Cairo University
Faculty of Veterinary Medicine
Anatomy and Embryology Department

Comparative Anatomical Studies on the Gastrointestinal Tract of the Rabbits and Cats with Special Reference to their Venous Drainage

Thesis Presented by

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(M.V.Sc., Cairo University, 2011)

Thesis submitted to
Cairo University
Faculty of Veterinary Medicine
For the Degree of Ph.D (Anatomy and Embryology)

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2015

Cairo University
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Dedication

*To **Aya,***

*I Dedicate This Dissertation To **Aya;** My **Wife**.*

*To My great **Father** and **Mother**.*

*To My Brothers **"Emam – Bassem"**.*

*To My Beloved Sisters **"Fatma – Shaymaa"**.*

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Specialization: Anatomy & Embryology. **Degree:** Ph.D.

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ABSTRACT

In the present study, the rabbit was chosen as a true herbivore while the cat was chosen as a typical carnivore. Both animals were nearly similar in size.

The study was carried out on twenty clinically healthy adult animals of both species and of both sexes. For the gross anatomical studies, external and internal description of the different organs of the gastrointestinal tract as well as its venous drainage was recorded. Also, light, histochemical as well as transmission electron microscopical studies were performed. The obtained results were confirmed by photographs and discussed with the available literatures, aiming to give an adequate data about the relation of the form and structure of the stomach and different parts of the intestine with the type and amount of food consumed by these animals.

(**Key words:** Rabbits – Cats – GIT – Macroscopic and microscopic anatomy – Venous drainage).

ACKNOWLEDGMENT

*I would like to express my greatest appreciation and sincere thanks to my supervisors, Prof. Dr. **S. M. Hagrass**, professor of anatomy & embryology, faculty of veterinary medicine, cairo university, Prof. Dr. **M. A. El-Sakhawy**, professor of cytology & histology, faculty of veterinary medicine, cairo university, Prof. Dr. **Fouad M. Farag**, professor & head of the anatomy & embryology department, faculty of veterinary medicine, cairo university and Dr. **Shaymaa H. M. Hussein**, lecturer of cytology & histology, faculty of veterinary medicine, cairo university for their valuable supervision, guidance, continuous encouragement and patience during preparation of this work.*

*My cardial appreciation to Dr. **Nora A. Shaker**, lecturer of anatomy & embryology, faculty of veterinary medicine, cairo university for her help and guidance during my entire practical work.*

*Finally, I wish to express my grateful acknowledgment to my **colleagues** in the anatomy & embryology department for the continuous encouragement.*

INTRODUCTION

The stomach and intestine were closely associated in function and were collectively known as the gastrointestinal tract. In the stomach the processes of digestion were initiated. The small intestine constituted the principal organ of digestion and absorption, while the large intestine specifically concerned with dehydration of food residue **(Frandson, 1981** and **Colville** and **Bassert, 2002)**.

There was a relationship between the size of the different organs of the gastrointestinal tract and the amount of food intake as well as the type of the diet. The concentrated diet of carnivores was most easily digested and these animals had small and uncomplicated intestine. The fodder of herbivores had a low nutritive value and must be consumed in large amounts. Moreover, the major part consisted of cellulose and other complex carbohydrate. These substances could be utilized only if they were first breakdown by microorganism, this required a large fermentation chamber. In some herbivores species such a chamber was supplied by a greatly enlarged and subdivided stomach, in others by a voluminous and complicated intestine. Ruminants illustrated the first alternative, the horse the second **(Dyce *et al.*, 2002)**.

According to **Davies** and **Davies (2003)** the rabbit was true non-ruminant herbivores. Its digestive tract radically differed to that of better herbivores such as the ruminants (gastric fermenter) and the horse (colon fermenter). The digestive tract of rabbit made a complete separation of the cecal fermentation and the feces, allowing reingestion and absorption of the cecal rich nutrients in the small intestine (Cecotrophy).

Murray (2005) recorded that the rabbit was a monogastric hindgut fermenting herbivores. Their smaller size limited the amount of coarse fiber that might be stored for bacterial and protozoal digestion. The rabbits system allowed the rapid removal of coarse fiber from the gastrointestinal tract, while retaining the more digestible less coarse portion of the diet for cecotrophy. He also added that, while it was not important as a fermentable nutrient, the coarse fiber was critically important for the maintenance of the normal gastrointestinal motility.

The rabbit was widely distributed animal species, commonly used for economical purposes and as a model for numerous medical experiments, while the domestic cat was a pet animal and represent a typical carnivore. Furthermore, the rabbit simulated the cat in their smaller size and the monogastric stomach. The question thus arose, how the different organs of the gastrointestinal tract of an herbivore differed in form, size and structure from that of a carnivore. Therefore, the present study was carried out to high light on the gross morphology, including the venous drainage, and microscopic anatomy of the different organs of the gastrointestinal tract in rabbits and cats and its adaptation to the type of food consumed by these animals.

MATERIAL AND METHODS

Twenty clinically healthy adult rabbits and twenty clinically healthy adult cats of both sexes had been studied. The animals were of Balady breeds and weighing from 2 to 2.5 kg. After ether anesthesia, the animals were killed by exsanguination through the common carotid artery.

Macroscopic dissections and observations were carried out on eight animals of both species, dissected fresh, and other six were fixed by arterial perfusion with 10 % neutral buffered formalin. The dissection was performed via one median and two transverse incisions of the soft abdominal wall to expose at maximum the abdominal viscera.

To follow the blood vessels of the gastrointestinal tract, the extrahepatic part of the portal vein, just before the hepatic porta as well as the abdominal aorta, of the fresh specimens, were injected by colored latex neoprene. The specimens were fixed in 10 % formalin for 2-3 days and then dissected to follow up the tributaries of the portal vein with their satellite arteries through the abdominal organs.

The findings were documented with a digital photo camera ***Nikon COOLPIX L310 14.1 Megapixels*** in 36 photos. As the rabbit was not included in the **NAV (1994)**, therefore the anatomical nomenclatures used in the present study were adopted to the terminology of **Barone (1997, 2001)** as well as to the recent available literatures.

For microscopic investigations, six clinically healthy adult animals of both sex and of both species were used. The animals were nearly having the same size.

Distribution of samples used for general Histological and Histochemical studies:

Rabbit samples	Cat samples
• **Stomach:** Cardiac – fundic – pyloric regions • **Intestine:** - **Sacculus rotundus** - **Cecum** - **Vermiform appendix** - **Ascending colon** - **Fusus coli** - **Anal canal**	• **Stomach**: Cardiac – fundic – pyloric regions • **Intestine:** - **Cecum** - **Anal canal**

I- **<u>Light microscopy</u>**:

- Samples were immediately fixed in 10% neutral buffered formalin, dehydrated and embedded in paraffin blocks.
- Paraffin sections 5-6 µm were stained using the following methods:
  1) **Harris Haematoxylin and Eosine (H & E)** stain for general tissue structure studies.
  2) **Masson's trichrome** stain for demonstration of collagenous fibers and smooth muscle cells.

The aforementioned methods were used as outlined by **Drury** and **Wallington (1980)**.

II- **<u>Histochemical studies</u>**:

The paraffin sections for histological studies were stained with:

1) **Periodic Acid Schiff (PAS)** for detection of neutral mucopolysaccharides and glycoproteins.
2) **Alcian blue** pH 2.5 for demonstration of acidic mucopolysaccharides.
3) **Grimulis argyrophil** stain for demonstration of enteroendocrine cells.

These techniques were used as outlined by **Carson (1990)**.

III- **<u>Transmission Electron Microscopy (TEM)</u>**:

Small tissue blocks from fundic region and cecum of adult male rabbits and cats were fixed in parafolmaldehyde-gluteraldehyde in phosphate buffer **(Karnovsky, 1961)**. Specimens were post fixed in 1% **osmium tetraoxide** for one hour, washed in 0.1 M phosphate buffer (pH 7.3), then dehydrated in graded ethanol and embedded in Epon araldite mixture **(Mollenhauer, 1964)**. **Semithin sections** (1 µm) were cut, stained with toluidine blue **(Richardson *et al.*, 1960)** and examined with light microscope. **Ultrathin sections** were cut and stained with **uranyl acetate** and **lead citrate**.

The sections were examined under **JEOL 1010** transmission electron microscope at **Regional Center for the Mycology and Biotechnology (RCMB), Al-Azhar University, Cairo, Egypt.** The histological results were documented with 71 photos.

REVIEW

1.1. The stomach:

Nickel *et al.* (1973) recorded that the stomach of the domestic mammals differed with the nutritional habits that had involved and the kind of food that was usually consumed. They added that there were differences not only in the external shape and position of the organ but also in the composition of its lining.

Jordan and **Verma (1983)** and **Thakur** and **Puranik (1984)** described the stomach of the rabbit as a thin-walled curved sac-like structure, situated behind the diaphragm on the left side of the abdominal cavity. They divided the stomach into a broad cardiac region, a narrow pyloric region and a fundic region interposed between the two. However, **Ghoshal** and **Bal (1989)** mentioned that the rabbit`s stomach was large, simple and thin wall without specialized regions. Meanwhile, **Davies** and **Davies (2003)** and **Brewer (2006)** mentioned that the rabbit`s stomach was demarcated into three portions; the cardiac portion, was large, thin-walled and nonglandular, the fundus, was the major secretory organ and the pyloric region had a much thicker muscular wall.

On the other hand, **Colville** and **Bassert (2002)** reported that the monogastric stomach was generally divided into five regions; the cardia, the fundus, the body, the antrum and the pylorus. They added that the pylorus was the muscular sphincter that communicated the stomach with the small intestine and regulated the movement of the chyme from the stomach to the duodenum, thus it prevented backflow of duodenal contents into the stomach.

Pasquini *et al.* (1997) mentioned that the cardiac, fundic and pyloric gland regions lining the stomach did not necessary corresponding to the external area of the same name.

Davies and **Davies (2003)** and **Delaney (2006)** cited that the stomach of the rabbit comprised about 15 % of the volume of the gastrointestinal tract and normally the stomach was never empty in a healthy rabbit. **O'Malley (2005)** and also **Delaney (2006)** stated that the stomach normally contained a mixture of food, hair and fluid even after 24 hours fasting.

Pérez *et al.* (2005) reported that most of the greater omentum in the rabbit was on the right side of the abdominal cavity and attached the stomach to the whole length of the transverse colon, with irregularly distributed fat tissue. Also they described a very thick gastropancreatic fold, while the lesser omentum did not have fat tissue.

Regarding the stomach in the cat, **Sebastiani** and **Fishbeck (2005)** described the stomach as a J-shaped organ lying mainly on the left side of the body, and differentiated the stomach into four regions; the portion of the stomach below the cardiac sphincter was the cardiac region, and the narrow portion connected to the intestine was the pyloric region and the large inflated portion between these two ends consisted of the upper fundus and the lower body.

De Lullis and **Pulera` (2007)** mentioned that the pyloric sphincter appeared as a slit-like opening in the distal wall of the cat stomach, and also recorded numerous longitudinal folds or rugae lining the gastric mucosa. They added that, posterior to the stomach, the greater omentum formed a large, double-layered fat-laced mesentery called the omental bursa that covered the intestine like an apron and extended posteriorly to the urinary bladder.

1.2. The small intestine:

Snipes (1978) described that, in the rabbit, the large size and the position of the cecum ventrally, displaced the intestine dorsally and laterally in the abdominal cavity. He also added that the duodenum proceeded in its course from the right to the left forming U-shaped loop. The jejunum and the jejunal-ileal junction were found on the left side of the abdomen, dorsal to the cecum and behind the stomach, and appeared convoluted.

Pérez *et al.* (2011) asserted that the duodenum of the chinchilla started at the pylorus with a cranial dilated portion, directed to the right, forming the duodenal ampulla then followed by the cranial flexure and continued to form U-shaped tube.

Unlike the situation in most mammals, the common bile duct and the pancreatic duct in the rabbit entered the duodenum at widely separated points, as the bile duct opened near its origin, in the descending duodenum, while the pancreatic duct entered its terminus, in the ascending duodenum **(Thakur** and **Puranik, 1984; Wingerd, 1985; Brewer, 2006;** and **Delaney, 2006)**.

Amitrano and **Tortora (2006)**, in the cat, observed that the common bile duct and the pancreatic duct opened into the duodenum near the pyloric sphincter at an enlargement called hepatopancreatic ampulla.

Davies and **Davies (2003), Brewer (2006)** and **Delaney (2006)** stated that in rabbits, both jejunum and ileum were not well differentiated from each other, although the jejunum appeared convoluted and formed numerous jejunal coils, the ileocecal ligament might be used as a line of demarcation between the two. **Brewer (2006)** also added that the jejunum was less vascular and its wall was less thick than the duodenum and ileum.

According to **Jordan** and **Verma, 1983; Thakur** and **Puranik, 1984; Donelly, 1997; Jenkins, 2000; Davies** and **Davies, 2003;** and **Brewer, 2006;** the terminal part of the ileum was modified to form the sacculus rotundus as a round, thick-walled sac, while **Wingerd, 1985; Murray, 2005;** and **Delaney, 2006;** described it as a muscular enlargement. Both, **Brewer** and **Delaney** called it the cecal tonsil because of its lymphoid tissue and macrophage composition. All the previously mentioned authors were in agreement that the sacculus