Morphology of oesophagus and crop of the partrigde *Rhynchotus rufescens* (Tiramidae)

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ABSTRACT. Twenty adult partridges *Rhynchotus rufescens* were used to study the morphology of oesophagus and crop. Materials to the morphologic study were collected and lengths of the oesophagus and of the crop were measured. For histological study, fragments of the oesophagus and of the crop were stained routinely with Masson's trichrome stain. Total oesophagus was larger in females. In the entrance of the thorax, its ventral wall is enlarged broadly, forming the crop, which is larger in males. Oesophagus mucosa is constituted by stratified squamous epithelium, with mucous glands and lymphatic tissues. There are three layers of smooth muscle, involved in serosa. The histological structure of the crop is similar to the oesophagus. The mucous glands are reduced in size and the lymphatic tissues are dispersed in the connective tissue. There is a thin stratum of smooth muscle and other two wider layers of longitudinal and circular musculature.

Key words: oesophagus, crop, partridge, morphology.

RESUMO. Morfologia do esôfago e do papo de perdizes *Rhynchotus rufescens* (Tiramidae). Vinte exemplares de *Rhynchotus rufescens* foram utilizadas para estudar a morfologia do esôfago e do papo. O material para o estudo morfológico foi coletado e o comprimento dos órgãos foi avaliado. Para o estudo histológico, as secções histológicas foram coradas com tricromo de Masson, posteriormente analisadas e descritas. O comprimento médio total do esôfago foi maior em fêmeas. Na entrada do tórax, a parede ventral do esôfago se dilata, formando o papo, maior em machos. A mucosa do esôfago é formada por epitélio escamoso estratificado, com glândulas mucosas e nódulos linfáticos. Há três camadas de músculo liso, as quais são envolvidas por serosa. A característica histológica do papo é semelhante à do esôfago. No papo, as glândulas mucosas são menores e os nódulos linfáticos estão dispersos no tecido conjuntivo. Há uma camada delgada de músculo liso e outras duas camadas mais largas de musculaturas longitudinal e circular.

Palavras-chave: esôfago, papo, perdiz, morfologia.

Introduction

White (1968) analyzed the swallowing mechanisms in chicken and described the following: the food taken by the beak is dislodged by the tongue to the roof of the oral cavity, sticking there through the mucous secretion of the salivary glands; by fast rostral and caudal movements, the tongue rolls the food bolus through its caudal face and the palate until the pharynx. Passing caudally to the tongue, food bolus is moved by movements of the larynx prominence. With fast rostral and caudal movements, the larynx prominence rolls the bolus between its caudal face and the roof of the pharynx.

Latimer and Rosenbaum (1926) showed the length of the female turkey oesophagus. Marsden (1940) verified that the cervical oesophagus is twice larger than the thoracic oesophagus. Oesophagus in ducks and gooses is described by Das *et al.* (1965) and Das and Biswal (1967).

The avian oesophagus is on the right side of the neck (mammals present it on the left side). Sisson and Grossman (1986) described chicken oesophagus. It is placed between the oropharynx and the stomach glandular portion; oesophagus has thin and dilatable walls and it has a diameter relatively larger than that of mammals.

According to Sisson and Grossman (1986), the chicken cervical oesophagus is shorter than its

cervical column, not extended, and shaped like an "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, the oesophagus is located on the right side of the neck, among the jugular vein, the vagus nerve and the thymus, dorsally, and the trachea, ventrally. Immediately cranial to the thoracic entrance, the oesophagus returns to the median line and it expands ventrally to form a diverticle, the crop, which is ventral and lateral to the oesophagus and cranial to the clavicle and breast muscles.

Oesophagus and crop internal surfaces present longitudinal folds and they are lined for stratified squamous epithelium in which several mucous glands open up (Sisson and Grossman, 1986).

The oesophagus and the crop epithelia in fowl are stratified squamous, and in some species such as the pigeon it is extremely keratinized (Banks, 1992). In contrast with mammals, the esophageal glands are found in the mucosal layer and not in the submucosa; these are tubular and secrete lubricating mucus (George *et al.*, 1998). The lamina propria is formed by loose connective tissue with diffuse lymphatic tissues and some lymphatic nodules. Nodular lymphatic tissue is especially evident in the crop. The mucosa forms longitudinal folds (Banks, 1992).

According to George *et al.* (1998), the muscularis mucosae of the fowl oesophagus varies in species, in number of present layers (one or two) and in orientation of the muscular fibers bunches. Simple tubular mucous glands are present in the oesophagus. Outside the muscularis mucosae are the submucosa and, finally, the tunica muscularis with inner circular and outer longitudinal layers. The latter is covered by the adventitia.

The ingluvies or crop is the extensive part of the cranial oesophagus to the entrance of the thorax. Its structure and function vary according to the species and the diet. The crop is absent in the gulls and penguins, and the food passes directly for the proventriculus or it is stored in the tubular oesophagus. Nickel (1977) relates the chicken oesophagus as unilateral and the pigeon crop is symmetrically bilateral. According to Banks (1992), the epithelium of the crop in general is denser than the one of the oesophagus. Simple tubular mucous glands are present in ducks, but they are absent in chickens and pigeons. In pigeons, the superficial cells of the epithelium suffer a lipid alteration and develop into a substance called crop milk. The remaining wall tunics are similar to that of the oesophagus. The crop of the pigeon presents seromucosa secretion, which can participate in the pre-digestion of the victuals, especially of starches (George *et al.*, 1998).

The purpose of this paper was to study the morphology of the partridge *Rhynchotus rufescens* Temminck, 1815 oesophagus and crop.

Material and methods

Twenty adult partridges *Rhynchotus rufescens* were used (10 males and 10 females). The fowls were euthanased with ethyl ether. After the laparotomy and after uncovering the esternal breastplate, organs were documented "in loco" and later partial evisceration of the alimentary tract was made. The materials destined to the morphologic study were collected and the lengths of the oesophagus (thoracic and cervical portion) and the crop were measured. Afterwards, these organs were fixed in a 10% formalin solution.

For the histological study, fragments of the oesophagus and the crop were immersed in Bouin for 24 hours and then submitted to the dehydration process with alcohol and embedded in Paraplast (Merk®). Histologic sections of 7 μm thick were obtained and stained routinely with Masson's trichrome stain. Later, the sections were documented in Olympus microscope, model BX50, analyzed and described histologically.

Whenever possible, the anatomical nomenclature used was based on Nomina Anatomica Avium (NAA) (Baumel *et al.*, 1993).

After obtaining the data, variance analysis and qui-square test (5% significance) were calculated using the software "SAS" (1999) for comparison between the sexes.

Results and discussion

The oesophagus of the partridge is an organ located to the right of the fowl body in the cervical portion, and it extends from the oropharynx to the stomach. For this reason, it can be studied in two parts: cervical (Figure 1) and thoracic oesophagus, just as observed by Chikilian and De Speroni (1996) in tinamous, and by Bailey *et al.* (1997) in bustards.

The cervical part is long, with approximately 11.72 cm of length in the female partridge, and 11.20 cm of length in the male. It extends from the oropharynx to the crop. The thoracic portion is placed below the crop, dorsally to the trachea, and it presents a mean length of 4.50 cm for females and 4.30 cm for males, extending until the stomach. There was no significant difference between the

sexes in relation to the length of the partridge oesophagus, which shows a contrast to the study of Bailey *et al.* (1997), who described the esophagi of male bustards as being significantly larger than the female ones. The total partridge oesophagus length presents 17.05 cm and 16.60 cm of length for females and for males, respectively.

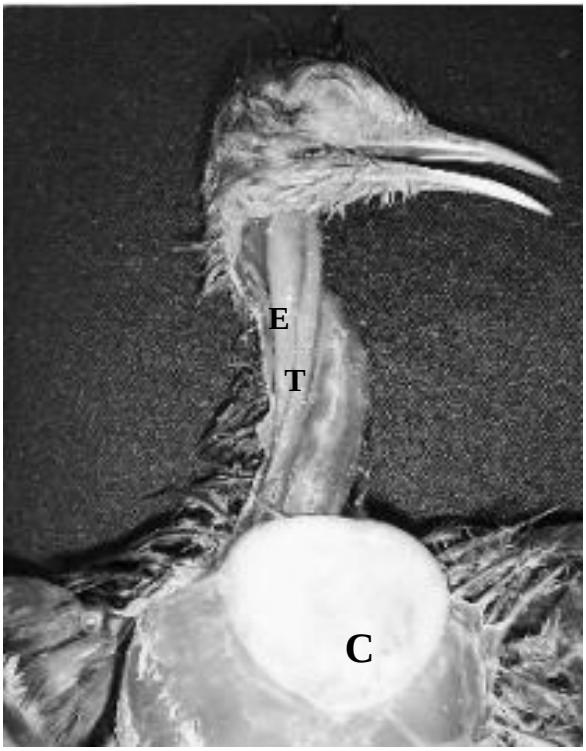

Figure 1. Ventral view of partridge oesophagus (E), trachea (T) and crop (C) filled with food.

Oesophagus mucosa of the partridge is constituted by stratified squamous epithelium and it contains ramified mucous glands and nodular lymphatic tissues (Figure 2A). Lymphatic nodules are prominent within the connective tissue (lamina propria). Suganuma *et al.* (1981) and Bacha and Bacha (2000) explained that the fowls esophageal glands are always of mucous type and they are only on the lamina propria. On the lamina propria of the partridge oesophagus there are three layers of smooth muscle: an inner longitudinal, a medium circular and an outer longitudinal, which is involved in a typical serosa (Figure 2A).

In the entrance of the thorax, its ventral wall is enlarged broadly, forming a diverticule (crop) (Chikilian and De Speroni, 1996; Dyce *et al.*, 1996). The crop is responsible for the storage of victuals (Turk, 1982). Partridge crop (Figure 1) is located in the clavicle area, and its length is 3.10 cm in females and 3.35 cm in males.

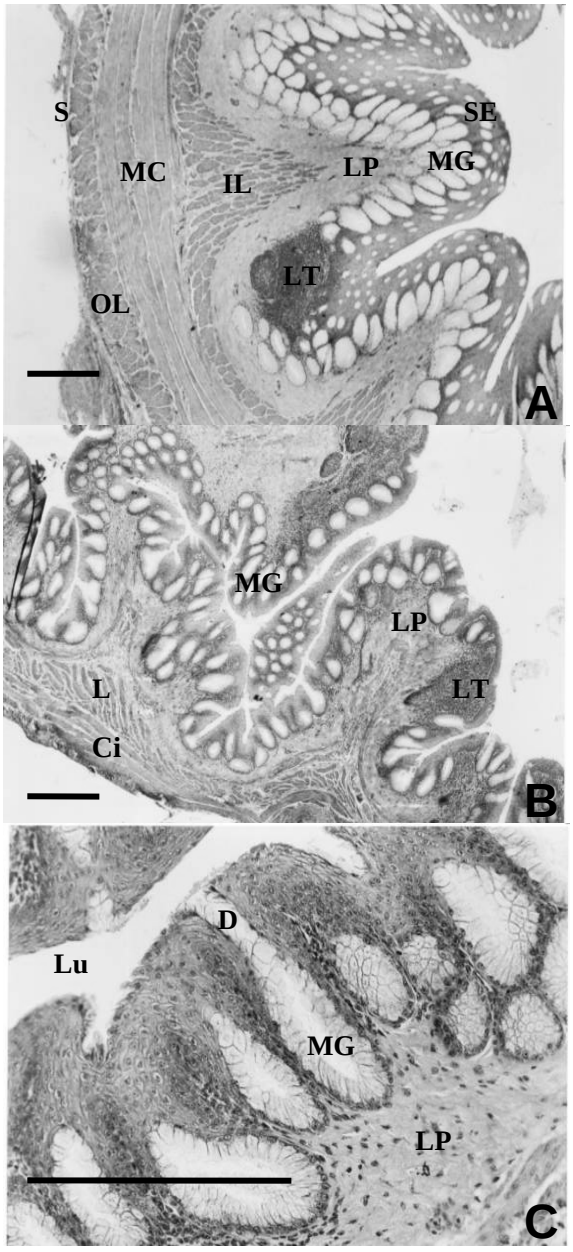

Figure 2. A - Transversal section of partridge oesophagus. Mucosa presents a stratified squamous epithelium (SE) with mucous glands (MG) spread close to the lamina propria (LP). There is a nodular lymphatic tissue (LT) in this region. There are three layers of smooth muscle, an inner longitudinal (IL), a medium circular (MC) and an outer longitudinal (OL), involved in the serosa (S). 10x. **B -** Transversal section of partridge crop. Presence of mucous glands (MG) and diffuse lymphatic tissues (LT). Within the lamina propria (LP) there are the musculature layers: longitudinal (L) and circular (Ci). 10x. **C -** Detail of partridge crop mucosa. Observe the mucous glands (MG) ducts (D) opening in the lumen (Lu), and its opposite extremity is prominent within the lamina propria (LP). 40x. Masson's trichrome stain. Barr = 100 μm.

Turk (1982) described that the entrance of the food bolus into the crop is controlled by the tonus

of the oesophagus in the region of the crop. When this region is relaxed under the influence of a gizzard filled with food, the food bolus descending the oesophagus is directed into the crop. Food is moved out of the crop into the lower oesophagus by small groups of contractions within its walls. In ducks and geeses, as in most of the birds, the crop is merely a fusiform expansion of the oesophagus (Dyce *et al.*, 1996). In bustards, the crop is absent (Bailey *et al.,* 1997).

The histological structure of the crop is similar, in several aspects, to the structure of the oesophagus. However, the mucous glands are reduced in size and the lymphatic tissues are dispersed in the connective tissue (Figure 2B and 2C). George *et al.* (1998) found simple tubular mucous glands in ducks. Lining the mucosa, there are a thin stratum of smooth muscle and other two wider layers of longitudinal and circular musculature, which are associated with the form of the organ (Figure 2B), differently from what George *et al.* (1998) found in pigeons. In those animals, the tunics of smooth muscle are uniform, as in the oesophagus.

Conclusion

Total partridge oesophagus length is not significantly longer in females than it is in males ($p>0.05$). Oesophagus mucosa is constituted by stratified epithelium, with ramified mucous glands and nodular lymphatic tissues. On the lamina propria there are three layers of smooth muscle, which is involved in serosa.

In the entrance of the thorax, its ventral wall is enlarged broadly, forming a diverticule (crop), located in the clavicle area, longer in males ($p>0.05$). The histological structure of the partridge crop consists of mucous glands reduced in size and the lymphatic tissues are dispersed in the connective tissue. There is a thin stratum of smooth muscle and other two wider layers of longitudinal and circular musculature which are associated with the form of the crop.

References

BACHA, W.J.; BACHA, L.M. *Color Atlas of Veterinary Histology*. 2. ed. Philadelphia: Lippincott Williams & Wilkins, 2000.

BAILEY, T.A. *et al.* Comparative morphology of the alimentary tract and its glandular derivatives of captive bustards. *J. Anat,* Cambridge, v. 191, p. 387-398, 1997.

BANKS, W.J. *Histologia veterinária aplicada*. 2. ed. São Paulo: Manole, 1992.

BAUMEL, J.J. *et al. Handbook of Avian Anatomy: Nomina Anatomica Avium*. 2. ed. Cambridge: Nuttall Ornithological Club, 1993.

CHIKILIAN, M.; DE SPERONI, N.B. Comparative study of digestive system of three species of tinamou. I. *Crypturellus tataupa*, *Nothoprocta cinerascens*, and *Nothura maculosa* (aves: Tinamidae). *J. Morph.,* Hoboken, v. 228, n. 1, p. 77-88, 1996.

DAS, L.N.; BISWAL, G. Microscopic anatomy of oesophagus, proventriculus and gizzard of the domestic duck (*Anas boscas*). *Indian Vet. J.*, Chennai, v. 44, n. 4, p. 284-289, 1967.

DAS, L.N. *et al.* Comparative anatomy of the domestic duck (*Anas boscas*). *Indian Vet. J.*, Chennai, v. 42, p. 320-326, 1965.

DYCE, K.M. *et al.* Anatomia das aves. *In*: DYCE, K.M. *et al.* (Ed.). *Tratado de anatomia veterinária*. 2. ed. Rio de Janeiro: Guanabara Koogan, 1996.

GEORGE, L.L. *et al. Histologia comparada*. 2. ed. São Paulo: Roca, 1998.

LATIMER, H.B.; ROSENBAUM, J.A. A quantitative study of the anatomy of the turkey hen. *Anat. Rec.,* Charleston, v. 34, p. 15-23, 1926.

MARSDEN, S.J. Weights and measurements of parts and organs of turkeys. *Poult. Sci.,* Savoy, v. 19, p. 23-28, 1940.

NICKEL, R. *et al. Anatomy of the domestic birds*. Berlin: Verlag Paul Parey, 1977.

"SAS"- Statistics Analysis Institute. User's guide. North Caroline: SAS Institute Inc, 1999.

SISSON, S.; GROSSMAN, J.D. *Anatomia dos animais domésticos*. 5. ed. Rio de Janeiro: Guanabara Koogan, 1986.

SUGANUMA, T. *et al.* Comparative histochemical study of alimentary tracts with special reference to the mucous neck cells of the stomach. *Am. J. Anat.,* Philadelphia, v. 161, n. 2, p. 219-238, 1981.

TURK, D.E. The anatomy of the avian digestive tract as related to feed utilization. *Poult. Sci.,* Savoy, v. 61, n. 7, p. 1225-1244, 1982.

WHITE, S.S. Mechanisms involved in deglutition in *Gallus domesticus*. *J. Anat.*, Cambridge, v. 104, p. 177, 1968.

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