

Fetal Differentiation of the Ileum of one Humped Camel (*Camelus dromedarius*): A Histomorphology

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Abstract

An embryonic developmental study was conducted on the ileum of 35 fetuses of the dromedarian camel collected from the Sokoto metropolitan abattoir, over a period of five months at different gestational ages. The approximate age of the fetuses was estimated and categorised into first, second and third trimester. Grossly, the color of the small intestine was whitish at first trimester and grayish to white in second and third trimester. Histological observation of the tissues in this study revealed a complete structure of the tubular organ. The ileum was found to consist of four layers namely: *Tunica mucosa*, *Tunica sub mucosa*, *Tunica muscularis* and *Tunica serosa*.

The epithelium of the *Tunica mucosa* was stratified squamous epithelium with varying degree of stratification at first trimester and transformed to low columnar/cuboidal epithelium at second trimester. At third trimester, the epithelium was simple columnar epithelium. The *lamina propria mucosa* was found absent at first trimester but prominent at second and third trimester. The *Lamina muscularis mucosa* was found prominent at third trimester but not identified at first and second trimester. At first trimester of age, the *tunica submucosa* was prominent while at second trimester, it consisted of connective tissue cells and fibres scattered all over the layers with preliminary blood vessels.

The cells and fibres were undifferentiated at this stage. There was evidence of lymphatic nodules found scattered within the layer. At third trimester of age, the connective tissues and blood vessels were found prominent and the lymphatic nodules were found throughout the length of the ileum. The *tunica muscularis* of camel ileum consist of inner circular and outer longitudinal smooth muscle layers. At first trimester this layer did not differentiate into these two zones but only longitudinal orientation of smooth muscle layer. At second trimester, the layers of two zones with clear demarcation were observed. A thin layer of connective tissue comprising of undifferentiated cells lined the ileum externally was observed in all the stages of development. Based on the above findings, it showed that development of the camels' ileum layers and lymphatic nodules was histologically in succession.

Keywords: Camel; Ileum; Fetal differentiation; Histomorphology

Introduction

One humped camels (*Camelus dromedarius*) are very important in many countries as they are used as food and draft animals [2]. The ability of camels to utilize range in marginal areas and to survive and produce under harsh environmental conditions has been recognized over the years [4]. The digestive anatomy and physiology of dromedarian camel at embryonic level is least understood when compared to Llama, Guanaco, Cattle, Sheep, Goat and Pig [4]. The description of dromedarian camel is usually made as if it is identical with Llama specie [4,5]. Though, they are pseudo-ruminants that possess a three-chambered stomach, lacking the omasum that is part of the four-chambered stomach of the order Ruminantia [4,25]. The true camels (*Camelus dromedarius* and *Camelus bactrianus*) are closely related anatomically to the South American Camelids [1,7- 9,11,15, 23,27,28].

Research work dealing with morphology, physiology, pathology, gross and developmental anatomy of various organs and system of dromedarian camel has been carried out in many countries using foetal and adult camel [1,2,4-6,8,9,11,13,14,16,24,25,27] but little attentions have been paid for the developmental changes of the cranial part of the small intestine of the camel fetus. Thus, paucity of information on the prenatal development of camel ileum exists; hence the present study was undertaken to bridge the information gap.

Materials and Methods

The study was carried out on 35 fetuses of the one-humped camel collected from the metropolitan abattoir Sokoto, as fetal wast-ages using standard animal ethics approved by the government, at different gestational ages. The collected fetuses were then taken to the Veterinary Anatomy laboratory of Usmanu Danfodiyo University; where the weight and age of the foetus were determined. The foetal body weight was measured using electrical (digital) weighing balance for the smaller fetuses and compression spring balance (AT-1422), size C-1, sensitivity of 20kg X 50g in Kilogram for the bigger fetuses. The approximate age of the fetuses was estimated by using the following formula adopted by El-wishy, *et al.* [8]: $GA = (CVRL + 23.99)/0.366$, Where GA is age in days and CVRL is the Crown Vertebral Rump Length.

Fetuses below 130 days were designated as first trimester, 131-260 days as second trimester and 261-390 days as third trimester [4]. Crown Vertebral Rump Length (CVRL) was measured (cm) as a curved line along the vertebral column from the point of the anterior fontanel or the frontal bone following the vertebral curvature to the base of the tail. Based on this, foetal samples were divided into 3 main groups as described by Bello, *et al.* [5]. The digestive tract of each fetus was collected by placing the fetus on dorsal recumbency and a mid-ventral skin incision was made via the abdomino-pelvic region down to the thoracic, to the neck up to the inter-mandibular space in order to remove the entire digestive tract.

1 cm² thick of sample from each segment was collected and fixed in 10% formalin solution. After fixation was achieved, the tissue sample was processed for paraffin blocks preparation. The sections of 5 µm were subjected to haematoxylin and eosin for routine morphology [2]. The standard sections were examined under light microscope and micrographs taken using Sony digital camera (x5) with 12.1 mega pixel.

Results and Discussion

The current study attempted to contribution to the histological differentiation of the camel small intestine. Result of the investigation show that there was an increase in the body weight, organ weight and individual segments of the small intestine in the fetuses with advancement in gestation period (Table 1). This is in agreement with the observations of Bello, *et al.* [5] and Sonfada [25], who observed obvious body weight increase with advancement of gestation period in different species of animals. Bello, *et al.* [4] suggested that nutritional status and health condition of the dam played a vital role in the development of the fetus hence increase in weight of the fetus

Grossly, the color of the small intestine was whitish at first trimester and greenish in second and third trimester. The ileum was divided into two main portions namely the dilated ampulla and the thin straight part which formed the long part of the ileum in all the trimesters. At first trimester the thin part was not differentiated but divided into three parts such as the descending part, caudal duodenal flexure (transverse part) and ascending part at second and third trimester (Plate1).

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Parameters	First Trimester	Second Trimester	Third Trimester
Number of sample (N)	13	11	11
CVRL (cm)	20.06 ± 3.0	60.27 ± 4.0	103.83 ± 6.0
Fetal weight (Kg)	1.40 ± 0.6	6.10 ± 0.5	17.87 ± 0.6

Table 1: The CVRL and weight of fetuses at various trimesters (mean ± SEM).

Similar findings were reported on the color and divisions of ileum of various animals at different gestational ages such as Llama [4] and nutria [24]. On the other hand, the ampulla was not found in sheep [17], cattle [5] and pampas deer [8]. While in horse, there were two ampullae with constriction between them prenatally [13]. The thin part of the ileum was not divided at first trimester but differentiated into three parts, descending part, caudal duodenal flexure (transverse part) and ascending part at second trimester (Plate 2). This finding agreed with previous work on Llama [12], pampas deer [23], sheep [11] and cattle [21].



Plate 1: Photograph showing the entire digestive tract of camel fetus at first trimester with no clear demarcation in the small intestine (Sm); ileum (Red arrow), abomasum (Black arrow) and ileum (L), Ampullae (Green arrow), and rumen (Rm).



Plate 2: Photograph showing the entire digestive tract of camel fetus at third trimester with clear demarcation in the small intestine; ileum (B), jejunum (C) and ileum (D), oesophagus (1) caecum (E), colon (2) and rectum (3).

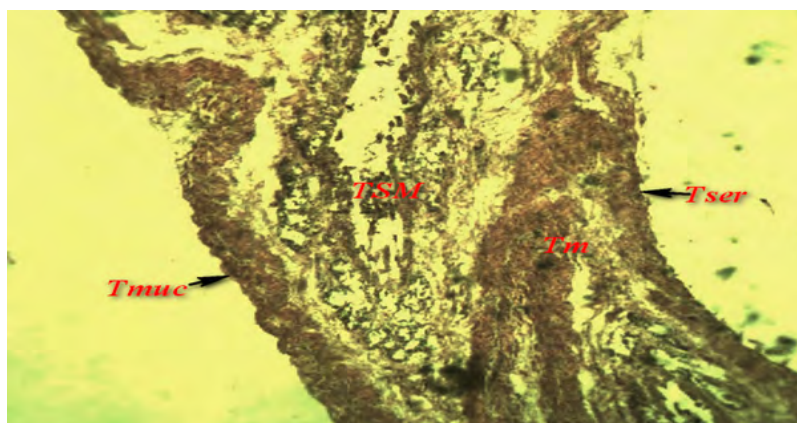


Plate 3: Transverse section of the ileum at first trimester showing Epithelium (Tmuc), Submucosa (Tsm), tunica muscularis (Tm), serosa (White arrow), 150x.

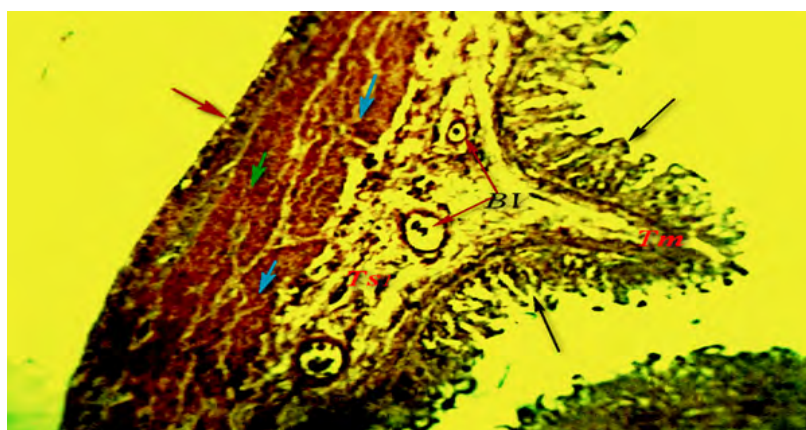


Plate 4: Transverse section of the ileum at second trimester showing Epithelium (Tmuc), Submucosa (Tsmc), internal (circular) layer of tunica muscularis (Tm2), external (longitudinal) layer of tunica muscularis (Tm1), serosa (Tser), 400x.

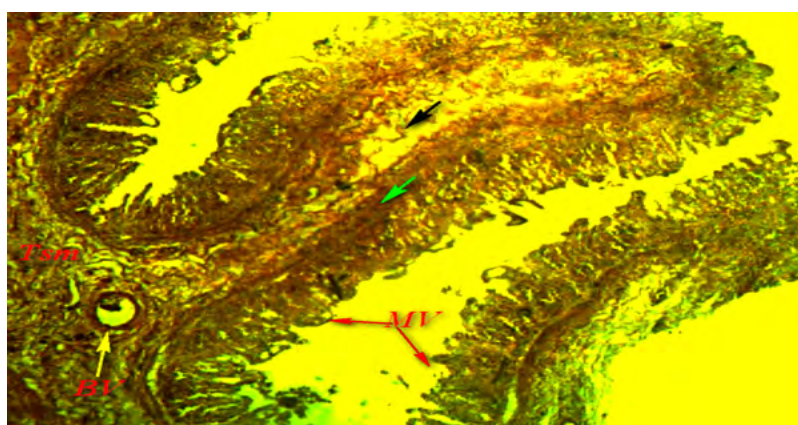


Plate 5: Transverse section of the ileum at third trimester showing keratinized stratified Epithelium (Tmuc), Submucosa (Tsmc), internal (circular) layer of tunica muscularis (Tm1), external (longitudinal) layer of tunica muscularis (Tm2), serosa (Tser), 400x.

The internal mucosa of the ileum of the camel was pinkish at first trimester and greenish in color at second and third trimester, with thin longitudinal folds at the thin part and crossed longitudinal and circular folds at the ampulla. This is in line with the findings of some researchers, who reported that the internal mucosa of small intestine of other domestic animals had circular folds "Plicae Circulares" [10,11].

At first trimester, the ampulla was small and straight in shape. At second and third trimesters, the ampulla of the ileum was prominent, large and rounded in shape. The thin part was directed craniodorsally forming the cranial flexure. The study findings agree with those reported in Llama by Smuts and Benzuidenhout, [13] who concluded that the ileum begins at the pylorus which is situated on the right side below the tenth costochondal junction at second trimester.

Histologically, observation of the tissues in this study revealed a complete structure of the tubular organ. The ileum was found to consist of four layers namely: *Tunica mucosa*, *Tunica sub mucosa*, *Tunica muscularis* and *Tunica serosa*.

The distinguishing features observed in the developmental stage at tunica mucosa were, *lamina epithelialis*, *lamina propria mucosa* and *lamina muscularis mucosa*. At *tunica muscularis* the divisions were inner circular muscularis layer and outer longitudinal muscularis layer.

From the study, the epithelium of the *Tunica mucosa* was stratified squamous epithelium with varying degree of stratification along the length at first trimester (plate 1) and transformed to low columnar/cuboidal epithelium at second trimester (plate 2). At third trimester, the epithelium was simple columnar epithelium (plate3). Similar observations were seen on Llama [3], cow [7], sheep [6], horse [8], rodent [24], human [20], monkey [27], dog [27] and cat [18]. At first trimester, the epithelium show slight ridge of differentiation at variable intervals (Plate 3), at second trimester the ridges differentiate to form villi with less pronounce crypt of lieberkhn (Plate 4). At third trimester of age, the villi became more visible, highly vascularised with extensive network of microvilli and highly developed crypts of lieberkhum (Plate 5).

The lamina propria mucosa was found absent at first trimester but prominent at second and third trimester (plate 3 and plate 4). The *Lamina muscularis mucosa* was found prominent at third trimester but not identified at first and second trimester. The above finding showed that the development of the laminae of the camel's ileum was in succession.

At first trimester of age *tunica submucosa* was prominent (plate 3) while at second trimester, it consisted of connective tissue cells and fibres scattered all over the layers with preliminary blood vessels. The cells and fibres were undifferentiated at this stage. There was evidence of duodenal gland found scattered within the layer (plate 4). At third trimester of age, the connective tissues and blood vessels were found prominent and the duodenal glands were found throughout the length of the ileum. The above findings were contrary to those of ruminant, horse and cat as reported by Kumar, *et al.* [17], which showed the presence of submucosa duodenal glands at the ampulla, descending part and caudal duodenal flexure (transverse part) region only.

This is in accordance with the finding of Qayyum, *et al.* [22] on Llama; Erdunchaolu, *et al.* [10] and Peng, *et al.* [19] on Bacterian camel, Emura, *et al.* [7] and Kumar, *et al.* [17] on sheep and Chamorro, *et al.* [4] on Horse.

The *tunica muscularis* of camel ileum consist of inner circular and outer longitudinal smooth muscle layers. At first trimester this layer did not differentiate into these two zones but only longitudinal orientation of smooth muscle layer (plate 3).

At second trimester, the layers of two zone with clear demarcation was observed (plate 4), while at third trimester, the inner circular layer appeared to be much thicker than the outer longitudinal layer (plate 5). The above finding was in conformity with that of Llama [9] goat [4] and buffalo fetuses [25].

A thin layer of connective tissue comprising of undifferentiated cells lined the ileum externally was observed in all the stages of development. This was observed at first trimester and became well developed at second and third trimester of age (plate 3,4 and 5).

Conclusion and Recommendations

The development of the camels' ileum based on embryonic stage was in succession both gross and histologically. The thin part of the ileum was not divided at first trimester but differentiated into three parts; descending part, caudal duodenal flexure (transverse part) and ascending part at second trimester. The information obtained in this study will serve as a base-line data for the camel specie in this environment. There is need for thorough investigation of the features observed in the findings using electron microscope with standard histological techniques to conclude on the above findings.

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