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Research Article

Foetal Differentiation of the Caecum of One Humped Camel (Camelus dromedarius): A Histomorphology

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Abstract

A research involving histomorphological differentiation was conducted on the caecum of 35 foetuses (both sex) of the one-humped camel collected from the Sokoto metropolitan abattoir, over a period of five months at different gestational ages. The approximate age of the foetuses was estimated and categorised into first, second and third trimester. Grossly, the color of the large intestine was whitish at first trimester and grayish to white in second and third trimester. The caecum was divided into three main portions namely the ascending caecum, the coiled and the descending part which formed the long part of the caecum in second and third trimesters. At first trimester the coiled part was not differentiated but divided into two parts such as the centripetal and centrifugal part at second and third trimester. Histological observation of the tissues in this study revealed a complete structure of the tubular organ. The caecum 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 *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 no evidence of lymphatic nodular cells within the layer. At third trimester of age, the connective tissues and blood vessels were found prominent and the lymphatic nodular cells were found throughout the length of the caecum. The *tunica muscularis* of camel caecum consist of inner skeletal 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 caecum externally was observed in all the stages of development. Based on the above findings, it showed that development of the camels' caecum was histologically in succession and different from other domestic animals by having an extensive skeletal muscle at the *tunica muscularis*.

Keywords: *Camel; Caecu; Embryonic differenciation; Histomorphology; Prenatal development*

Introduction

The prime function of the caecum as part of the large intestine is to reclaim excess moisture and return it to the body [1]. In the process, foecal balls are formed, which can be passed through the rectum and are expelled out the anus [2]. The digestive anatomy and physiology of dromedarian camel at embryonic level is least understood when compared to Llama, Guanaco, Cattle, Sheep, Goat and Pig [2,3]. The description of dromedarian camel is usually made as if it is identical with Llama specie [2,3]. 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 [3,4]. The true camels (*Camelus dromedarius and Camelus bacterianus*) are closely related anatomically to the South American Camelids [5-10].

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 [2,11-13] and adult camel [1,3,4,10,14-17,24] but little attentions have been paid for the developmental changes of the caudal part of the intestine of the camel foetus. Thus, paucity of information on the prenatal development of camel caecum exists; hence the present study was undertaken to bridge the information gap.

Materials and Methods

The study was carried out on 35 foetuses (both sexes) of the one-humped camel collected from the metropolitan abattoir, Sokoto using standard animal ethics approved by the government, at different gestational ages. The collected foetuses 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 foetuses and compression spring balance (AT-1422), size C-1, sensitivity of 20kg X 50g in Kilogram for the bigger foetuses. The approximate age of the foetuses was estimated by using the following formula adopted by El-wishy [18]. 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 [3]. 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 [25]. The digestive tract of each foetus was collected by placing the foetus 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 cm^2 thick of sample from each group 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. The standard sections were examined under light microscope and micrographs taken using motic cam camera with 2.0 mega pixel.

Results and Discussion

The current study attempted to contribution to the histological differentiation of the camel large intestine. Result of the investigation shown that there was an increase in the body weight, organ weight and individual segments of the large intestine in the foetuses with advancement in gestation period (Table 1). This is in agreement with the observations of Jamdar and Ema [19] and Sonfada [4], who observed obvious body weight increase with advancement of gestation period in different species of animals. [25] suggested that nutritional status and health condition of the dam played a vital role in the development of the foetus hence increase in weight of the foetus.

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).*

Grossly, the color of the large intestine was whitish at first trimester and grayish to white in second and third trimester. The color of the large intestine was whitish at first trimester and grayish to white in second and third trimester. The caecum was divided into three main portions namely the ascending caecum, the coiled and the descending part which formed the long part of the caecum in second and third trimesters. At first trimester the coiled part was not differentiated but divided into two parts such as the centripetal and centrifugal part at second and third trimester (Figure 1). Similar findings were reported on the color and divisions of caecum of various animals at different gestational ages such as Llama [20] and nutria [10]. On the other hand, the ascending part was not found in sheep [21] cattle and pampas deer [10]. While in horse, there were divided in to four major parts with three flexure (sterna flexure, pelvic flexure and diaphragmatic flexure) prenatally [21]. The caecum was divided into three main portions namely the ascending caecum, the coiled and the descending

part which formed the long part of the caecum in second and third trimesters. At first trimester the coiled part was not differentiated but divided into two parts such as the centripetal and centrifugal part at second and third trimester. This findings agreed with previous work on Llama [20], pampas deer [10], sheep [22] and cattle.

Figure 1: *Photograph showing the entire digestive tract of camel fetus at first trimester with no clear demarcation in the small intestine (Sm); caecum (B), abomasum (Black arrow) and ileum (L), Ampullae (Green arrow) and rumen (Rm) 50x.*

Figure 2: *Photograph showing the entire digestive tract of camel fetus at third trimester with clear demarcation in the small intestine; caecum (B), jejunum (C) and ileum (D), oesophagus (1) caecum (E), caecum (2) and rectum (3) 50x.*

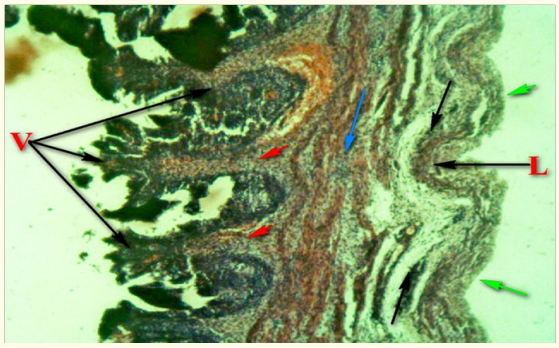

Figure 3: Transverse section of the Caecum at first trimester showing Epithelium (Tmuc) with Villi (V) Submucosa (red arrow), tunica muscularis (blue arrow) with evidence of skeletal muscle (black arrow), serosa (Green arrow), 400x.

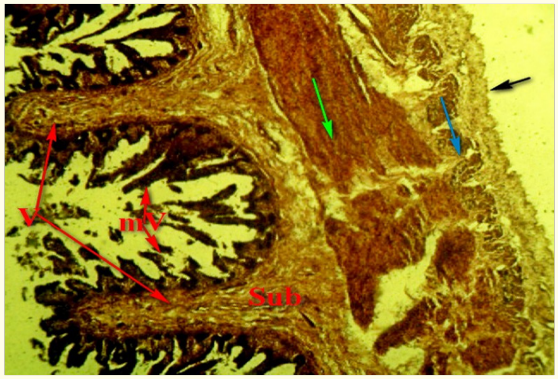

Figure 4: *Transverse section of the Caecum at second trimester showing Epithelium (Tmuc) with Villi (V) and microvilli (mV), Submucosa (Sub), internal (Green arrow) layer of tunica muscularis, external (longitudinal) (Blue arrow) layer of tunica muscularis (Tm1), serosa (Black arrow), 400x.*

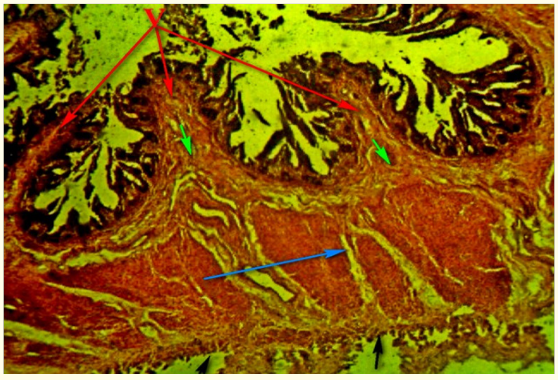

Figure 5: *Transverse section of the Caecum at third trimester showing Epithelium (Tmuc) with Villi (V) and microvilli (mV), Submucosa (Green arrow), internal layer of tunica muscularis (Skeletal), external (longitudinal) (Blue arrow), layer of tunica muscularis (Tm1), serosa (Black arrow), 400x.*

The internal mucosa of the caecum of the camel was pinkish at first trimester and grayish in color at second and third trimester, with thin longitudinal folds at the ascending part and crossed longitudinal and circular folds at the coiled part. This is in line with the findings of some researchers, who reported that the internal mucosa of large intestine of other domestic animals had circular folds "Plicae Circulares" [8,22].

At first trimester, the ascending part was small, straight and elliptical in shape. At second and third trimesters, the ascending part of the caecum was prominent, large and rounded in shape followed by coiled part. The ascending part was directed craniodorsally forming the cranial flexure. The study findings agree with those reported in Llama by [20] who concluded that the caecum begins at the caeco-colic junction 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 caecum 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 epithalialis, 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 (Figure 3) and transformed to low columnar /cuboidal epithelium at second trimester (Figure 4). At third trimester, the epithelium was simple columnar epithelium (Figure 5). Similar observations were seen on Llama, cow, sheep, horse, rodent, human, monkey, dog and cat [1-4,10,13-17,24].

The lamina propoia mucosa was found absent at first trimester but prominent at second and third trimester (Figure 4 and 5). The *Lamina mascularis* 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 caecum was in succession.

At first trimester of age *tunica submucosa* was prominent (Figure 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 no evidence of lymphatic nodular cells within the layer (Figure 3). At third trimester of age, the connective tissues and blood vessels were found prominent and the lymphatic nodular cells were found throughout the length of the caecum. The above findings were contrary to those of ruminant, horse and cat as reported by Schummer (1979), which showed the presence of submucosa lymphatic nodular cells at the ascending part, coiled part and the descending part region only.

The *Tunica muscularis* of camel caecum consist of inner skeletal and outer longitudinal smooth muscle layers (Figure 3). At first trimester this layer did not differentiate into these two zones but only longitudinal orientation of smooth muscle layer (Figure 3). At second and third trimester, the layers of two zones with clear demarcation were observed (Figure 4 and 5). while at third trimester, the inner circular layer appeared to be much thicker than the outer longitudinal layer (Figure 4). The above finding was in conformity with that of Llama [7] goat and buffalo foetuses [16].

A thin layer of connective tissue comprising of undifferentiated cells lined the caecum 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 (Figure 3, 4 and 5).

Conclusion

Based on the above findings, it showed that development of the camels' caecum was histologically in succession and different from other domestic animals by having an extensive skeletal muscle at the tunica muscularis.The information obtained in this study will serve as a base-line data for the camel specie in this environment.

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