four of 12 cecostomised roosters did not convalesce satisfactorily post-surgery and were thus euthanised. Postmortem examination of these 4 roosters revealed haemorrhage and damage to the mesentery and/or blood vessels around the cecostomy site. These 4 of 12 cecostomised roosters that did not convalesce satisfactorily experienced large reductions in body weight and had reduced feed and water intake post-surgery. Affected roosters assumed a vulture-like posture. The cecostomised birds should be caged individually and allowed *ad libitum* access to food and water after awakening from anaesthesia. After surgery birds may temporarily lose appetite and activity, but they are restored gradually in a few days. The incision usually heals within 10 d post-surgery.

Table 1 illustrates the effect of cecostomy on uric acid excretion from fed and feed-deprived roosters. Amount of uric acid excretion was significantly increased in fed roosters. Uric acid content of the ceca was 7.74 % and 5.31% for fed and feed-deprived roosters, respectively.

## DISCUSSION

The surgical technique used in the study allowed us to accomplish our study objective. The roosters produced excreta

**Table 1.** An observation of cecostomy on uric acid excretion in rooster

Treatments	Total	Cecum	Cloaca
Feeding	450.9a	34.9b	416.0a
Fasting	151.0a**	8.0b**	143.0a**
SEM	54.7	2.6	54.3

Values are means of 6 birds.

a,b: Significantly different from each other in the same diet  
P<0.01.

\*\* : Significantly different from each other in the same source  
P<0.01.

with a soft, sticky consistency immediately after surgery that gradually normalized 5~7 days post-surgery. In a study such as this, the amount eaten and excreted should be noted each day after surgery to detect possible problems with the cecostomized birds. In this study, cecostomized roosters were in suitable condition after surgery and their feed intakes were similar.

Average dry matter intake was 25 to 40 grams/ kg BW/ day for conventional and cecostomized roosters used in the experiment. Birds regained most of their body condition within 5 days post-surgery. We assume that the roosters would have regained their lost weight more rapidly if they had not been handled frequently post-surgery. Average weight gains were usually between 10 and 30 grams/ day of body weight in healthy chickens that were accustomed to handling. Previously, it was reported that birds had a greatly increased water turnover after cecal ligation, cecectomy and colostomy (Son and Karasawa 2000b,c; Son et al., 2000). Following surgical preparation of the cecostomized roosters, water consumption and excretion were increased, but not as much as observed with colostomy.

In birds, urine contains uric acid as a major end product of nitrogen metabolism instead of urea in mammals (O'Dell et al., 1960). Urinary excretion of uric acid is nearly 100 % in the chicken (Karasawa and Maeda 1992, 1994). Retrograde movement of urine from the urodeum into the colon and caeca of birds via colonic antiperistalsis (Lai and Duke, 1978) is well known (Koike and McFarland, 1966; Akester et al., 1967; Fenna and Boag, 1974; Rhoades and Duke 1977; Duke, 1989). This would deliver urinary constituents to the caeca. These

results are the first report of quantitative estimates of urine backflow into the caeca in the chicken. The results of the study raised two pertinent questions. How are the bacteria of the caeca affected by cecostomy, and how do changes in cecal microflora impact uric acid content of excreta? These are important issues since it is possible that the degree of degradation of urinary uric acid in the caeca (Barnes and Impey, 1974; Mortensen and Tindall 1981) and of the ileo-cecal-colic junction (Karasawa et al., 1994) may affect recovery of nitrogen from cecostomized roosters. Another concern regarding the procedure is the effect of cecostomy on lower gut function and urine movement into the caeca. It is concluded that 7.8 % or 5.3 % of daily urine production flows anteriorly from the urodeum to the caeca in fed or feed-deprived roosters, respectively.

The results of the study indicated that at least 5 % of daily urine production flow retrograde into the caeca of roosters.

## 적 요

닭에서 맹장으로 뇨의 역류량을 측정하기 위해서 사료급여 및 절식의 조건에서 Cecostomy(맹장으로 튜브를 삽입하는 수술) 기술이 개발되었다. 시술 이틀 뒤부터 맹장에 튜브가 장착된 닭은 20ml의 따뜻한 생리적 식염수를 이용하여 격일 간격으로 10일동안 수술부위를 환류시켰다. 맹장에 장착된 튜브와 총배설강에 외과적으로 시술된 플라스틱 채집병을 이용하여서 배설물이 매일 모아졌다. 요산 배설량은 사료채식시가 절식시 보다 유의하게 증가하였다 (P<0.05). 맹장을 통해서 검출된 요산의 양은 사료급여시와 절식시에 각각 총 요산 배설량의 7.74, 5.31%를 나타내었다. 사후검사에서 맹장에 삽입되었던 고무튜브 주위를 둘러싸고 있는 완벽한 맹장이 확인되었다. 본 연구의 결과 수탉에서 적어도 매일 약 5%의 뇨가 맹장으로 역류됨을 알 수 있었다.

(색인어 : 닭, 뇨, 역류, 맹장, 맹장수술)

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