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# Histomorphological studies of the prenatal development of oesophagus of one humped camel (*camelus dromedarius*)

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ABSTRACT

A Histomorphological study was conducted on the oesophagus of 35 foetuses 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 from the crown vertebral rump length (CVRL) and samples were categorised into first, second and third trimester. At the first trimester, only three layers were identified, ie; *Tunica mucosa, Tunica muscularis and Tunica adventitia.* At the second trimester, the orientation of fibres changed, resembling that of the adult with all the four layers prominent i.e. *Tunica mucosa, Tunica sub-mucosa, Tunica muscularis and Tunica adventitia.* At the third trimester, the Oesophageal gland appeared prominently in the tunica sub-mucosa resembling that of the adult camel. The *Tunica mucosa* epithelium was simple squamous epithelium at first trimester and began to change at second trimester to stratified squamous epithelium. At third trimester, the epithelium was keratinized stratified squamous epithelium with the oesophageal (sub-mucosal) glands appearing to be prominent and abundant. The *tunica muscularis* showed clearly a single layer at second trimester while at third trimester; both inner circular and outer longitudinal layers appeared. The *tunica adventitia*

was typical. Blood vessels and nerve fibres became very visible at the *tunica sub-mucosa* and *muscularis* in third trimester fetuses. Based on the above findings, it showed that development of the camels' oesophagus (based on embryonic stages) was morphological in succession. Presence of keretinised stratified squamous epithelium throughout the length of the oesophagus showed adaptive features of the animal to its environment and mode of feeding. Base on histological differentiation, camels' oesophagus had little/few similarities with true ruminants embryologically.



**1. Introduction**

Camels are in the taxonomic order *Artiodactyls* (even-toed ungulates), sub order *Tylopoda* (pad-footed), and Family Camelidae (Wilson, 1995).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 (Sonfada, 2008). The true camels (*Camelus dromedrius and Camelus bacterianus*) are closely related to the South American Camelids, (Llama, Alpaca, Vicuna and Guomaco) anatomically (Malie, 1987).

Histomorphological studies of post-natal oesophagus has been carried out extensively in camel (Asari *et al*., 1985; Wilson, *et al*., 1990; Reece, 1997; Bustinza, 1979; Franco *et. al.,* 2004a; Belknap, 1994; Smith, 1989; Watrous *et al.,* 1995; Jamdar and Ema, 1982) but little of such studies have been conducted on the developmental changes of the entire digestive tract of the camel fetus. However, there is thus, paucity of information on the prenatal development of camel oesophagus (Luciano *et al*., 1979); hence the present study was undertaken to bridge the gap of the existing information.

## 2. Materials and methods

The study was carried out on 35 foetuses of the one-humped camel collected from the metropolitan abattoir, Sokoto 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 (1981).

[GA = (CVRL + 23.99)/0.366] [El-Wishy *et al.* 1981]

Where GA is in days

$1^{st}$ trimester = below 130 days
$2^{nd}$ trimester = 131- 260 days
$3^{rd}$ trimester = 261 - 390 days

CVRL (Crown Vertebral Rump Length) is measured 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 adopted by Sonfada, (2008):

Grossly, samples of oesophagus were divided into 3 major regions as highlighted by Sukon, (2009); the cervical oesophagus, thoracic region and abdomen region

Histologically, samples of oesophagus were divided into 5 main regions in order to have an overview of the entire organ: cranial cervical, mid cervical, Thoracic inlet, mid thoracic and Cardiac region

The length of the entire oesophagus was measured from the caudal end of the pharynx to the point of entrance of the first compartment of the stomach (rumen) in centimetre. The mean diameter of the oesophagus was taken at 5 different regions of each sample in centimetre as postulated by Jamdar and Ema (1982).

About 1cm$^2$ 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 5-6µm were subjected to haematoxylin and eosin for routine morphology (Luiz and Jose, 2005). The standard sections were examined under light microscope and micrographs taken using motic cam camera with 2.0 mega pixel.

**3. Results and discussion**

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

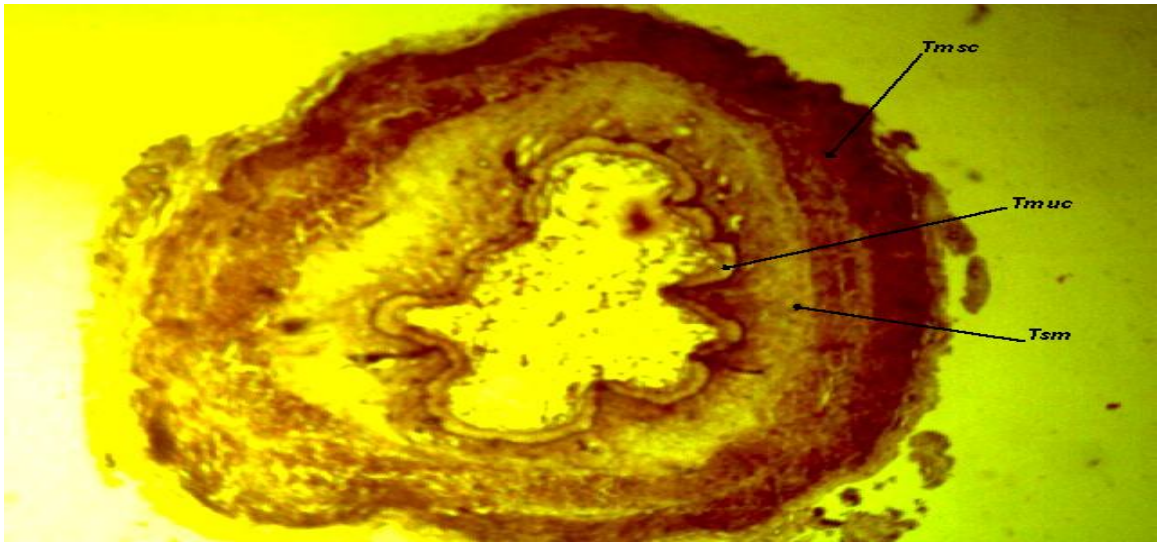


**Plate 1.** Transverse section of the oesophagus at first trimester showing Epithelium (Tmuc), Submucosa (Tsm), tunica muscularis (Tmsc), serosa (White arrow), 150x

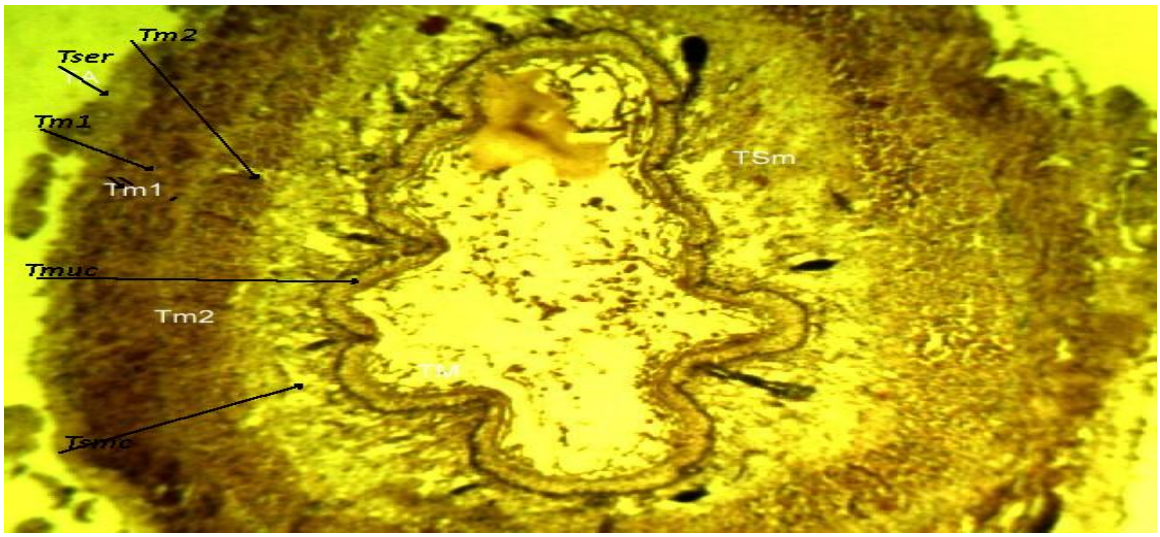


**Plate 2.** Transverse section of the oesophagus at second trimester showing Epithelium (Tmuc), Submucosa (Tsmc), internal (circular) layer of tunica muscularis (Tm2), external (longitudinal) layer of tunica muscularis (Tm1), serosa (Tser), 400x

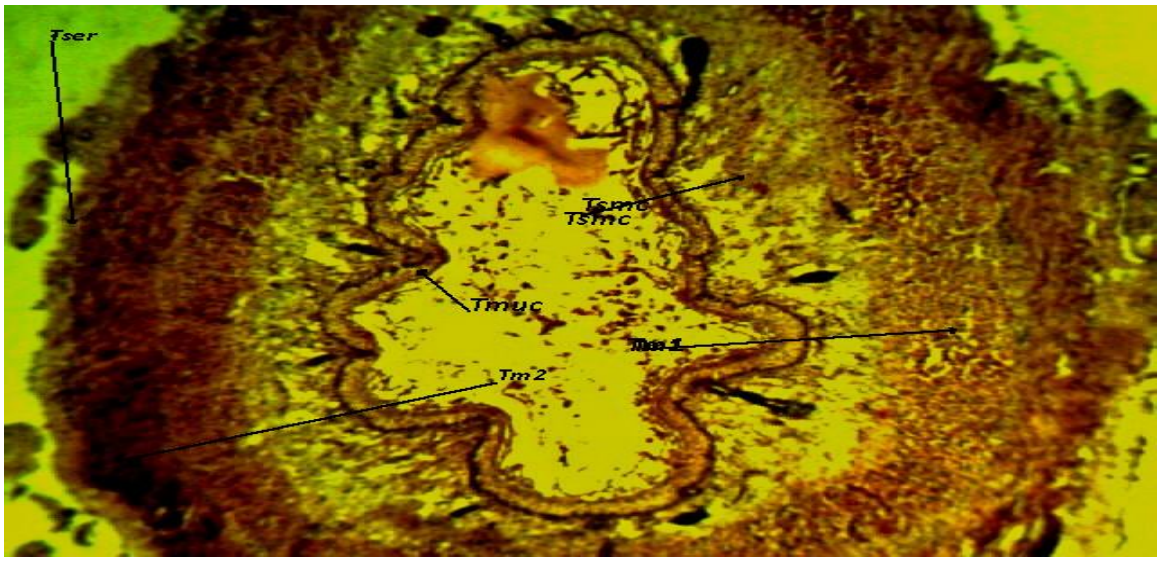


**Plate 3.** Transverse section of the oesophagus at third trimester showing keratinized stratified Epithelium (Tmuc), Submucosa (Tsmc), internal (circular) layer of tunica muscularis (Tm1), external (longitudinal) layer of tunica muscularis (Tm2), serosa (Tser), 400x.

From the study, the epithelium of the *Tunica mucosa* was pseudo-stratified columnar at first trimester (plate 1) and transformed to stratified squamous epithelium with varying degree of stratification along the length of the oesophagus at second trimester (plate 2).At third trimester , the epithelium was keratinised stratified squamous epithelium throughout the length of the oesophagus (plate3). Similar observation on the progressive development and thick heavily keratinised mucosal epithelium were seen on Llama, cow, sheep, horse and rodent but differs from that of human, monkey, dog and cat (Schummer *et al.,* 1979; DeNardi and Riddell, 1991; Fawcett and Raviola, 1994).

The lamina propoia mucosa was found absent at first trimester but prominent at second and third trimester (plate 2 and plate 3).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 tunis of the camel's oesophagus was in succession.

At first trimester of age *tunica submucosa* was poorly developed (plate 1) 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 oesophageal gland found scattered within the layer (plate 3). At third trimester of age, the connective tissues and blood vessels were found prominent and the oesophageal glands were found throughout the length of the oesophagus. The above findings were contrary to those of ruminant, horse and cat as reported by Schummer *et al.,* (1979), which showed the presence of submucosa oesophageal glands at the pharyngo-oesophageal region only.

The *tunica muscularis* of camel oesophagus 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 1). At second trimester, the layers of two zone with clear demarcation was observed (plate 2), while at third trimester, the inner circular layer appeared to be much thicker than the outer longitudinal layer (plate 3). The above finding was in conformity with that of Llama (Watrous *et al.,* 1995) goat (Getty, 1975) and buffalo foetuses (Luciano *et al*., 1979).

A thin layer of connective tissue comprising of undifferentiated cells lined the oesophagus externally and blended to the neighbouring structures, this was observed at first trimester and became well developed at second and third trimester of age.

**4. Conclusion**

The development of the camels' oesophagus based on embryonic stage was morphological in succession. Presences of keratinised stratified squamous epithelium throughout the length of the oesophagus suggested the adaptive features of the animal to its environment and mode of feeding. Based on histological differentiation, camels' oesophagus had little/few similarities with true ruminant embryologically.

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