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Morphological Study of Trachea in Swan Goose (*Anser cygnoides*)

Hasanain jaafar Ali, Fatimah Swadi Zghair

Department of Anatomy and Histology, College of Veterinary Medicine, University of Al-Qadisiyah, Al-Diwaniyah City, Iraq.

Corresponding Author Email Address: fatimah.zghair@qu.ed.iq

ORCID: https://orcid.org/0000-0002-8871-0634

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Abstract:The current investigation was done to study the characteristic anatomical features of the trachea in the swan geese (*Anser cygnoides*). For that purpose, the methods included using 10 birds (5 males 5 females) collected between October and March. The birds were euthanized, the trachea was collected, and features such as location, relationship, length, weight, and volume were reported. The results revealed that the trachea was located between (caudally) first tracheosyrnigeal cartilage border and (rostrally) in the caudal border of the cricoid cartilage of the larynx. The skeleton of the trachea and each ring of the tracheal cartilages included both broad and narrow regions, with the broad parts of adjacent rings overlapping the narrow parts of the adjacent rings. The trachea was joined to two muscles. Sternotracheolaryngeus muscles, also called sternotrachealis muscles, are a pair of large skeletal muscles securely attached to the trachea at the tenth ring of the distal half, cranial to the pessulus cartilage of the syrinx. They are easy to see, face forward, and come from the craniolateral process of the sternum. This serves as the primary origin of the caudolateral and caudomedial extrinsic muscles of the larynx. This study clearly shows the characteristic features of the trachea of the swan geese that could be useful buildups for future studies that deal with different sciences related to this important bird.

Keywords: Anatomical features, *Anser cygnoides*, Swan goose.

Introduction

The geese are one of the oldest birds that have been domesticated in the world and have been a part of the history of many countries. This is evident from the excavations in Egypt, as well as the pictures on the walls of the temples. Also, geese were holy birds to the Romans (1). The

avian respiratory system is one of the most important parts of exchanging oxygen and carbon dioxide during inhalation and exhalation. In many countries, such as Egypt, China, and Thailand, geese were the most common birds in villages. This was done so that farm waste could be used to good effect, giving small-scale farmers a way to make extra money and giving their families a healthy source of animal protein. It would be best to look into how birds keep their body temperature stable. From there, it travels down the trachea and into the lungs (2, 3). The tracheal part, a cartilaginous tubular component that parallels the esophagus in terms of anatomy, is responsible for airway regulation. There are certain similarities between the respiratory systems of birds and mammals, although the tracheal part in birds is a full tracheal ring. The norm connective tissue is the ciliated pseudocolumnar epithelial layer and mucosal glands that border the tracheal region. Supportive tissue, such as cartilages with accompanying blood vessels, can be found in the lamina property and the submucosal layer (4).

The avian respiratory system consists of nonvascularized respiration air sacs and solid gas-exchanging bronchial part-based lungs. Together, these two parts of the lung enable the unification of air and blood. The pulmonary system is linked to temperature control, smell senses, and interaction. Nontidal breathing is used to define the mechanism used by birds to breathe. The syrinx is the point at which the tracheal part of a bird divides into the right and left bifurcations (1).

Materials and methods

Birds and collection of tracheae

The methods included using 10 birds (5 males 5 females). The birds were euthanized, the trachea was collected, and features such as location, relationship, length, weight, and volume were reported.

Morphological examination

All studied birds were weighed and then euthanized by inhalation by chloroform (3). Each bird was dissected by fixing it on a suitable dissecting board to view the neck and thoracic trachea. A mid-line incision in the thoracic-abdominal wall was made, and after that, the trachea was identified and photographed in situ using a digital camera (Sony Dsc-H90). Samples were extirpated and washed with normal saline to remove adhered debris and blood; then, they have cleaned again with normal saline. Then, the weight of the trachea was measured in grams using a sensitive digital scale (Notebook Series-Digital scale).

The collected segments' macroscopic measurements (length and diameters) were conducted in centimeters and millimeters using the electronic vernier caliber. At the same time, the volume was measured by the water displacement method. Statistical analysis used by spss (T-test), version 1.

Results

Morphological features of trachea:

In our study, the trachea was longer than the neck and appeared empty cartilaginous. The mean length was (49.38±3.585 and 42.68±1.765cm, in males and females, respectively) The trachea was located between (caudally) first tracheosyringeal cartilage border and (rostrally) in the caudal border of the cricoid cartilage of the larynx (Fig. 1). The proximal part extends from the cricoid cartilage of the larynx to the thoracic inlet, it is located in the ventral midline of the esophagus (Fig. 1).

The mean weight of the trachea was 24.908±4.761 and 24.14±1.468 for males and females, respectively. The skeleton of the trachea and each ring of the tracheal cartilages included both broad and narrow regions, with the broad parts of adjacent rings overlapping the narrow parts of the adjacent rings (Fig.3). Annular ligaments connected the full circular cartilages. The distal trachea's last few millimeters show thick, non-overlapping rings instead of the previously present overlapping characteristics (Fig. 4).

There were an average 135±0.632 and 135.2±0.4, of total tracheal rings in males and females, respectively. The tracheal rings in the proximal part were transverse ovoid rings, with a mean diameter of 16.05±0.219 and 16.04±0.314 cm, for males and females, respectively. In contrast, the vertical oval rings in the distal part had a mean diameter of 16.996±0.412 and 16.6±0.237 cm, for males and females, respectively. The trachea changes to a syrinx close to the heart's base, dividing it into two significant bronchi (Fig. 4).

Two muscles were attached to the trachea. Sternotracheolaryngeus muscles, also called sterntrachealis muscles, are a pair of large skeletal muscles attached to the trachea at the tenth ring of the distal half, cranial to the pessulus cartilage of the syrinx.

They have a craniomedial orientation and come from the sternum's craniolateral process (Fig. 4). Then, it runs cranially and is firmly implanted on the lateral aspect of the larynx and joined to the lateral aspect of the trachea. This serves as the primary origin of the caudolateral and caudomedial extrinsic muscles of the larynx (Fig. 4). Lateralis muscles of the trachea Coupled small skeletal muscles that are barely noticeable and transparent arise from the lateral aspect of the trachea of the distal part and extend cranially to the pessulus cartilage of the syrinx (Fig. 2, 4) before running cranially and loosely attaching to the trachea, where they terminate at the lateral aspect of the cricoid body of the larynx.

Table 1: Dimension and weight for trachea and syrinx of swan geese.

Morphol. measurement	Trachea		T test	P value	Syrinx		T test	P value
	Male	Female			Male	Female		
Length (cm)	49.38±3.585	42.68±1.765	3.353	0.01(S)	2.59±0.363	2.22±0.116	1.937	0.089 (NS)
Width(cm)					1.62±0.231	1.4±0.141		
Diameter (mm) cranial	16.05±0.219	16.04±0.314	0.052	0.960(NS)			1.622	0.143 (NS)
Diameter (mm) caudal	16.996±0.412	16.6±0.237	1.664	0.135(NS)				
Weight (gm)	24.908±4.761	24.14±1.468	0.308	0.766(NS)	0.806±0.083	0.838±0.041	0.685	0.512 (NS)
Number of rings	135±0.632	135.2±0.4	0.535	0.608(NS)				

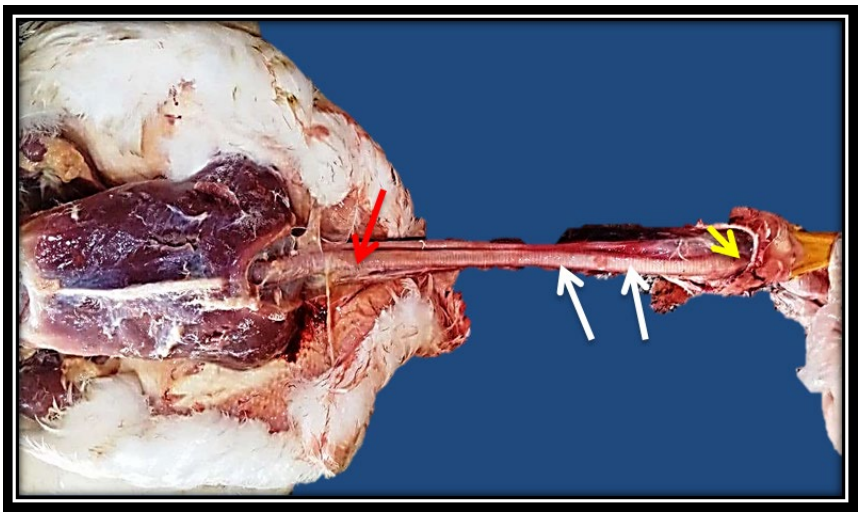

Fig. 1: Dorsal views of the trachea and larynx of the swan goose show the larynx (yellow arrow), the proximal portion of the trachea (white arrows), and the distal portion of the trachea (red arrows).

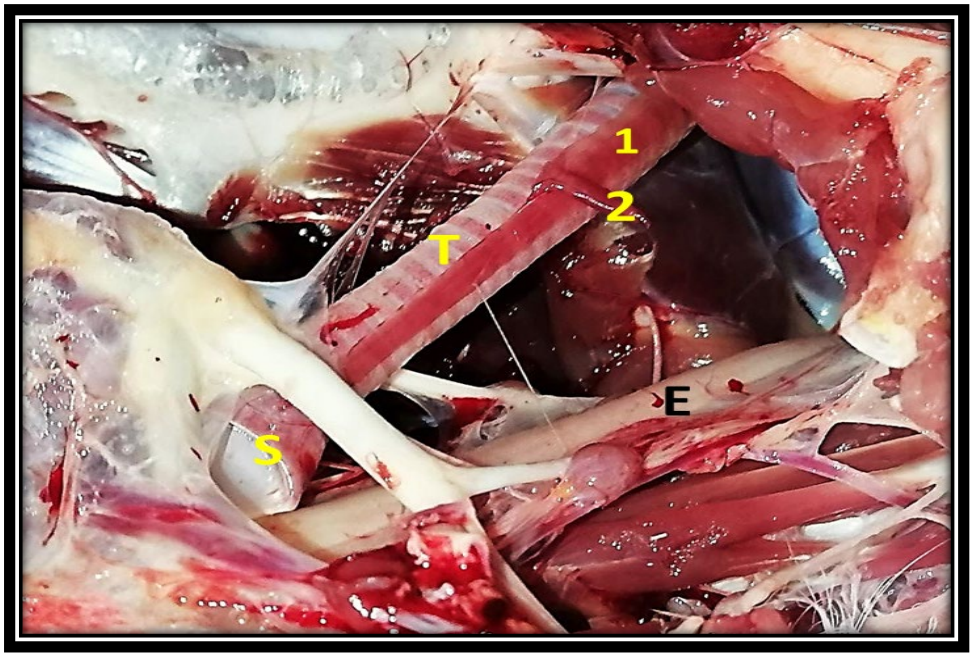

Fig. 2: Lateral view of the muscles and organs of swan goose shows: trachea (T), sternotrachilis muscle (2), trachilis latralis muscle (1), esophagus (E), and syrinx (S).

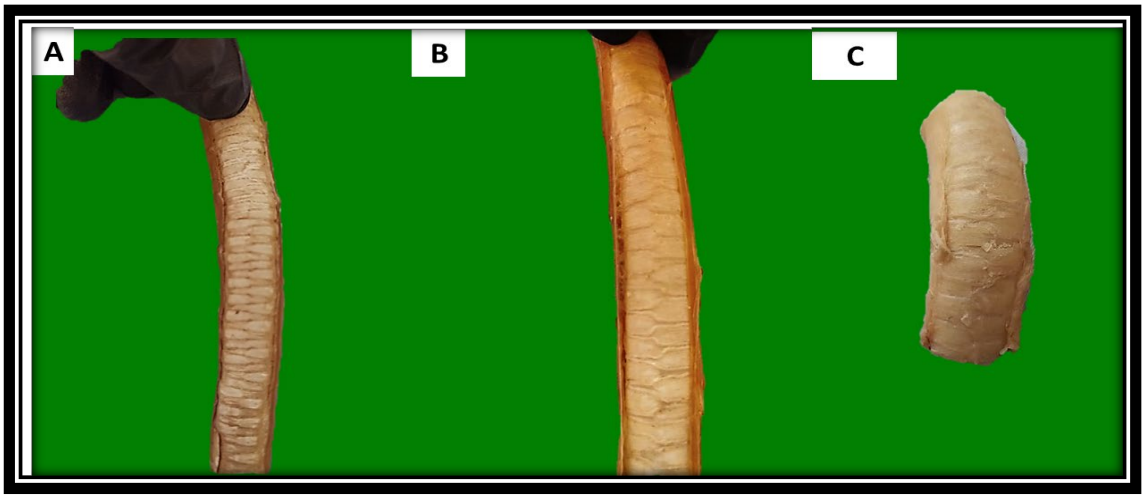

Fig. 3: Photograph trachea of swan goose shows upper part of trachea (A.), middle part of trachea (B) and lower part of trachea (C).

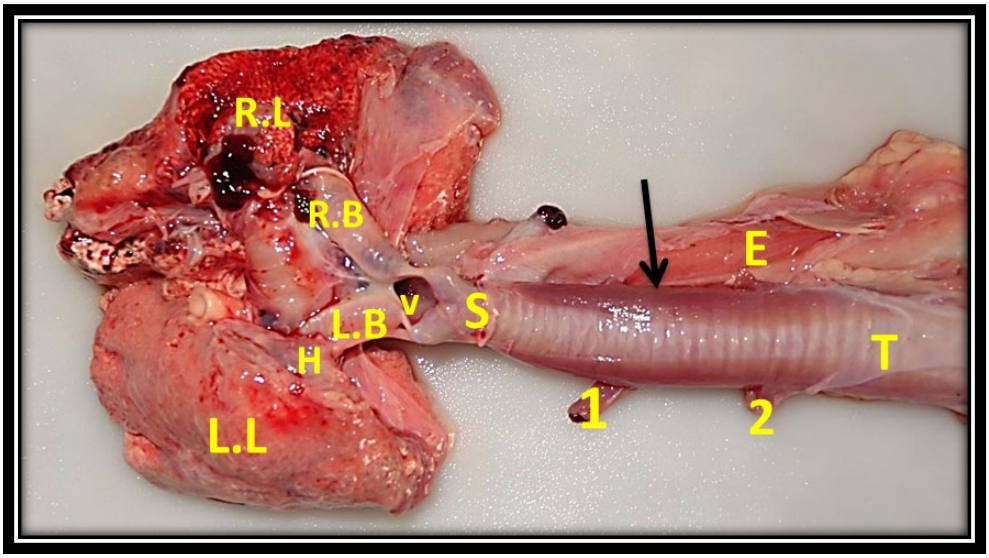

Fig. 4: Dorsal view of the muscles and organs of swan goose shows: esophagus (E), trachea (T), sternotrachilis muscle (1), trachilis latralis muscle (black arrow) origin of trachilis latralis muscle (2), syrinx (S), extra pulmonary primary bronchi right and left (R.B & L.B) right and left lung (R.L & L.L), triangular of the voice (v) and hillus of lung (H).

Discussion

In spite of the abundance of avian anatomy resources, the relative placement of the cervical viscera, including the trachea, in birds and other vertebrates has received surprisingly little consideration. Given our extensive knowledge of mammalian anatomy, it may seem natural to assume that all vertebrate tracheae and esophagus are located in the midsagittal plane of their respective necks, just as they are in humans. However, comparative research on the relative placement of these anatomical characteristics is limited (2). These occurrences are mentioned briefly and ambiguously, and almost as an afterthought. An interesting facet of the esophagus and the windpipe has been missed since it may not appear crucial or visible. In birds, trachea is often located far to one side. The trachea and esophagus are located in the middle of the neck, whereas the external carotid arteries, jugular veins, and vagus nerve are on each side. The trachea and esophagus may lie lateral to the neck's body (the vertebrae and their accompanying muscles) rather than in a midsagittal arrangement. Dissecting the necks of vertebrates shows the presence of displaced

cervical viscera, but the system and its variety in birds and reptiles have yet to be systematically described. Therefore, we will refer to this morphological change going forward as tracheoesophageal dislocation (5).

The current anatomical consequences of the trachea in the swan geese disclosed that this respiratory portion came into sight as a cartilaginous empty pipe structure. It was lengthy compared with the neck. These results jived with those from prior studies on birds given by (6,7), but they were independent of those investigations. In the Family Atidae (ducks &swans), Cyginus, Grueds, American species of cranes& have discovered evidence of this. It was identified in goose (*Anser anser* domesticus) (8,9).

It was found in guinea fowls and coot birds (3). The total tracheal length was (49.38±3.585 and 42.68±1.765cm for males and females, respectively). The mean total length of the trachea in west African guinea fowl was measured to be 26.363± 0.383 centimeters, which is consistent with these results. While we agree with him that the budgerigar's (Melopsittacus undulates) tracheal measures are about (5 cm) from the glottis to the bottom of the syrinx. The upper vocal tract works as a filter, presumably modifying the pitch or loudness of sounds created by the avian vocal organ (syrinx). Beak, tongue, and laryngeal motions, as well as tracheal length modifications, are all examples of filter features (5). This is congruent with recent research (5) results, which claimed that tracheal length alterations were a plausible mechanism for modifying the upper vocal tract. At the beginning of song bouts, the zebra finch's trachea contracts, and during the entire theme, the tracheal length reduces during expiratory pressure pulses and rises during the short inspirations (Taeniopygia Bata). It was reported that the budgerigar's tracheal resonances did not affect the contact call's spectrum (10).

Rings to the trachea had a mean diameter of (16.05±0.219 and 16.04±0.314cm for males and females, respectively). These findings contradict the findings of (3) in guinea fowl.

In the trachea, the rings of cartilage that make up the structure overlap, and each ring contains both broad and narrow regions. These effects aligned with earlier results. Most birds agree with (8), but they disagree what (11,12) for domestic fowl

The number of tracheal ring areas of roughly 30 little passerines to over 350 in long-necked flamingos and cranes (14). The mean total of tracheal rings' number was (135±0.632 and 135.2±0.4 for males and females, respectively). The tracheal rings are a bony structure that helps prevent the trachea from collapsing. A recent study by (15,16) lends support for this view; they hypothesized that the inhalation of air creates a negative pressure within the trachea, which may force it to collapse if it were not for the cartilaginous rings that make up the trachea.

There were two tracheal muscles associated with the caudal part of the trachea caudally and cricoid laryngeal cartilage cranially (sternotrachealis and trachiolateralis muscles). These consequences harmonized

with (14) in pigeons. The tracheal muscles of brown thrashers are the tracheolateral dorsalis, tracheolateralis, stermotrachealis, and tracheobronchialis ventralis (15).These characteristics of the trachea complete rings, readily movable overlapping rings, length, and strong tracheal muscles can be linked to the trachea's duty for specific distinctive adaption of sounds as well as its assistance in the migration of mucus secretion toward the larynx and although the sternotrachealis muscles are more prominent in males than in females, they are expected to adjust the length of the trachea during inspiration and/or expiration and to regulate the rigidity of the cartilages of the vocal organ (syrinx) during phonation (16).

Conclusion

This study clearly shows the characteristic features of the trachea of the swan geese that could be useful buildups for future studies that deal with different sciences related to this important bird.

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دراسة شكلية للرغامي في اوزة البجع (*Anser cygnoides*)

حسنين جعفر علي و فاطمة سوادي زغير

فرع التشريح والانسجة، كلية الطب البيطري، جامعة القادسية، مدينة الديوانية، العراق.

الخلاصة

تم إجراء البحث لدراسة السمات المميزة التشريحية للرغامي في إوز البجعة (*Anser cygnoides*). تم استخدام 10 طيور (5 ذكور و 5 إناث). وقتل الطيور بطريقة القتل الرحيم حيث جمعت عينات الرغامي ، وتم تسجيل السمات التشريحية مثل الموقع والعلاقة والطول والوزن والحجم. أوضحت النتائج أن الرغامي كان يقع بين حدود الغضروف الرغامي المصفاري الذيلي و (منقاريا) في الحدود الذيلية للغضروف الحلقي في الحنجرة. الهيكل العظمي للرغامي، كل حلقة من غضاريف الرغامي تضمنت مناطق واسعة وضيقة ، مع الأجزاء العريضة من الحلقات المجاورة المتداخلة مع الأجزاء الضيقة من الحلقات المجاورة. حيث تربط عضلتين بالرغامي، تسمى عضلات الـ Sternotracheolaryngeus ، متصلة بإحكام بالرغامي ، الحلقة العاشرة للنصف البعيد ، قحفيا إلى غضروف الـ pessulus من المصفار يقترن بالعضلات الهيكلية الكبيرة التي يمكن رؤيتها جيدًا ، قحفيا وانسيا بالاتجاه ، وتنبثق قحفيا ووحشيا للقص. بعد ذلك ، تتجه قحفيا ومزروعة بقوة على الجانب الوحشي من الحنجرة وترتبط بالجانب الوحشي للرغامي. هذا بمثابة الأصل الأساسي للعضلات الذيلية الوحشية والذيلية الانسية للحنجرة. توضح هذه الدراسة بوضوح السمات الشكلية المميزة للرغامي لأوز البجعة والتي يمكن أن تكون دراسة اساسية للدراسات المستقبلية التي تتعامل مع العلوم المختلفة المتعلقة بهذا الطائر.

الكلمات المفتاحية: الخصائص التشريحية ، اوز البجع، *Anser cygnoides*.