Anatomical investigations of the syrinx (voice box) of the adult male West African guinea fowl (Numida meleagris galeata) in the AL-Najaf AL-Ashraf province

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Abstract

Morphological examination of the syrinx in male West African guinea fowl (WAGF) at the second year of their age and (1244±114 g) the mean live weight which collected randomly from centre of the AL-Najaf AL-Ashraf province for making use this study in the future studies of the physiology of system and histopathological study of respiratory disease. After bird preparation, the syrinx was identified, then, position, shape and related of syrinx with other thoracic organs of specimen was recorded. The cartilages were the main the building units of the syrinx that the hyaline type (three tracheosyringeal cartilages, two the intermediate cartilages, three bronchosyringeal cartilages and pessulus). Therefore classified as tracheobronchial type. The tracheosyringeal cartilages was ring-like shape, and intermediate cartilages and bronchosyringeal were (C) shape, while pessulus was wedge-shape and divided the syringeal cavum in two primary bronchi. pessulus partial ossified. Addition to that there were paired lateral vibrating membranes which attached with the last tracheosyringeal cartilage and first intermediate cartilages craniocaudally and medial vibrating membranes which restricted between pessulus cranially and third bronchosyringeal cartilage caudally and continued as medial bronchial walls. The interbronchial ligament connects the left and right primary bronchi at the terminal part of the medial vibrating membranes.

Key words: Anatomy, aves, guinea fowl, syrinx, voice
Introduction

The West African guinea fowl (Numida meleagris galeata) is sub-specie of the guinea fowl. This bird is named after “Guinea”, a country on the sub-Saharan west coast of Africa. (1). Bird vocalization plays an important role on their differentiation grouped as passerines and non-passerines according to their voice device’s structural differences, and singing and calling (2, 3). The German anatomist classified bird species by their syringeal anatomy already in 1878 (4). Three different types of syrinx, namely tracheobronchial, tracheal and bronchial, can be found according to distinction between tracheal and bronchial elements of syrinx and topographical position of the main sound producing mechanism (5, 2). For example long-legged buzzard the syrinx is tracheobronchial origin (6). Whereas in the duck the origin of the syrinx is almost entirely from the bronchi, the trachea contributing very little (7). In Suboscine (superfamily Furnarioidea and Budgerigars) have a tracheal syrinx (5). As with the mammalian larynx, sound is produced by the vibration of air flowing through the organ. The syrinx of the (bird) was placed at a level of the 2nd or 3rd thoracic vertebrae and between trachea and primary bronchus, and related with the clavicular air sac close to the heart at the dorsal side of the glandular stomach and ventrally of the esophagus (8). Like the human larynx, however, the syrinx consists of specialised cartilaginous structures (tracheosyringeal cartilages, The pessulus, bronchio-syringeal cartilages and intermediate syringeal cartilages), connective tissue masses, vibrating membranes, and a syringeal muscles (9). Tracheosyringeal cartilages usually forms the tymanum which cartilaginous rings fused to each other by annular ligaments. It is a characteristic of the tracheobronchial type of syrinx and sometime of tracheal type, the diameter of it exceeds that of the tracheal cartilages (7, 5, 10), but in bronchial type like in Steatornis the tymanum is absent (5). The Pessulus located vertically at the bifurcation of the trachea splits the airway of the syrinx and it was observed as a wedge-shaped structure, but it’s absent in Oscine Alandidae (5). In roller pigeon The medial walls of the right and left primary bronchus fused at the level of the bifurcation of trachea and formed the pessulus, which extended dorsoventrally as a double-folded mucous membrane (11). While in the male Stock duck, the pessulus is massive and is showed as longish oval and transparent area ventrally, in the left side the middle part of the pessulus has a nose-shaped process (8). Bronchiosyringeal Cartilages: It is C-shaped and the ends attach with the pessulus and together. It is various in numbers according to bird species (8, 6). Intermediate syringeal location, shape In Chicken, there are cartilages which are hyaline types found between the tracheal and bronchial syringeal cartilages, four in number on each side, as C-shaped, attached to the pessulus at ventral end and free at dorsal end of it, this cartilages may be tracheal in type (7, 5). In turkey is similar to that description preceding, but they are different in numbers (10). The lateral tympanic membrane lies on the lateral aspect of the syrinx, runs from the caudal edge of the last intermediate cartilage to the cranial edge of the first caudal cartilage, and attaches dorsally and ventrally to the pessulus. The medial one attaches to the caudal border of the pessulus cranially, and continued caudally by the heavy fibrous tissue of the medial bronchial wall, dorsally and ventrally attached to the ends of the bronchiosyringeal cartilages, forming V-shaped space immediately caudal to the syrinx (7, 5; 9, 6, 11, 10). These membranes are activated by the intrinsic and extrinsic muscles (12). Birds that vocalize possess both the intrinsic and extrinsic syringeal muscles. There is much variation among species (13, 14) the vast majority of nonsinging birds possess m. sternotrachealis and m. tracheolateralis which are extrinsic syringeal muscles (6, 5). The sternotrachealis muscle in most birds originates in the sternum and inserts on the trachea, the tracheolateral muscle originates from the glottis, extends laterally along the trachea and inserts on the
caudal portion of the trachea or the cranial portion of the bronchi in the region of the syrinx or the first bronchosyringeal cartilage (15, 16, 17). This muscle often inserts on the syrinx therefor considered as intrinsic syringeal muscle (18). In chicken and domestic fowl have not intrinsic and extrinsic syringeal muscles (7). Some avian groups (e.g. Passeriformes, Psittaciformes and Steatominthidae) have an independent set of muscles restricted to the syrinx and known as intrinsic muscles of the syrinx (19).

Materials and methods

Six cocks of guinea fowls were used for this study. The birds were obtained from center of the AL-Najaf AL-Ashraf province. Birds (2-years-old, and had an average weight of 1244±114 g.) were anaesthetized with an IM injection of ketamine (50 mg/ kg) and xylazine (20 mg/kg), then specimens were prepared by bleeding of birds, by cutting the major neck blood vessels. The thoracic cavity was dissected and exposed by a mid-ventral incision. Each specimens of syrinx observed immediately after prepared, described the position in situ and shape registered, then carefully removed, fine dissections immediately, and by using the subsequently instruments (balance, ruler, amplifier lens (X12, X6), registered the length of bronchidesmus (interbronchial ligament).

Results

The present macroscopical examinations of the syrinx in male West African guinea fowl was demonstrate presence of syrinx situated inside the thoracic cavity between the last ring of the distal part of the trachea and the first ring of the left and right primary bronchi, at the base of the heart, dorsal to the major heart vessels and ventral to the anterior part of the esophagus (Fig. 1 and 2). It appears as an symmetrical sides umbrella-shaped cartilaginous structure (Fig. 2).

Skeleton of the Syrinx

A-Syringeal cartilages:-

1-Tracheosyringeal cartilages:- Three rings-shaped hyaline cartilages were categorized by being larger than that the preceding tracheal rings, partially ossified, joined with each other dorsoventrally (Fig. 2).

Fig. (1) Ventral view of the syrinx in the male West African guinea fowl. A) syrinx B) trachea, C) heart, D) esophagus, E) sternotracheal muscle. Notice the syrinx is hidden at the dorsal surface of the heart.
Fig. (2) Ventral view of thoracic inlet of West African guinea fowl demonstrate the syrinx insitue: A) trachea, B) tracheo-syringeal cartilages, C) intermediate syringeal cartilages, D) bronchiosyringeal cartilages, E) lateral vibrating membrane, F) interbronchial foramen, H) bronchidismus, I) sternotrachealis muscle

Fig. (3) Caudal view of the syrinx of the male West African guinea fowl demonstrate: A) right and left medial vibrating membrane. B) Caudal surface of the pessulus.
2-Intermediate syringeal cartilages:- Two C-shaped hyaline on each side, between the tracheal and bronchial syringeal cartilages, Ventral and dorsal ends attached to the pessulus (Fig. 2).

3-Bronchiosyringeal cartilages:- Three C-shaped hyaline cartilages on each side, dorsal and ventral ends of all these cartilages meeting at the medial side of the left and right extrapulmonary primary bronchi to formed the left and right ends of the interbronchial ligament (bronchidesmus), they were not attached to the pessulus (Fig 2).

4-Pessulus:- Appeared as wedge-shaped centralized bony hyaline cartilage, which splits the lumen of the trachea into the left and right primary bronchi. The caudal aspect of the pessulus act as cranial attachment of the left and right medial vibrating membranes (Fig 3).

B-Vibrating membranes:-

1-Medial vibrating membranes: - paired of membranous connective tissue, extend from pessulus and 3th bronchiosyringeal cartilages. Then continued as medial membranous walls of the extrapulmonary primary bronchi (Fig 2 and 3).

2-Lateral vibrating membranes: - paired of membranous connective tissue, lies on the lateral aspect of the syrinx, which stretches between the caudal edges of last cartilage of tracheosyringeal cartilage to the cranial edge of the first intermediate syringeal cartilage. They are attached to the pessulus from its dorsal and ventral side. (Fig 2).

C- Interbronchial ligament (bronchidesmus): cord like structure connected the left and right primary bronchi at the medial side at the left and right ends of the bronchiosyringeal cartilages. The mean length of the bronchidesmus was (0.42 ± 0.11 cm). There was interbronchial foramen between bronchidesmus and pessulus.

Discussion

The position of syrinx in the male West African guinea fowl in this study fully confirmed with (20, 6, 21, 11, 22) in the pigeon, ostrich, long-legged buzzard, the Mallard (Anas platyrhynchos) and turkey. Both the trachea and primary bronchi participated in syrinx formation, therefor could be classified tracheobronchial type as described in most common birds such as duck (8, 21), hen (23, 2), ostrich (20), Bursa roller pigeon (11), turkey (10, 22), goose (24) and long-legged buzzard (6). The present macroscopic examinations of the syrinx explained to umbrella-shaped cartilaginous structure, and similar sides. This result agree with (10) in turkey and inconsistent with (25) who said that the syrinx most obvious external feature is constricting organ in Chicken and Ostriches. Bulla tympaniformis was not observed in syrinx of male West African guinea fowl this result harmonizes with (10, 26, 22) in turkey and sea gull, but the syrinx of the male mallards have Bulla tympaniformis (8, 21).

Skeleton of the Syrinx

A-Syringeal cartilages:-

The shape and characteristic of tracheosyringeal cartilage of male West African guinea fowl corresponding to (5) in bronchial type like (Steatornis) and (14) in most tracheobronchial type, but on contrary with (7, 5, 11, 21, 22) who made clear the tympanum was a characteristic of the tracheobronchial type of syrinx and some tracheal type. Whereas all features of intermediate syringeal cartilages were consistent with (7, 5, 10) in the chicken, and turkey, but different in numbers. The bronchiosyringeal cartilages were fully confirmed with (6, 22, 11, 24, 26) except the numbers of bronchiosyringeal cartilages were 4 in long-legged buzzard and turkey, 5 in pigeon, 6 in goose and 7 in seagull. While in the Mallard the first bronchiosyringeal cartilage had relation with pessulus; (21). The results of pessulus were accordance with (5, 10, 21,24) and unharmonized with (5) in oscine (Alandidae) and (11) in pigeon who elucidated that the pessulus formed by a double-folded mucous membrane, and (8) in the male stock duck, while (26) who explained that pessulus of seagull was triangular shaped and ossified structure.

B-Vibrating membranes:-
The medial and lateral vibrating membranes located at syrinx undertake the voice production, these results fully confirmed with other authors in several types of birds (7, 5, 11, 10, 21). The locations of these membranes were the same with turkey (10) but different from that in sea gull (26) and in the Mallard (Anas platyrhynchos) (21). The length of the bronchidesmus was uncorresponding to (10) who said the mean total length was (0.85 ± 0.15 cm) in turkey. There was interbronchial foramen between bronchidesmus and pessulus agreement with (8, 6, 10, 22, 26, 21). The syringeal muscles were absent in the guinea fowl in this study, therefore the sound production was controlled in the vast majority of birds solely by the tracheal muscles, which configure the syrinx and trachea appropriately for sound production. These were results agreement with (15, 27) but different with (11, 21, 26).

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