A NOTE ON THE BILIARY SYSTEM OF THE DOMESTIC DUCK AND A METHOD FOR COLLECTING BILE

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INTRODUCTION

One aspect of the continuation of our earlier work on the environment of the acanthocephalan parasite Polymorphus minutus in the intestine of domestic ducks (Crompton & Nesheim, 1970) made it necessary to devise a surgical method for preventing bile from entering the duck's intestine. In outline, the method was to ligate the bile ducts and to cannulate the gall-bladder so that all the bile synthesized in the liver could be collected and jaundice avoided. The method is described in this paper since it may be useful to others studying nutrition and digestion in other animals besides ducks.

The development of the method needed some knowledge of the morphology of the duck's biliary system. This information does not appear to be readily available in the literature and we include our observations to supplement those of Weber & Ferret (1903).

MATERIALS AND METHODS

All observations and surgical techniques were carried out on male Pekin ducks varying in age from 21 to 47 days. The ducks were allowed to feed ad libitum on water and on a diet which contained, in 106.015 g: yellow maize, 58.75 g; soybean meal, 35.00 g; maize oil, 5.00 g; alfalfa meal, 2.00 g; dicalcium phosphate, 2.00 g; limestone, 1.00 g; sodium chloride, 0.25 g; vitamin mixture (Crompton & Nesheim, 1969), 1.00 g; chromic oxide bread, 1.00 g; magnesium sulphate, 0.01 g; and zinc oxide, 0.005 g.

Morphological observations were made by dissection of both freshly killed, unfixed ducks and material fixed for 24 h in 5% formalin. In some freshly killed specimens cannulae were inserted into both bile ducts, the bile was drained and coloured latex was injected under gentle pressure. One duck was starved for 7 h before being forcibly fed with three tablets of iopanoic acid (Telepaque, Winthrop Laboratories, N.Y.). This duck was allowed water only for an additional 16 h before a radiograph was taken of the abdominal region.

Food was withheld from ducks destined for surgery for at least 4 h before anaesthesia was induced with a mixture of ether and oxygen. Details of the surgical procedure and the design of the apparatus for collecting the bile are given below.

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The morphological observations are shown in Figs. 1 and 2. Dissection of eight specimens revealed that the cysto-enteric duct drains the right lobe of the liver and the hepato-enteric duct drains the left lobe of the liver, both ducts entering the distal portion of the ascending limb of the duodenum. These observations confirm those of Weber & Ferret (1903), whose fig. 1 is very similar to Fig. 2. We made, however, one major additional observation. The cysto-hepatic duct and the hepato-enteric duct join to form a sinus into which are directed several of the biliary vessels from the liver (Figs. 1 and 2, s.). Some vessels enter the cysto-hepatic duct directly and some enter the hepato-enteric duct directly, but the presence of the junction or sinus means that bile from the left lobe of the liver may reach the gall-bladder and bile from the right

Fig. 1. The gall-bladder, bile ducts and principle biliary collecting vessels of a domestic duck. The arrow indicates the direction of intestinal flow. a.d., ascending limb of duodenum; ce.d., cysto-enteric duct; ch.d., cysto-hepatic duct; g., gall-bladder; h.d., hepato-enteric duct; l.f., longitudinal fold; r.t., possible reabsorptive tissue; s., sinus.
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Fig. 2. The region of the duck involved in the operation to fit the collection apparatus, a.d., ascending limb of duodenum; ce.d., cysto-enteric duct; ch. d., cysto-hepatic duct; d.p.l., dorsal lobe of pancreas; f., fundus; g., gall-bladder; h.d., hepato-enteric duct; h.p.v., hepatic portal vein; i., incision; l.l., left lobe of liver; p.d.s., pancreatic ducts; r.l., right lobe of liver; s., sinus; sp., spleen; s.f., surgical field; t., ventriculus; v.p.l., ventral lobe of pancreas. The gall-bladder been displaced during dissection and is shown diagrammatically.

lobe may be discharged into the duodenum through the hepato-enteric duct. Additional evidence for the connexion between the bile ducts is the fact that injection of material into the hepato-enteric duct fills the gall-bladder; this could not occur if the lobes of the liver were drained separately and there were no junction between the cysto-hepatic and the hepato-enteric ducts. We do not claim to have made the first observation of this junction between the bile ducts, but we have not yet found a description of it in the literature.

In specimens injected with latex, longitudinal folds, like those described by Weber & Ferret, were seen to be present in the wall of the gall-bladder (Fig. 1, l.f.). In other specimens the wall of the hepato-enteric duct below the sinus was seen to be distended and to possess a few striations which looked like the folds of the wall of the gall-bladder. About half of the ducks used for the morphological and surgical work had swollen hepato-enteric ducts, and on the basis of the longitudinal folds it is tempting to suggest that the region labelled ?r.t. in Fig. 1 could be tissue capable of concentrating bile by reabsorption.
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Apparatus

The reservoir, attachment unit and plug are made from perspex and assembled on polyethylene tubing (Intramedic, I.D., 0.045 in. and O.D., 0.062 in., Clay Adams, Parisippany, N.J.) as shown in Fig. 3. The tubing is supported by wrapping thin wire around it, the loose end of the wire being embedded in the epoxy resin (Araldite) used to attach the plug to the tubing.

Surgical procedure

1) After anaesthesia has been induced and the duck has been secured in a supine position, the surgical field (Fig. 2, s.f.) is cleared of feathers and cleaned with 70% ethanol.

2) Radiographs showed that the gall-bladder is found to the right of the sternum near the most posterior rib. A sagittal incision about 4 cm in length is made through the skin caudad to the sternum and then through the body wall and peritoneum as shown in Fig. 2. Swabs of cotton-wool are used to hold the lobes of liver away from the site of the bile ducts.

3) The adipose and connective tissue in the region where the bile ducts are expected to be found are cleared away, care being taken to avoid damage to the pancreatic ducts and hepatic portal vein. The hepato-enteric duct, which is the more ventral of the ducts, is freed from surrounding tissues and a cotton ligature is tied round it. The cysto-enteric duct is not so easy to locate but can be found by dissecting the connective tissue away from the gall-bladder until the point of exit of the duct is seen. The cysto-enteric duct is then ligated. The ends of the ligatures are not cut off but are held with a haemostat, the weight of which helps to pull the ducts and the gall-bladder nearer to the region of the incision.

4) The fundus of the gall-bladder (Fig. 2, f.) is grasped with forceps, connective tissue is cleared away and small cotton-wool swabs are placed around and behind the
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Fig. 4. The collection apparatus in position in a duck.

gall-bladder. While the fundus is held, bile is withdrawn with a hypodermic needle and syringe. The point of insertion of the needle is opened with fine scissors and the plug of the cannula is pushed into the gall-bladder. The wall of the gall-bladder is now tied firmly round the corrugated plug; two cotton ligatures are sufficient to ensure strong attachment with no leakage of bile into the body cavity of the duck.

(5) All the swabs are removed, the free ends of the ligatures round the bile ducts are trimmed and about 50 mg of penicillin (Mylipen Q.R. Cerate, Glaxo Laboratories Ltd., England) are applied to the gall-bladder and bile ducts.

(6) The body wall is closed with sutures and the plate (Fig. 3) is attached with three sutures to the outer surface of the body wall. The skin is then sutured over the top of the plate which serves to anchor the apparatus in the duck. The surgical field is again cleaned with 70% ethanol and sprayed with a plastic dressing (Norbecutane, B.D.H. Pharmaceuticals, London). The reservoir is screwed into position on the threaded portion of the attachment unit and the duck, having the appearance of that shown in Fig. 4, is returned to food and water about 1 h after the induction of anaesthesia.

Once the design of the apparatus was considered to be satisfactory, the operation was performed successfully on each of 16 ducks. All of the ducks were allowed to survive for at least 24 h and one for 5 days. No sign of jaundice, bile leakage, adhesion or internal infection was found at post-mortem. Collection of bile is simple; the full reservoir is unscrewed and replaced by another empty reservoir when necessary.

SUMMARY

1. The morphology of the biliary system of the domestic duck is described. There is a connexion between the hepato-enteric and cysto-hepatic ducts. Consequently, the bile secreted in the right and left lobes of the liver need not drain separately into the duodenum via the cysto-enteric and hepato-enteric ducts respectively.

2. A simple apparatus and method for collecting bile from ducks is described. The method could easily be modified for other animals which possess a gall-bladder.

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REFERENCES


