

Comparative anatomical and histological study of the esophagus of local adult male and female homing pigeon (*Columba livia domestica*)

Khalid Hadi Kadhim

Coll. of Vet. Med. / Uni. AL-Muthana

Ahmed Adeeb Mohamed

Coll. of Med. / Univ. of AL-Muthana

email: dr-kh8195@yahoo.com

(Received 16 February 2014, Accepted 3 September 2013)

Abstract

The purpose of this study was to unveil the comparison of the macroscopic and microscopic features of the esophagus in males and females homing pigeons, 10 males and 10 females of health adult local homing pigeons of all anatomical and histological studies, the present study showed that the mean total length of the esophagus of male was longer than that of female, mean length, diameter of lumen of cervical esophagus was greater than that of thoracic esophagus in each sex. The esophageal wall was composed of the four tunicae (mucosa, submucosa, muscularis and adventitia). Mucosa consist of epithelium formed by non-keratinized stratified squamous epithelium, lamina propria was a loose connective tissue contain mucous glands, these glands were less developed in cervical esophagus than that in thoracic esophagus of each sex and muscularis mucosa was a thick layer of longitudinal bundler of smooth muscles, mean thickness of mucosa in male was thicker than that in female, and longitudinal folds in the cervical esophagus were great deep than that in the thoracic esophagus of each sex. Submucosa consist of thin layer of loose connective tissue, mean thickness of submucosa in male was thicker than that in female, means the thickness of mucosa and submucosa in cervical esophagus were thicker than that in thoracic esophagus of each sex. Muscular is composed of a circular and longitudinal smooth muscle layer, mean thickness of muscularis in male was thicker than that in female and mean it thickness in thoracic esophagus was thicker than that in cervical esophagus of each sex. Adventitia made up of loose connective tissue with blood vessels, mean thickness of adventitia in male was more than that in female and in cervical esophagus was more than that in thoracic esophagus of each sex.

Key words: Esophagus, anatomy, histology, glands, homing pigeon.

دراسة تشريحية ونسجية مقارنة لمرء الذكر والأنثى في الحمام الزاجل المحلي البالغ (*Columba livia domestica*)

أحمد أديب محمد

كلية الطب / جامعة المثنى

خالد هادي كاظم

كلية الطب البيطري / جامعة المثنى

الخلاصة

تهدف الدراسة الحالية لمعرفة الفروقات في المظاهر العيانية والمجهرية للمريء بين الذكر والأنثى للحمام الزاجل المحلي. أجريت الدراسة على 10 ذكور و10 إناث لحمام الزاجل المحلي السليم البالغ لكلا الدراستين التشريحية والنسجية. أظهرت الدراسة الحالية إن متوسط الطول الكلي للمريء في الذكور أطول من الإناث ، ومتوسط طول وقطر التجويف للمريء العنقي يكون اكبر من المريء الصدري في كلا الجنسين. جدار المريء يتكون من أربع غللات (مخاطية، تحت المخاطية ، العضلية والبرانية). الطبقة المخاطية تتكون من نسيج ظهاري مؤلف من نسيج حرشفي مطبق غير متقرن ،الصفحة الأصلية المكونة من نسيج رابط يحتوي غدد مخاطية ،هذه الغدد تكون اقل تطور في المريء العنقي مما هي عليه في المريء الصدري لكلا الجنسين ، والمخاطية العضلية المكونة من طبقة سميكة من الحزم الطولية للعضلات الملساء ، متوسط سمك الطبقة المخاطية في الذكور تكون اسمك مما هي عليه في الإناث. والطيات الطولية في المريء

العنقي تكون أكثر عمقا مما هي عليه في المريء الصدري لكلا الجنسين. الغلالة تحت المخاطية تتكون من طبقة رقيقة من النسيج الرابط الرخو ، وان متوسط سمك الغلالة تحت المخاطية في الذكور تكون اسمك مما هي عليه في الإناث ، وان متوسط سمك الطبقتين المخاطية وتحت المخاطية في المريء العنقي تكون اسمك مما هي عليه في المريء الصدري لكلا الجنسين. الطبقة العضلية تتكون من طبقتين دائرية وطولية من العضلات الملساء ، متوسط سمك الطبقة العضلية في الذكور تكون اسمك مما هي عليه في الإناث ومتوسط سمكها في المريء الصدري يكون اسمك مما هو في المريء العنقي لكلا الجنسين. الغلالة المصلية مكونه من نسيج رابط رخو مع أوعية دموية ،متوسط سمك الغلالة المصلية في الذكور تكون اسمك مما هي عليه في الإناث وسمكها في المريء العنقي يكون اسمك مما هي عليه في المريء الصدري لكلا الجنسين.

الكلمات المفتاحية: المريء ، تشريحيا ، نسيجيا ، الغدد ، الحمام الزاجل .

Introduction

Birds have the coelomic cavity without diaphragm, the avian esophagus is long distensible tube connect the oropharynx and the proventriculus, it lies on the right side of the neck (mammals present it on the left side) dorsally to the trachea. Immediately cranial to the thoracic entrance the esophagus returns to the median line and expand ventrally to form the crop (1), in geese (2) and (3) in white stork. (4 and 5) mentions the esophagus of rheas and captive bustards no form the crop. The mean length of total esophagus of white stork is 400 mm, and diameter of it 10 mm (3). (5) described the esophagus of male bustards is longer than that of female also in tufted ducks *Aythya fuligula* (6), while in common pheasant and partridge the length of the esophagus of male is shorter than that of female (7 and 8). Avian esophagus consists of two parts are cervical and thoracic, in mammals there is three parts cervical, thoracic and abdominal (1), while (9) mention the esophagus of the common quail has three anatomical parts are cervical part, crop and thoracic part. (10) said the chicken cervical esophagus extends from the oropharynx and expended to form the crop, and it shaped like (S). Cranially, it is located in the median line, dorsally to the larynx and trachea, which is intimately fixed by a connective tissue. Caudally to the fifth cervical vertebra, mean length of it shorter than its cervical column and thoracic esophagus, while in white stork considerable longer than the thoracic esophagus (3). It more distensible and folded more than the thoracic part in the ostrich and has 12 longitudinal folds (11). (12) said the cervical esophagus of chicken has 6-8 longitudinal folds. (8) mention the length of cervical esophagus of partridge in male and female are (112 mm, 117.2 mm respectively), and in

geese is 164.1mm (2). The thoracic esophagus placed below the crop, dorsally to the trachea extend until the proventriculus, mean length of it in male and female partridge is (40.30 mm, 40.50 mm respectively) (8), and in geese is 38.3mm (2). The esophageal wall of the chicken consists of four tunicae (mucosa, sub mucosa, muscularis and adventitia) (10). Mucosa of emu esophagus formed by a non-keratinized stratified epithelium (13), while the epithelium of the esophagus of White stork and wild birds (Rock Dove and Linnet) is keratinized stratified squamous (3 and 14). The lamina propria in esophagus of emu contained numerous simple tubular mucus glands (13), these glands are developed in thoracic esophagus more than that in cervical esophagus of common quail (9), muscularis mucosa is thick consist of a longitudinal smooth muscle layer, mean thickness of epithelium in cervical esophagus of common quail is thicker than that in thoracic esophagus (9). Sub mucosa layer of avian composed of loose connective tissues only and no has glands as in mammals (10), tunica muscularis composed of a thicker inner circular and a thinner outer longitudinal smooth muscle layer (15) in homing pigeon and in wild birds (mallard) (16), (9) mention mean thickness of tunica muscularis of the common quail esophagus in thoracic part is thicker than that in cervical part and in male is thinner than that in female. Tunica muscularis is surrounded by the tunica adventitia at the cervical esophagus, and by the tunica adventitia at the thoracic esophagus of wild birds (14).

Materials and methods

For anatomical study ten adult healthy local homing pigeons (5 male and 5 female)

were collected from local market in Muthana city during March 2013, the birds were sacrificed after anesthesia by intramuscular injection of a mixture of ketamine and diazepam at dose 25 and 5 mg /kg BW respectively, according to (17). Measuring the total body length (from beak to the end of rump, sternum length (exact to 0.5 mm) according to (18). Freed the whole esophagus of 10 birds (from oropharynx to proventriculus) and washed with distilled water. The total length of esophagus, length, diameter of lumen of each part of esophagus of each sex measured by digital electronic vernier, measurement tape and ruler. The histological study was carried out on (10) specimens of esophagus of adult healthy local birds (5 male and 5 female). Specimens was washed with normal saline solution (0.9%), and 5 samples from different regions of each part of the esophagus were taken and fixed by 10% formalin 24 hours at room temperature, and then treated by routine histological processing (19), embedding with paraffin wax (58-60 C⁰) and sectioning to 5-7µm. The stains were used, Harries Hematoxylin and Eosin (H&E) stain for demonstrating the general histological components, and Periodic Acid Schiff (PAS) stain for distinguish of carbohydrates. The thickness of the all tunicae of each part of esophagus in each sex, in 5 sections in each section of each part of the esophagus by ocular micrometer. The mean (M) and the standard error (SE) were calculated for 5 slides for each part of the esophagus (20).

Results

In the present study the mean length of the total body and sternum of male was (232.26 ± 9.4 mm, 82.1 ± 5.7 mm respectively) and was longer than that of female (219.1 ± 7.7 mm, 63.1 ± 4.5 mm respectively) (Table 1). In the present study the esophagus was long, muscular, longitudinally folded tube, located on the right side of the neck dorsally to the trachea, extend from oropharynx to the proventriculus (Fig. 1), the mean total length of the esophagus of male was (124.9 ± 6.8 mm) and was longer than that of female (106.3 ± 8.6 mm) (Table 1). The esophagus of homing pigeon consist of two parts were

cervical and thoracic parts (Fig. 1), the cervical esophagus extends from the oropharynx and in the entrance of the thorax, its ventral wall was enlarged to form the crop that end in it, located dorsally to the larynx and trachea, and considerable longer than the thoracic esophagus, the internal surface of it has well demarcated longitudinal folds (Fig. 2), mean length of the cervical esophagus in male was (82.8 ± 4.3 mm), while in female was (68.84 ± 5.9 mm) (Table 1). Mean diameter of the lumen in cervical esophagus was greater than that in thoracic esophagus in each sex (Table 1). The thoracic esophagus was placed below the crop, dorsally to the trachea and opened into the proventriculus within thoracoabdominal cavity (Fig. 1), mean length of it in male was (42.4 ± 3.9 mm), while in female was (37.52 ± 4.9 mm) (Table 1), and the longitudinal folds in the internal surface of the thoracic esophagus were less deep than that in the cervical esophagus in each sex, with larger space occurred between them (Fig. 2, 3). The esophageal wall was composed of the four tunicae (mucosa, submucosa, muscularis and adventitia) (Fig. 4). Tunica mucosa consist of epithelium formed by non keratinized stratified squamous epithelium, lamina propria consist of loose connective tissue with large mucous glands (Fig. 5), these glands were take positive reaction with (PAS) (Fig. 5), and were less developed in cervical esophagus than that in thoracic esophagus in each sex (Fig. 4, 6, 7) nodular lymphatic tissue were within the lamina propria and muscularis mucosa was very well developed consist of longitudinal bundle of smooth muscles fibers (Fig. 7), mean thickness of epithelium, lamina propria and muscularis mucosa in cervical esophagus of male were (76.6 ± 14.3, 322.3 ± 80.1, 291.5 ± 91.6 µm) respectively, while in female were (60.6 ± 15.6, 317.3 ± 96.5, 243.6 ± 86.3 µm) respectively (Table 2), and mean thickness of epithelium, lamina propria and muscularis mucosa in thoracic esophagus of male were (59.8 ± 9.6, 303.3 ± 76.8, 158.5 ± 56.7 µm) respectively, while in female were (41.6 ± 6.5, 280.2 ± 87.5, 139.7 ± 61.4 µm) respectively. And mean thickness of mucosa in the cervical esophagus was thicker than

Table (1): Measurements of length; Total body length, sternum length, esophagus length, and diameter of lumen of esophagus of each sex of homing pigeon (mm) (M ±SE)

Measure Sex	BL M± SE	SL M± SE	EL M±SE	CE		TE	
				L	Di	L	Di
Male	232.26 ± 9.4	82.1 ± 5.7	124. ± 6.8	82.8± 4.3	4.77± 1.2	42.4 ± 3.9	3.82 ± 0.9
Female	219.1± 7.7	63.1± 4.5	106.3 ± 8.6	68.84 ± 5.9	3.24 ±1.4	37.52 ± 4.9	2.01 ±1.1

BL: Body length, SL: Sternum length, EL: Esophagus length, CE: Cervical esophagus, TE: Thoracic esophagus, L: Length, Di: Diameter of lumen, (Mean ± Stander Error) (n=5 for each sex).

Table (2): Measurements of thickness of the esophagus wall layers for each sex in homing pigeon (µm) (M ±SE).

Measure Region	TM M± SE				TSM M± SE	TMS M± SE			TS M± SE
	Total	Ep	Lp	Mm		Total	Cir	Long	
CE Male Female	690.6±111.6 620.5±113.7	76.6±14.3 60.6±15.6	322.3±80.1 317.3±96.5	291.5±91.6 243.6±86.3	60.7±11.5	500.6±44.6 427.7±41.6	311.7±31.3 267.1±24.5	188.3 ±30.1 161.2±18.6	75.3±7.4
					40.2±7.5				70.1 ±3.2
TE Male Female	520.6±92.2 460.6±95.6	59.8±9.6 41.6±6.5	303.3±76.8 280.2±87.5	158.5±56.7 139.7±61.4	40.6±8.9	700.5±51.5 601.8±47.8	491.9±37.9 407.6±22.2	208.7±34.4 193.6±17.6	67.5±8.2
					20.6± 3.6				60.4±4.6

CE: Cervical esophagus, TE: Thoracic esophagus, TM: Tunica mucosa, TSM: Tunica sub mucosa, TMS: Tunica muscularis, TS: Tunica adventitia, Ep: Epithelium, Lp: Lamina propria, Mm: Muscularis mucosa, Cir: Circular muscularis, Long: Longitudinal muscularis. (Mean ± Stander Error) (n=5 for each sex).

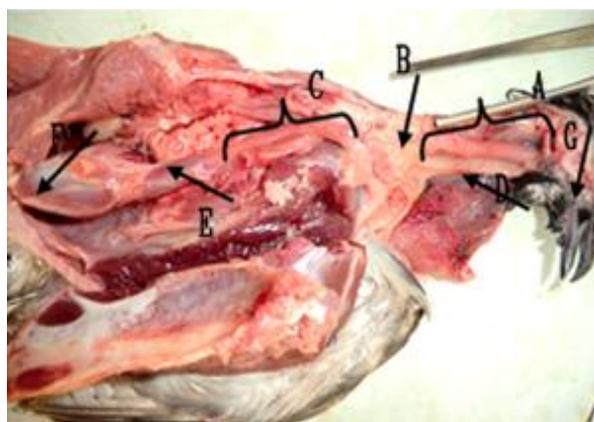


Fig. (1): Gross appearance of the esophagus of homing pigeon, cervical esophagus (A), crop (B), thoracic esophagus (C), trachea (D), proventriculus (E), gizzard (F), oropharynx (G).

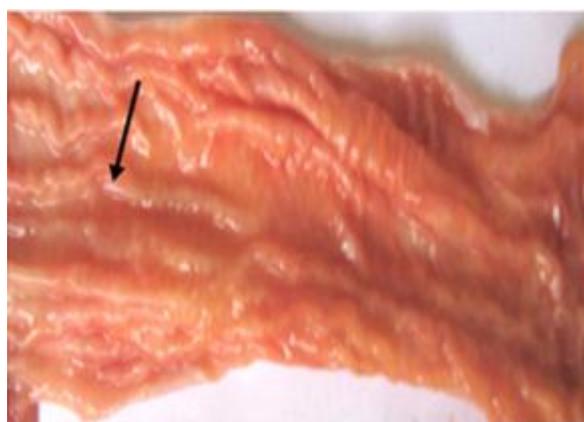


Fig. (2): Gross appearance of the internal surface of the cervical esophagus of homing pigeon, longitudinal folds were deep (arrow).

that in the thoracic esophagus of each sex (Table 2), longitudinal folds in the cervical esophagus was great deep than that in the thoracic esophagus in each sex (Fig. 8-10). Sub mucosa was no evidence, consist of loose connective tissue with blood vessels (Fig.4,9), mean thickness of sub mucosa in cervical esophagus of male was (60.7±11.5µm), while in female was (40.2 ± 7.5µm), and mean thickness of sub mucosa in

thoracic esophagus of male was (40.6 ± 8.9µm), while in female was (20.6 ± 3.6 µm). The mean thickness of sub mucosa in cervical esophagus is thicker than that in thoracic esophagus of each sex (Table2). Tunica muscularis composed of a thicker inner circular and a thinner outer longitudinal smooth muscle layer (Fig. 9), mean thickness of tunica muscularis in cervical esophagus of male was (500.6 ± 44.6µm), while in female



Fig. (3): Gross appearance of the internal surface of thoracic esophagus of homing pigeon, longitudinal folds were less deep (arrow).

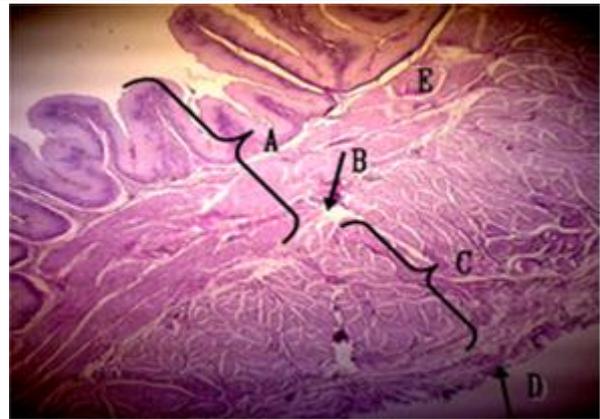


Fig. (4): Cross section of the cervical esophagus mucosa (A), sub mucosa (B) (arrow), muscularis (C), adventitia (D) (arrow), mucous glands (E). H&E X40.

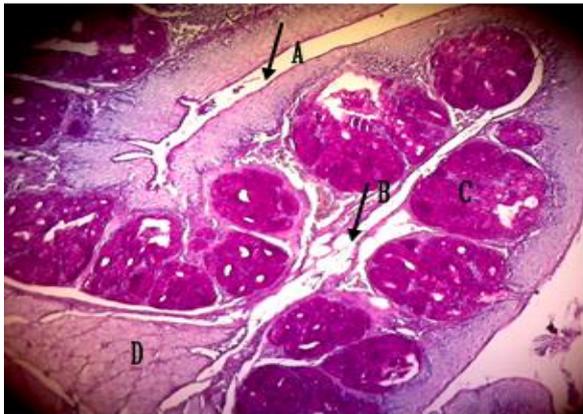


Fig. (5): Cross section of the thoracic esophagus, non-keratinized stratified squamous epithelium (A), lamina propria (B), mucous glands (C), muscularis mucosa (D), PAS X100.



Fig. (6): Cross section of the thoracic esophagus, non-keratinized stratified squamous epithelium (A), lamina propria (B), mucous glands (C), longitudinal folds (D), H&E X100.

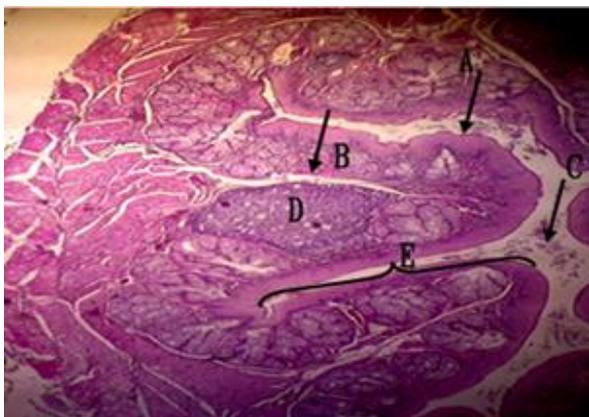


Fig. (7): Cross section of the thoracic esophagus, epithelium (A), lamina propria (B), esophageal lumen (C), lymphatic tissue (D), longitudinal folds (E), H&E X40.

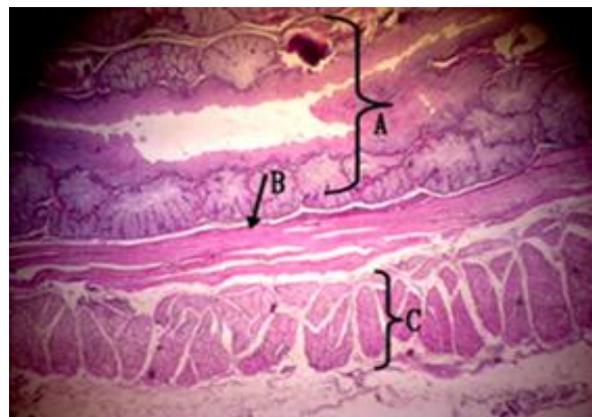


Fig. (8): Cross section of the cervical esophagus, longitudinal folds less deep, lamina propria (A), muscular mucosa (B), tunica muscularis (C), H&E X40.

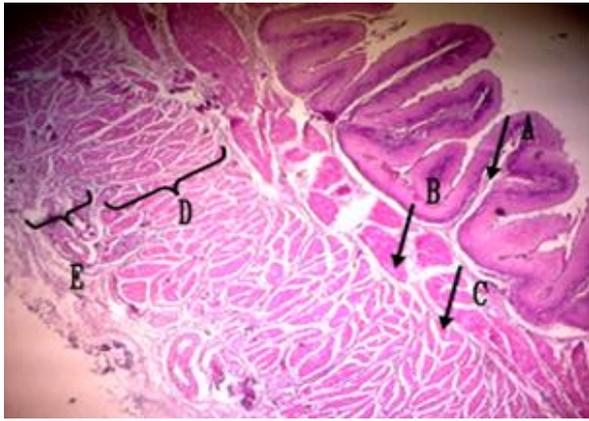


Fig. (9): Cross section of the cervical esophagus, lamina propria (A), muscularis mucosa (B), submucosa (C), inner muscularis (D), outer muscularis (E), H&E X40.

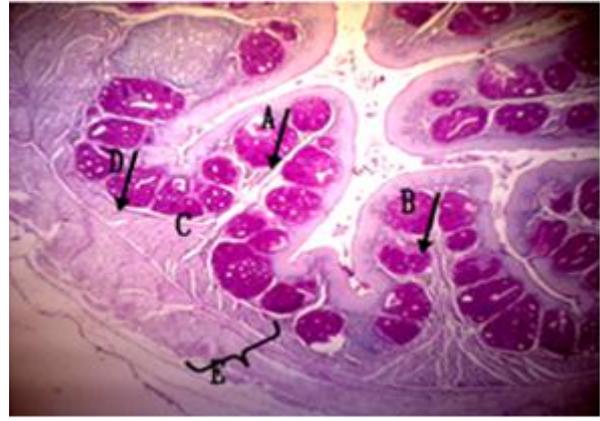


Fig. (10): Cross section of the thoracic esophagus, lamina propria (A), mucus glands (B), muscularis mucosa (C), submucosa (D), muscularis (E), PAS X40.

was ($427.7 \pm 41.6 \mu\text{m}$), and mean thickness of tunica muscularis in thoracic esophagus of male and female were (700.5 ± 51.5 and $601.8 \pm 47.8 \mu\text{m}$ respectively), mean thickness of muscularis in thoracic esophagus was thicker than that in cervical esophagus of each sex (Table 2). Tunica adventitia made up of loose connective tissue and contains blood vessels (Fig. 4), mean thickness of

adventitia in cervical esophagus of male was ($75.3 \pm 7.4 \mu\text{m}$), while in female was ($70.1 \pm 3.2 \mu\text{m}$). And mean thickness of adventitia in thoracic esophagus of male and female were (67.5 ± 8.2 and $60.4 \pm 4.6 \mu\text{m}$ respectively), mean thickness of adventitia in cervical esophagus was thicker than that in thoracic esophagus of each sex (Table 2).

Discussion

The present study revealed the esophagus of homing pigeon is long tube located in right side of the neck between the oropharynx and proventriculus, mean length of esophagus in male was longer than that in female this result agreement with (5, 6 and 21), while disagreement with (7) who study the common pheasant esophagus and (8) who study the partridge esophagus. The different may be due the esophagus length had relationship with body length and sternum length of bird. (22) mention the difference between male and female of black scoter in the relative esophagus length referring to body length and sternum length, and (21) in bean goose. Esophagus was composed of two parts, cervical and thoracic, mean length, diameter of lumen of cervical part is greater than that of thoracic part in each sex, this results agreement with (3), while disagreement with (10) who study the chicken esophagus. Esophagus carries food from the mouth to the crop and from crop to the proventriculus and is generally greater in

diameter due to the limited ability of avian to break down their food orally, and distensibility of it important to swallow bulky (23). The cervical esophagus in each sex expanded to form the crop this result agreement with (1, 2 and 3). While disagreement with (4) which mention the esophagus of rheas no form crop, also in captive bustards (5), the crop is responsible to storage and moistened of the ingested food by mucous secreted of the esophagus and crop glands. The longitudinally folds in cervical esophagus were deeper than that in thoracic esophagus, this agreement with (3), these folds assist in increased the extension of the esophagus that participate actively in the placement mechanism of the food to the crop then to the proventriculus (4). Tunica mucosa consist of epithelium formed by non keratinized stratified squamous epithelium, lamina propria and muscularis mucosa, mean thickness of mucosa in the cervical esophagus was thicker than that in the thoracic esophagus in each sex this result

agreement with (9) in common quail, present the reversed relation between mucous glands and longitudinal folds in parts of the esophagus, this may be due to important for lubrication and protecting of the mucosa for the passage of food particles. The submucosa consist of loose connective tissue with blood vessels, this description agreement with (12) who study the chicken esophagus, tunica muscularis consist of two layers, an inner circular and an outer longitudinal, it was similar to that found by (15), while disagreement with (8) which mention the cervical esophagus in partige Raynchotus contain three layers, an inner longitudinal, a medium circular and outer

longitudinal. The tunica muscularis at the thoracic esophagus of avian esophagus is formed of smooth fibers and not striated as in mammals (24), mean thickness of tunica muscularis in cervical esophagus is thinner than that in thoracic esophagus of each sex this result agreement with (9), but its thickness in the male was thicker than that in female this result disagreement with (9) who study the esophagus of common quail, The contractions of the tunica muscularis push the food to the gizzard. Adventitia consist of loose connective tissues, there was no difference between the structure of the tunica serosa and adventitia of birds (14).

References

- 1-Dyce K M, Sack W O, Wensing C J G (2010) Textbook of Veterinary Anatomy, 4th ed. The anatomy of birds. W B. Saunders company. Philadelphia.Pp:794-796.
- 2-Shehan N A (2012) Anatomical and histological study of esophagus in geese (*Anser anser domesticus*). Bas. J. Vet. Res. 11(1):13-22.
- 3-Rus V, Miclaș V, Nadas G C, Cadar D (2000) Structural particularities of the White stork (*Ciconia ciconia*) esophagus. Annals of RSCB, V14(1):177-179.
- 4-Rodrigues M N, Oliveira G B, Silva R, Tivane CT, Albuquerque J F G, Mi-gliano M A, Oliveira M F (2012) Gross morphology and topography of the digestive apparatus in rheas (*Rhea americana americana*). Pesquisa Veterinaria Brasileira, 32(7): 681-686.
- 5-Bailey T A, Mensah E P, Samour J H, Naldo J, Lawrence P, Garner A (1997) Comparative morphology of the alimentary tract and its glandular derivatives of captive bustards. J. Anat, Cambridge, v. 191.: 387-398.
- 6-Szczepan D E, Wesolowska I (2008) Morphometric characteristics of esophagus and intestine in tufted ducks (*Aythya fuligula*), wintering on the Baltic coastal areas in North –Western Poland, Electronic J. of Polish Agricultural uni. 11 (4):35-39.
- 7-Yovchev D, Dimitrov R, Kostov, Vladova D (2012) Age morphometry of some internal organs in common pheasant (*Phasianus colchicus colchicus*), Trakia J.of Sci.,10(3): 48-52.
- 8-Rossi J R, Baraldi S M, Oliveria D (2006) Morphology of esophagus and crop of partige Rhynchotus rufescens (tiramidae). Maringa, 28(2):165-168.
- 9-Parchami A, Dehkordi R A F (2011) Histological characteristics of the esophageal wall of the common quail (*Coturnix coturnix*). World applied sciences j. 14(3):414-419.
- 10-Sisson S, Grossman J D (1986) Anatomia dos animais domestic.5ed,Rio de Janeiro:Guanabara Koogan.
- 11-Tivane C (2008) A morphological study of the oropharynx and esophagus of the ostrich (*Struthio camelus*). MSc dissertation, University of Pretoria, South Africa.Pp:1-11.
- 12-Nagy N, Magyar A, Gazadag E, Palya V (2005) Esophageal tonsil of the chicken. Acta Vet Hung.53(2):88-173.
- 13-Crole M R (2009) A gross anatomical and histological study of the oropharynx and proximal esophagus of the emu (*Dromaius novaehollandiae*). MSc dissertation, Univ. of Pretoria.Pp:3-9.
- 14-Ebrahim R, Abolghasem N (2009) Histological study on the esophagus and crop in various species of wild bird .Avian Biology Research, 2(3): 161-164.
- 15-Battah A L (2009) Histological and histochemical study of the digestive tract in homing pigeon (*Columba livia domestica*), MSc dissertation, University of Basra, Collage of Vet. Med.Pp:16-25.
- 16-Shiina T, Shimizu Y, Izumi N, Suzuki Y, Asano M, Atoji Y, Nikami H, Takewaki T (2005) A comparative histological study on the distribution of striated and smooth muscles and glands in the esophagus of wild birds and mammals. J. Vet. Med. Sci. 67(1): 115–117.
- 17-Shindala M K (1990) Anesthetic effect of ketamine, ketamine with diazepam in chicken. Iraqi Vet.J.Sci.12:261-265.
- 18-Dziubin A and Cooch E (1992) Measurement of geese: general field methods, California Waterfowl Association. Sacramento, CA. 20. Cited by Szczepan,et al., (2008).
- 19-Luna I G (1968) Manual of histology staining methods of the armed force institute of pathology. 3Prd ed. McGraw. Hill book company. New York, Pp:33,76 -168 .
- 20-Al-Rawi K M, Kalaf-Allah I S (1980) Design and Analysis Agriculture Experiments. Dar-Al Kutub-Mosul, Iraq, Pp: 65, 95-107.

- 21-Szczepanczyk E, Kalisinska E, Ligocki M, Bartyzel B (2000) Morphometry of esophagus and gut in bean goose (*Anser fabalis*). *Zoologica Poloniae* 45(1-4):37-46.
- 22-Szczepan D E (2004) Mophometric characteristic of esophagus and intestine in black scoter, *Melanitta nigra* (*Anseriformes*), wintering in the Polish Baltic coast , *Vestnik zoo.*, 38(4): 31–37.
- 23-Clark F D (2005) Normal birds .A review of avian anatomy. University of Arkanas .J., *Avian advice* .7(1):1-3
- 24-Aughey E, Frye F L (2001) Comparative veterinary histology with clinical correlates, Manson publishing Ltd, Pp: 105-113.