

## Morphohistological study of the Esophagus of the one Humped Camel (*Camelus Dromedaries*)

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### Abstract

The esophagus of one-humped camel was studied grossly and histologically. Different stains were used to examine the glands and musculature. The esophagus of camel appeared to be similar to that of other ruminants in absence of the abdominal portion.

Specific modifications were observed in camel's esophagus different than the esophagus of other domestic animals in presence of a well developed pharyngoesophageal limen (fold), keratinization of the stratified squamous epithelium and irregularities of the tunica muscularis.

These changes were proposed to be factors in facilitating swallowing and regurgitation of rough food. Arterial blood supply was found to be similar to ox and small ruminants.

### دراسة شكلية ونسجية لمرئ الجمل ذي السنام الواحد (*Camelus Dromedaries*)

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### الخلاصة

هذا البحث اشتمل على الدراسة العيانية والنسجية لمرئ الجمل ذي السنام الواحد واستخدمت صبغات مختلفة لفحص الغدد والعضلات. وقد أظهرت الدراسة إن مرئ الجمل يظهر تشابه لبقية المجترات حيث انه يختلف في الجزء البطني.

كما لوحظ اختلاف في مرئ الجمل عن بقية الحيوانات الأليفة حيث تطور الطبقة البلعومية المريئية وكذلك تقرن الظهارة المطبقة الحرشفية وعدم انتظام الطبقة العضلية.

هذه التغيرات تساعد في تسهيل عملية بلع واجترار الطعام، أما التغذية الدموية فهي مشابهة في الثور والمجترات

الصغيرة.

### Introduction

Passage of food inside the esophagus is a phenomenon affected by the length of esophagus, presence or absence of glands as well as type of musculature of the wall and type of food passing through.

The extent of the striated musculature of the esophagus varies among different species; this is made up by two muscular layers, an inner circular and an outer longitudinal layer.

Depending on the location in the esophagus and the species involved, the musculature may be skeletal muscle, smooth muscle or a mix of two transition. Ruminants have all skeletal, cat and horse have lower one third smooth while the rest of the esophagus skeletal. The pig has three regions starting with skeletal; middle mixed and lower smooth musculature(2,4).

Submucosal glands were described in different regions of the esophagus of domestic animals. Tunica submucosa made up of loose connective tissue and contains arteries, veins, lymphatic vessels, ganglia and nerve fibers. Many seromucous glands are present in the submucosa (10,11) with their ducts to the luminal surface.

The section of the esophageal glands help the movement of boluses ingested. The distribution of the glands varies in different species of domesticated animals.

In dogs, they are found throughout the esophagus (5), whereas in water buffalo and horses only in the thoracic esophageal region (8, 9). In pig, the glands are more abundant in the cranial half, but do not extend into caudal half (10).

However, no information was found in the available literature concerning the arterial blood supply of the esophagus of the one humped camel. Due to lack of enough information concerning camel's esophageal structure this study was undertaken to describe different layers of the esophagus wall, to elucidate their role in the function of esophagus, to study the histo-morphology of esophagus of native one – humped camel and compare it with other animal species.

### **Materials and Methods**

Esophagi of ten adult one humped camel of different age and sexes were collected from the abattoir after thorough examination in situ.

Specimens of five of them were kept in 10% formalin. Regions of specimens included cranial, middle and caudal cervical and thoracic esophagus were cut and examined carefully (2, 12), and to facilitate the anatomical and histological investigation.

Tissues were processed and 5µm thick sections were prepared. Care was taken to obtain sections at a right angle to the longitudinal axis of the esophagus. Sections were stained with Hematoxyline and Eosin, Trichrome, and Weigert's iron hematoxyline stains in addition to Holmes methods for neural tissues. The remaining esophagi were used for gross anatomical study.

### **Results**

Pharyngoesophageal limen (fold) is located at junction esophagus and pharynx an it's a well developed structure in one humped camel which appeared as a transverse fold in the dorsal region extending from the mid ventral portion of the wall.

The epithelium at this region is highly keratinized stratified squamous epithelium in nature (Figs. 1,2,5). Further, additional longitudinal fold running in the dorsal surface of the esophagus disappearing between the folds of the esophagus wall as it extends down into the cervical region.

The esophagus has cervical and thoracic portions as the abdominal part does not exist in one humped camel.

Total length of the esophagus appeared to be in the range of 110-120 cm. with the cervical portion 68-70 cm and the thoracic portion is 50 cm. both with 8-10 cm in diameter (externally calculated).

The esophagus is dilated towards its junction with the rumen. The lining epithelium is non keratinized in areas and keratinized in other regions (Figs. 1, 2, 3,5).

Thickness of different layers of various regions of camel's esophagus is listed in Table(1). Mucous glands were found through the whole length of the esophagus (Fig. 3,6).

These mucous glands were differing in quantity from region to region and they appeared larger in number closer to the rumen.

Tunica muscularis is striated throughout the whole length of the esophagus with irregularities in arrangement in both inner and outer layers of muscle fibers (Fig. 4,6).

In a short segment of the cervical esophagus and close to the rumen a third oblique layer was well established. Lamina muscularis mucosa is absent in all regions examined except in the caudal thoracic portion. Therefore, propria tunica submucosa is used in these regions where lamina muscularis mucosa is absent (Fig. 1, 2,5).

#### - **Arterial supply**

The cervical portion of the esophagus gets its arterial blood supply from the rostral or middle thyroid arteries or from both, especially for the pharyngoesophageal junction and its upper cervical part.

The remaining portion of the cervical esophageal part gets its arterial blood supply directly from the common carotid artery. The thoracic part receives arterial supply from the ascending and descending branches of the bronchoesophageal trunk, originating from the thoracic aorta from one side at the level of the sixth intercostal region.

### **Discussion**

The esophagus of the one humped camel appeared to be similar to the ruminants in which no clear abdominal portion is present.

The pharyngo-esophageal lumen is well developed (large and prominent) which might play a role in squeezing the rough food or might play as a sphincter like structure described in sheep(3, 11).

The epithelial lining of the esophagus was highly keratinized in most regions under investigation similar to ruminants and horse (1,10,11).

The stratum corneum is a layer increased in thickness inside the thoracic part which could be due to the absence of powerful muscles which present in the cervical region; therefore, food passage is hindered resulted in increased keratinization due to continuous irritation of the wall by the food bolus passing through.

The lamina muscularis mucosa is found in the distal portion of the esophagus (thoracic part) which appeared as a transition towards the lumen, contrary to the ruminants, in which it appeared in the whole length of the esophagus (2, 11).

Therefore, the lamina propria is intermingled with the tunica sub mucosa in a tunic called propria tunica submucosa in other regions of the esophagus (2, 12).

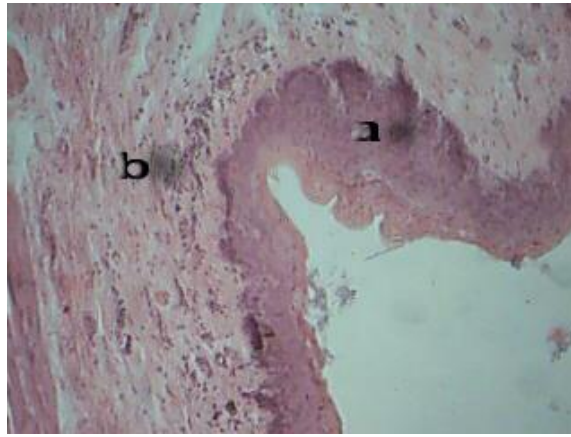
Tunica muscularis revealed its highest thickness at the cranial part of the thoracic region which might be explained how the bolus can travel through the length of the neck during regurgitation (2,10,11), stated that muscle fibers are reversed in their arrangements as inner longitudinal and outer circular in the esophagus of camel, while in this study the muscles arrangement revealed no clear layers in all sections examined.

There are few regions where oblique layer was evident and this kind of arrangement might give strength to the wall making it powerful during both swallowing and regurgitation to overcome the effect of the length of the esophagus.

The arterial blood supply of the camel esophagus is similar to that of the horse, ox, small ruminants and pig and it differs from the dog which has sometime paired vessels of the bronchoesophageal trunk (7, 10).

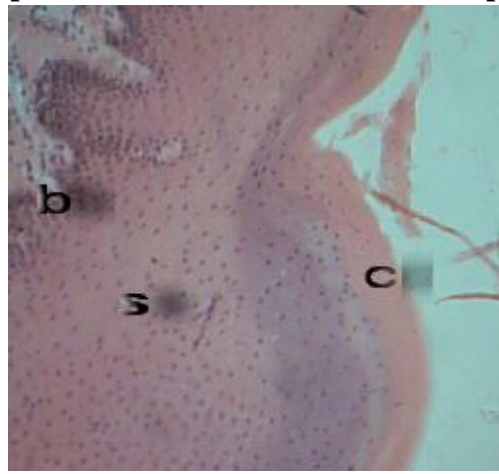
**Table (1) Thickness of different layers of various regions of the one humped camel esophagus in micrometers**

<b>Region of esophagus</b>	<b>Stratum corneum</b>	<b>epithelium</b>	<b>Propria submucosa</b>	<b>Tunica muscularis</b>	<b>Serosa adventitia</b>
<b>Cranial cervical</b>	40-60	160-240	1300-2100	2800-3200	240-280
<b>Middle cervical</b>	27-73	168-366	1133-2700	2533-3700	187-466
<b>Caudal cervical</b>	20-60	140-300	1200-2500	2100-3000	200-400
<b>Cranial thoracic</b>	60-90	200-320	1210-3800	4900-5600	200-350
<b>Middle thoracic</b>	60-120	170-350	1180-3200	2650-3250	200-350
<b>Caudal thoracic</b>	50-100	130-310	1150-3300	3050-3650	300-400



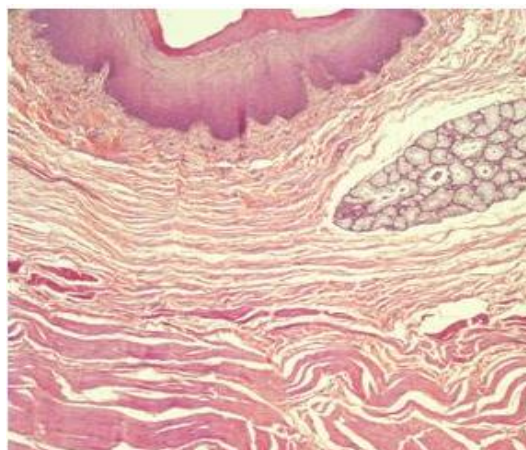
**Figure (1) A cross section of the wall of the esophagus of one humped camel lower cervical. H.&E. Stain. Mag. 150 X**

**A. Stratified squamous epithelium                      B. Lamina propria / submucosa**

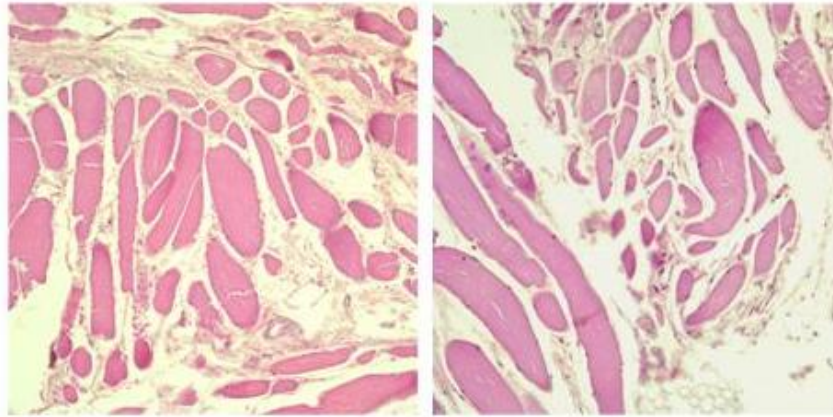


**Figure (2) stratified squamous epithelium of the esophagus of one humped camel inlet thoracic .H.&E. stain Mag. 300X**

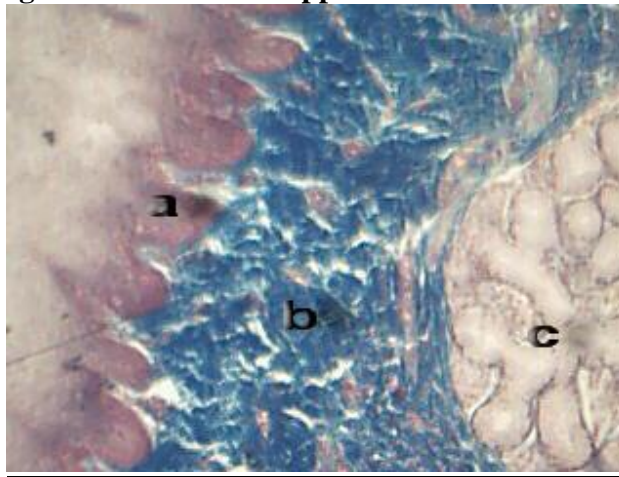
**C. Stratum corneum                      B. Stratum Basale                      S. Stratum spinosum**



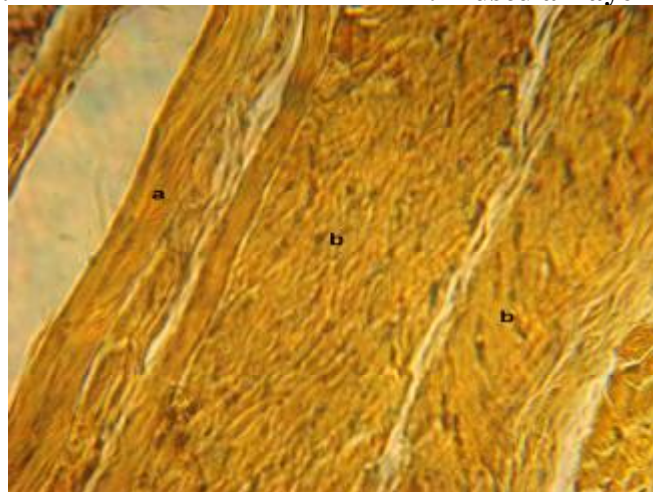
**Figure (3) Camel esophagus at the junction with the rumen. H.&E. Stain. Mag. 200X. presence of submucosal glands**



**Figure (4) Tunica muscularis of the camel esophagus. Notice different fibers direction irregular arrangement direction in upper cervical. H.&E. Stain. Mag. 250X**



**Figure (5) a cross section of the wall of the esophagus at caudal thoracic. trichrom stain ( X100)**  
**A. Stratified squamous epithelium. B. Lamina propria.**  
**C. Esophageal gland. D. Muscular layer**



**Figure (6) muscular layer of the esophagus upper and middle cervical region. Weigert iron hematoxylin stain**  
**A. Longitudinal muscular layer B. Circular muscular layer**

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