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Original Article

Topographical and biometrical anatomy of the digestive tract of White New Zealand Rabbit (*Oryctolagus cuniculus*)

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ABSTRACT

Objective: This study was constructed to build up the normal dimensions of the digestive tract of domestic Rabbit (*Oryctolagus cuniculus*).

Materials and methods: Five rabbits of both sexes were used in this study. After dissection of the rabbits, the exact positions of different parts of the digestive tract (*i.e.*, esophagus, stomach, small intestine, large intestine) were measured using Metric rule, thread, electronic and normal balance.

Results: The mean lengths of the small intestine and large intestine were 169.53±21.65 and 132.3±17.42 cm, respectively, and weight of the whole digestive tract was 263.60±56.80 gm. The mean lengths and mean diameter of esophagus, duodenum, jejunum, ileum, cecum, colon and rectum were 9.62±1.64, 41.26±4.06, 106.60±14.64, 21.64±46.32, 41.14±2.82, 83.16±13.74 and 8.0±1.08 cm and 1.16±0.12, 1.71±0.11, 1.70±0.09, 1.73±0.05, 5.47±0.15, 3.36±0.16 and 2.81±0.24 cm, respectively.

Conclusion: These results can be considered as a baseline study that may assist in disease diagnosis and clinical works with rabbits.

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KEYWORDS

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INTRODUCTION

Rabbits are natural burrowing herbivores that are considered as prey species. The domestic rabbit (*Oryctolagus cuniculus*) have been originated from the European wild rabbit. Over centuries, man used the rabbit for various purpose such as clothing, food, sport, scientific model and a hobby (Meredith, 2001).

The laboratory rabbit (*Oryctolagus cuniculus*) is belonging to the the family *Leporidae*. Three breeds are commonly used in the laboratory; the Dutch Belted (1.5-2 kg), the New Zealand White (5-6 kg); and the Flemish Giant (8-9 kg) (Nathan, 2006).

In Bangladesh, use of laboratory animals like rabbits, guinea pigs and rats is increasing day by day. The rabbits are considered as an excellent source of lean meat having good quality proteins. The anatomical knowledge is crucial for surgery and radiological studies.

Now-a-days rabbit are being used in human related scientific researches like digestibility trials, drug resistance trials in which digestive physiology, absorption criteria are very vital parameters. For doing these kind of research works, clear idea about topography and biometry of digestive tract is very much essential.

Now-a-day, rabbits are considered as economically important animals. The rabbit has already become considered to add in the meat production in Bangladesh. In spite of having these promising demands of this animal in future, the anatomical performance of different systems should be studied.

Despite of being a very familiar one, few works has been reported on morphology, physiology and pathology of digestive system of rabbit in different countries (Meredith, 2001; Cathy, 2006; Obadiah et al., 2011). So, little knowledge about the topography and biometry of digestive tract of White New Zealand rabbit is available. To maintain a good nutritional status, biometrical knowledge of the digestive organs of rabbit is crucial. The biometry of digestive tracts reveals the overall well-being of the animals. The knowledge of the biometry of digestive tract is essential to gain desirable live weight and facing the digestive problems and its treatment.

MATERIALS AND METHODS

Study location and time period: The study was constructed on 5 adult clinically healthy White New Zealand Rabbit (*Oryctolagus cuniculus*) of both sexes (**Figure 1**) which were bought from local market of Chittagong city during November 2011 to February 2012. The animals were transported using laboratory rabbit cages from the local market to the laboratory, Chittagong Veterinary and Animal Sciences University (CVASU). The animals were accustomed to new climate for one day prior to the research and had access to green grass, commercial feed supplement and water *ad libitum*.

Laboratory preparation: Before the measurement, all equipments were collected and prepared in the laboratory. Surgical equipments like scissors, scalpel, and forceps were sterilized.

Euthanasia of the animal: After physical examination, the animals were observed to be in good nutritional status before euthanasia. They were all euthanized by Diazepam dosed at 10 mg/kg intravenously introduced through the external jugular vein. The experiments were conducted by following ethical standards set by the Chittagong Veterinary and Animal Sciences University.

Dissection of the rabbits: All animals were weighed, euthanized and punctually dissected. The dissection was performed via one median-longitudinal incision on the ventral abdominal wall to expose the thoracic and abdominal viscera (**Figure 1**). After this, the entire digestive tract of each animal was dissected out (**Figure 1**) by giving ventral longitudinal incision.

Topographical examination and Biometrical measurement: Length of different parts of the digestive tract were recorded in centimeter (cm) using a calibrated scale and thread. Along with the length, the weight was recorded in gram (gm) using the sensitive electronic balance.

After cleaning the organs, the adhering tissues were removed. The organs were placed on a table in normal position. The intestinal tract was separated after studying topographical position. The pylorus was cut-off just before the duodenum, and was separated from the dorsal abdominal wall. The rectum was tied off at its union with the canal-anal and transected. The lengths of the different sections of the intestinal tract on the anti-mesenteric side were taken with a standard metric rule after removal of all mesenteric attachments. Stomach (**Figure 1**) and intestine contents were measured by weighing the unopened organs and then re-weighing it after been opened and contents were rinsed with tap water and dried with paper towels. Examination of the digestive tract was done under much light. The results were recorded and tabulated.

Statistical Analysis: All measurements were recorded in a tabulated form. The tabulated data were entered into Microsoft excel worksheet and analyzed for descriptive statistics. All of the data were tested using SPSS (version-16).

RESULTS

The mean length, diameter weight in White New Zealand rabbit are shown in **Table 1**. **Table 2** shows mean weight and circumference of stomach. Table 3 displays the mean length, diameter, weight of small intestine and Table 4 shows the mean length, diameter, and weight of large intestine of White New Zealand rabbit.

Esophagus

Esophagus is a muscular tube which extends from pharynx to stomach. It is the first part of the digestive tract. It was investigated that the cervical part of the esophagus situated dorsal to the trachea and ventral to the ventral cervical muscles. It extended from the pharynx to the thoracic inlet. At the thoracic inlet, it maintained its position dorsal to the trachea and runs as the thoracic esophagus, until it reached the trachea bifurcation and lay between the lung lobes.

The mean length of esophagus was recorded as (9.62±1.64) cm in White New Zealand rabbit (**Table 1**) and (**Figure 1**). The mean weight of esophagus was (1.57±0.278) gm in White New Zealand rabbit (**Table 1**). The mean diameter of esophagus was recorded (1.16±0.12) cm during the study.

Stomach

The rabbit stomach was observed of simple monogastric type. It was J-shaped, thin walled and located on the left of the median plane. The fundic part was comparatively big. The pyloric part was found well developed and connected with the fundic part. Esophagus opened into the lesser curvature.

The pylorus was anteriorly extended to the plane that goes through the 7th intercostal area, and was directed dorso-laterally and nearness to the dorsal part of the rib wall. The cardia was situated at the near of the 4th to 5th rib and the horizontal line, passing through the coxal tuberosity. The papillary process of the liver was positioned in the angle between the cardia and the lesser gastric curvature. The greater curvature was descending ventro-caudally, without touching the soft abdominal wall.

On the left, the stomach was passing cranially through the 9th intercostal space and caudally through the 12thintercostals space. The stomach was nearness to the visceral surface of the liver and from the 10th to the 12thintercostals space, was adjacent to the rib wall. Dorsally, it located with the diaphragmatic crura and the proximal part of ribs.

Table 1. The mean length, diameter and weight of esophagus of White New Zealand rabbit

Organ	Parameter	Mean±SD
Esophagus	Length (cm)	9.62±1.64
	Diameter (cm)	1.16±0.12
	Weight (gm)	1.57±0.278

Table 2. The mean weight and circumference of stomach of White New Zealand rabbit

Organ	Parameter	Mean±SD
Stomach	Weight (gm)	
	With content	48.114±20.09
	Without content	24.44±12.04
	Circumference (cm)	
	Cardiac	13.811±1.029
	Fundus	10.50±0.466
	Pylorus	10.04±0.349

Table 3. The mean length, weight and diameter of small intestine of White New Zealand rabbit

Organ	Parameter	Mean±SD
Duodenum	Length (cm)	41.26±4.06
	Weight (gm)	
	With content	9.682±1.95
	Diameter (cm)	1.71±0.11
Jejunum	Length (cm)	106.60±14.64
	Weight (gm)	
	With content	31.00±4.64
	Diameter (cm)	1.70±0.05
Ileum	Length (cm)	21.64±6.32
	Weight (gm)	
	With content	2.99±0.143
	Diameter (cm)	1.73±0.05

In this study, the mean weight of stomach with content was recorded as (48.114±20.9) gm and without content was (24.44±12.04) gm (**Table 2**). The mean circumference on cardiac part was (13.811±1.029) cm, on fundus part (10.50±0.466) cm and on pylorus part (10.04±0.349) cm (**Table 2**). The wall of the pyloric part was found comparatively thicker and few transverse folds were found on that part.

Small Intestine

The small intestine originates from pylorus and terminates at the ileocecal orifice, which consists of three parts- Duodenum, jejunum and Ileum.

Duodenum

The duodenum was found comparatively longer in White New Zealand rabbit. It began at the pylorus, passed dorsally and caudally at the visceral surface of liver. It was found to form an "S" shaped curve. Then it passed further caudally to the level of coxal tuber which called the descending duodenum. Then it again turned cranially by forming a caudal flexure and at last continues as the ascending duodenum. In this study the mean length of duodenum was found (41.26±4.06) cm. The mean diameter was recorded (1.71±0.11) cm and mean weight was found (9.682±1.95) gm.

Jejunum

It consists of most the length of the small intestine and comprises of a good number of close coils, attached to the border of mesentery. The close coils were found constricted and dilated and formed U-shaped tubular loops by the attachment of the mesentery. The loops were inserted towards the ventral margin of the liver along with the gall bladder. The jejuna loops were observed to be situated above the cecum and behind the stomach. Network of blood vessels was found arranged in few layers of arches in the mesentery. In this study the mean length of jejunum was (106.60±14.64) cm and diameter was (1.70±0.05). The mean weight was noted as (31.00±4.64) gm (**Table 3**).

Ileum

Ileum is the terminal part of small intestine and a thick tube. It is attached with caecum at its cranial part. It terminates at the medial surface of the cecum at the cecocolic junction. It was found as a straight muscular tube. A thick-walled enlargement was found called the succulusrotundus at the distal end of ileum which was specific for the species. It is also known as the "cecal tonsil". It directly drains into cecum. The mean length of ileum was (21.64±6.32) cm and diameter was (1.73±0.05) cm. The mean weight was recorded as (2.99±0.143) gm (Table 3).

Large Intestine

It comprises of Cecum, Colon and Rectum. Its diameter is greater than that of small intestine. During the study it was found that the course of large intestine started at the cecal tonsil. Most of its part was situated at the dorsal aspect of the abdominal cavity, enclosed by common mesentery.

Table 4: The mean length, weight and diameter of large intestine of White New Zealand rabbit.

Organ	Parameter	Mean±SD
Cecum	Length (cm)	41.14±2.82
	Weight (gm)	
	With content	90.69±45.09
	Without content	23.27±12.40
	Diameter (cm)	5.47±0.15
Colon	Length (cm)	83.16±13.74
	Weight (gm)	
	With content	29.98±4.99
	Without content	12.24±1.71
	Diameter (cm)	3.36±0.16
Rectum	Length (cm)	8.0±1.08
	Weight (gm)	1.48±0.356
	Diameter (cm)	2.81±0.24

Cecum

Cecum was found sacculated, spirally arranged and attached to the internal mucosal fold. It occupied the whole of the ventral abdominal cavity. Rabbit cecum was found extensively large and prominent which had a coiled anterior part and contain the base and the body. The elongated slender distal part ended at the apex. This part had no succulation and known as vermiform appendix. Results of this study showed the mean length of cecum was (41.14±2.82) cm and diameter was (5.47±0.15) cm. The mean weight of cecum was recorded (90.69±45.09) gm with content and (23.27±12.40) gm while empty (**Table 4**).

Colon

The first part of the rabbit colon was observed as similar to the cecum. Colon had three major parts- a ascending part, a transverse part and a descending part. Ascending part started from the base of the cecum. Transverse colon was observed small and directed backwards as descending colon. The mean length of colon was (83.16±13.74) cm and diameter was (3.36±0.16) cm (**Table 4**). The mean weight was recorded (29.98±4.99) gm with content and (12.24±1.71) gm while empty (**Table 4**).

Rectum

It is the terminal part of the intestine and consists of a cranial and a caudal part. It was found as a small, slightly dilated tube. It was surrounded by fat content. Its mean length was recorded as (8.0±1.08) cm and mean diameter was (2.81±0.24) cm (**Table 4**).

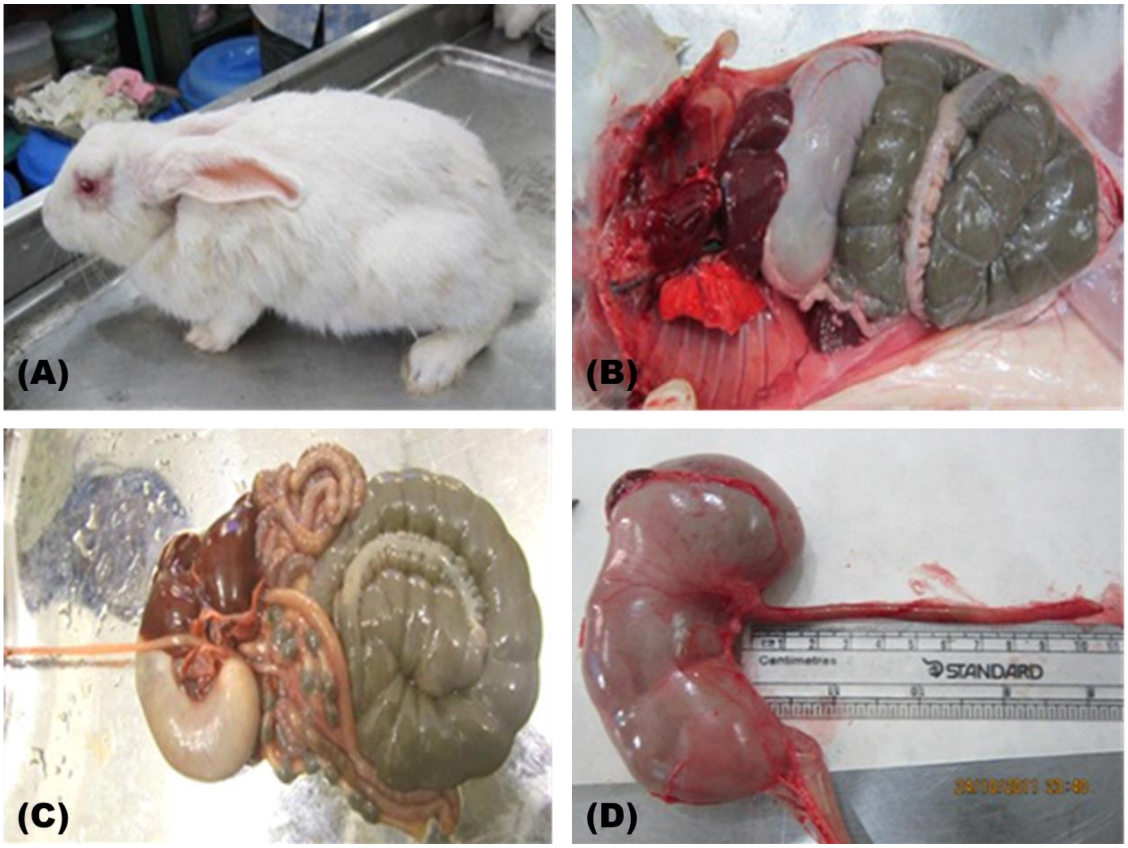

Figure 1. Topography and measurement of internal organs of rabbit. **(A)** Live rabbit, **(B)** Thoracic and abdominal viscera of rabbit, **(C)** Dissected out whole digestive tract of rabbit, **(D)** Measurement of length of esophagus.

DISCUSSION

The stomach is situated in the intrathoracic part of the abdominal cavity. After initial anatomical inspection, the visualization of the various parts of the stomach was prevented by the specific location of the cecum. In relation to the body axis, the longitudinal axis of the stomach was placed under an angle which is confirmed by the findings of Barone (1997).

The biggest part of the stomach locates to the left to the median plane. On the right side, only the pylorus was located, as reported by Gadjev (1995), Barone et al. (1973) and Popesco (1980).

The available literature does not however give details about the topographical features and relationships of the various gastric parts but the location of the stomach in rabbits is specific for the species where pylorus is directed dorsolaterally and nearness to the dorsal part of the rib wall. The cardia is located on the level of the 4th to 5th rib and the horizontal line passing through the coxal tuberosity and the body does not touch the soft abdominal wall. The spleen is situated on the caudomedial surface of the stomach. Similarly, Perez et al. (2005) stated that the anatomy of rabbit is not well known on the anatomical nomenclature.

The knowledge of the normal anatomy of rabbit liver is essential not only for medical purposes, but also for radiology. It is commonly accepted that the liver is situated just behind the diaphragm where Two-third is situated on the right and one-third on the left of the median plane (Gadjev, 1995; Barone et al., 1973; Popesco, 1980). This present study showed that the liver was located almost perpendicularly to the longitudinal axis of body. The right lateral lobe was pushed forward from the gastric pylorus where the right lateral and the left medial lobes were found the most developed liver lobes. They were well divided. The quadrate lobe was located behind the xiphoid cartilage. The gall bladder extended outside the ventral margin of the liver and inserted between the stomach on one side and the xiphoid cartilage on the other.

The spleen located in the middle third of the intrathoracic part of the abdominal cavity which is elongated, fusiform body (length 4-7 cm) and (width 1-3 cm) depending on the age and body weight. It was located on the caudomedial surface of the stomach and this information is supported by Gadjev (1995) and Barone (1997). Dorsally, it was extended up to the duodenum and the pancreas without relating the lumbar musculature. The loops of the jejunum were observed to laterally and ventrally of it.

In the rabbit, the ileum, cecum and a part of the ascending colon formed a spiral coil with one and a half loops which is also confirmed by Barone (1997). The cecum of rodents consists of ampulla ceci (Basis ceci), corpus ceci and apex ceci (Snipes, 1979; Perrin and Curtis, 1980; Snipes, 1981, 1982; Snipes et al., 1988; Snipes, 1990) which is similar to the present study. The cecum was found voluminous which agrees with the general direction in rodents (Perrin and Curtis, 1980; Kotze et al., 2006).
It was found by this experiment that the parts of the colon were well differentiated topographically. The ascending colon of the rabbit had two ansae, with a proximal, distal part and an intermediate part. But in the nutria (*Myocastor coypus*), there is two ansae, a proximal and a distal (Perez et al., 2008).

The transverse colon was found well differentiated in the present study; but Snipes et al. (1988) did not mention the transverse colon in their study about the nutria (*Myocastor coypus*) and Alogninouwa et al. (1996) in the grass cutter (*Thryonomyss winderianus*).

The differences between the results in this study and published results in rabbits might be due to breed difference. Differences in size and weight of digestive tracts may also be due to age, food habit and with the effects of the climate.

CONCLUSION

The rabbit is most widely used animal species, both in animal husbandry and laboratory practice. It is a means of research in the fields of biology, physiology, medicine etc. Several useful animal models for human diseases have been developed in rabbits. Despite of all of this, the data about the topographical and biometrical anatomy of digestive tract and their adjacent structures are rare. My study results might have established the baseline dimensions of the different segments of the digestive tract of the domestic rabbit and possibilities of diagnosis of various abnormalities of digestive tract. It needs further research of rabbit in Bangladesh for more conformation.

CONFLICT OF INTEREST

The authors declare that they have no competing interest.

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