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Macroscopical anatomy of the air sacs of the turkey

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Abstract

Because of its physiological importance in the rapid growth rate of birds and the continous air flow that provided it the lungs in both inspiration and expiration, the present study was performed to examine the air sac system on twelve mature turkeys of both sexes and different weight . Seven air sacs were demonstrated associated with the two lungs and characteristic for the turkey. They comprised; the single composite cervicoclavicular air sac and the paired medial clavicular, thoracic and abdominal air sacs. The cervicoclavicular air sac closed partially the thoracic inlet and aerated the coracoid, the clavicle, the sternum, the sternal ribs and most of the vertebral column. The medial clavicular air sacs were the smallest ones, characteristic in the turkey and connected with the preceeding air sac with several small ducts on each side. The thoracic air sac related to the last two ribs, cranially and the abdominal wall, caudally. The medial clavicular and thoracic airsacs had no diverticula and aerated no bones. The paired abdominal air sacs were the largest, interwoven with the abdominal organs and gave off the femoral, perirenal and iliolumbar diverticula as well as the unique pericloacal diverticula dorsolateral to the cloaca on both sides. The abdominal air sacs aerated the synsacrum and the ilium but did not ventilated the femur or any bone of the leg.

Keywords: Turkey- Air sacs- Morphology

Introduction

Dyce et al. (2002) described the air sacs as blind thin-walled enlargements of the bronchial system, extended beyond the lung in close relationship to the thoracic and abdominal viscera. Diverticula from these sacs entered some bones and even extended between the skeletal muscles. ***O'Malley (2005)*** recorded that the air sacs acts as bellows but do not participate in gas exchange. He added that, the bellows system allows continuous air flow to the lungs in both respiration and expiration.

In the embryo there are six pairs of air sacs: cervical, lateral clavicular, medial clavicular, cranial thoracic, caudal thoracic and abdominal. In nearly all species there is some fusion of the air sacs during the embryonic process or soon after hatching and consequently the final number of air sacs in the hatched bird is reduced (***King*** *and* ***Mclelland, 1984)***.

In general, there were a total of eight air sacs located in the body cavity of the domestic birds, two single and three double. The single sacs were the cervical and clavicular, while the paired ones were the cranial thoracic, the caudal thoracic and the abdominal ***(King, 1975; Mitchell, 1984; Scheid*** *and* ***Piiper, 1987*** and ***Dyce et al. 2002)***. However, in some species, the cervical sac was double making nine air sacs ***(Nickel et al., 1977; Baumel et al., 1993; Fedde, 1998; Duncker, 2004; El-Mahdy, 2005, O'Malley, 2005; Daoust et al., 2008*** and ***Casteleyn et al., 2010).*** Meanwhile, ***Bezuidenhout et al. (1999)*** in ostrich revealed five pairs of air sacs; cervical, clavicular, cranial thoracic, caudal thoracic and abdominal.

King *and* ***Atherton (1970)*** revealed seven air sacs in turkey. The paired cervical sacs fused early with the primordial pair of the lateral clavicular sacs forming a

single composite cervicoclavicular air sac. The primordial pair of the medial clavicular sacs persisted throughout life as a pair of very small separate sacs. Also, a pair of cranial thoracic and a pair of abdominal sacs were present. They added that the paired caudal thoracic air sacs were totally suppressed in the early embryo.

In mallard duck, ***Demirkan et al. (2006)*** revealed the general eight air sacs, while in white Pekin ducks, the caudal thoracic sacs were absent, and so six air sacs were present.

Onuk et al. (2009) in domestic native geese, reported a totally of seven air sacs; a single cervicoclavicular, and a paired cranial thoracic, caudal thoracic and abdominal sacs.

The cervical air sac consisted of a median chamber, situated between the lungs and dorsal to the esophagus, and a pair of tubular vertebral diverticula, on each side of the vertebral column, which aerate all the cervical vertebrae, except atlas and axis, and the first two thoracic vertebrae as well as the first two vertebral ribs. The cervical air sac was connected dorsally to the first medioventral secondary bronchus (***Nickel et al., 1977, King*** *and* ***Mclelland 1984, Dyce et al., 2002, El-Mahdy, 2005*** and ***Demirkan et al., 2006,*** in chickens, pigeon and mallard duck). On the other hand, ***Kurtul et al. (2004)*** demonstrated that the cervical sac of the rock partridge had a caudally pointed diverticula located between the two lungs. The latter diverticulum was termed the interpulmonary diverticulum by ***Onuk et al (2009)*** in the goose.

In chickens, the clavicular air sac was a large and complicated sac occupying the thoracic inlet. It consisted of intrathoracic diverticula which extended around the heart and along the sternum, and extrathoracic diverticula which spread between the bones and muscle of the thoracic girdle and shoulder joint. It aerated the sternum, the sternal ribs, the humerus and the coracoid. It was connected to the third medioventral bronchus ***(King, 1966*** *and* ***1975, Duncker, 1971, King*** and ***Mclelland 1984***and***O'Malley, 2005).*** Moreover, ***Demrkan et al. (2006)*** revealed that, in Japanese quails, the humerus and the sternum were not aerated and the pneumatic foramina were absent.

In the domestic fowl, the paired cranial thoracic air sacs were situated ventral to the lungs between the sternal ribs and the heart and liver, while the paired caudal thoracic sacs were placed more caudally between the body wall and the abdominal air sacs. The cranial thoracic sac was connected to the third medioventral while the caudal thoracic sac was connected to the first lateroventral secondary bronchi. Both thoracic air sacs possessed no diverticula and aerate no bones (***King 1975, Nickel et al., 1977, Dyce et al., 2002).*** Meanwhile, ***Crespo et al. (1998)*** recorded that, the turkey had paired single thoracic sacs with two ostia in 90 % of the examined specimens while in the other 10% the turkey had paired cranial and caudal thoracic air sacs, each with a single ostium, similar to that recorded by ***Ficken*** and ***Barnes (1990)*** and ***Ficken et al. (1991).***

In the domestic pigeon, ***El-Mahdy (2005)*** observed that the anterior ends of the cranial thoracic sacs were completely fused with the caudal border of the interclavicular air sac, and also attached by two small tubes-like connections with the cervical air sacs. Moreover, the caudal ends of the cranial thoracic air sacs were connected by two short narrow tubes with the caudal thoracic air sacs.

The abdominal air sacs were the largest ones in the chickens, and occupied the caudodorsal part of the celom. Their extensive lateral surfaces were in contact with the abdominal and pelvic walls while the medial surfaces of both sides enclosed the abdominal organs. Each abdominal sac gave off several perirenal and several femoral diverticula. The former was extended along the kidneys and invading the adjacent vertebrae of the synsacrum and pelvic girdle. The latter diverticula invading the muscles of the pelvic girdle and acetabulum but never aerate the femur or any other bone of the leg ***(King, 1966*** and ***1975*** and ***Duncker, 1975).*** Moreover, ***King (1975)*** added that, the abdominal air sacs detached also two iliolumbar diverticula which proceeded through the iliolumbar canal of the synsacrum. In the duck and geese, the abdominal air sac aerated the synsacrum as well as the last two or three ribs ***(Demirkan et al., 2006*** and ***Onuk et al., 2009).***

Materials and Methods

Twelveadult baladi turkeys of both sexes and different weight were slaughtered and allowed to exsanguinate.The trachea of six birds was injected by latex neoprene. The specimens were fixed in 10% formalin for 3-4 days and then dissected. In addition, the kem-apoxy 151 was injected intratracheally in the other six birds (***Sawad and Udah 2012)***for cast preparations.The specimens wereleft in cold room for about one week and then the specimens were

macerated in 3% potassium hydroxide solution for 48hrs, finally the air sacs were painted by different acrylic colors.

Results

In the turkey, seven thin walled and transparent air sacs were extended from the lungs, penetrating between the viscera and into some bones. They comprised a single cervicoclavicular, paired medial clavicular, thoracic and abdominal air sacs.

I. Saccus cervicoclavicularis

The cervicoclavicular sac was a fairly large complicated air sac formed by the fusion of the cervical and lateral clavicular air sacs. It could be divided into a cervical and a clavicular part.

1.1. Pars Cervicalis (figs 1, 2 & 4 \2) was represented as a small central cavity, situate cranioventral to the lungs in close contact with the ventral muscles of the vertebral column and extended between the last two cervical and first thoracic vertebrae dorsal to the trachea and oesophagus. Caudoventrally, it was communicated with the right and left lateral clavicular parts. It gave off three diverticula; two vertebrales and an interpulmonary.

1.1.1. Diverticula vertebrales (figs 1, 3 & 5\2a) : a right and a left diverticulum erupted from the dorsal aspect of the central cavity and proceeded cranially and caudally through the transverse foramina of the vertebrae, on both sides of the vertebral column, at the end of the notarium, each one was reinforced by iliolumbar diverticulum **(fig. 5\ 6e)** from the abdominal air sac, then continued caudally through the lumbosacral canal of the synsacrum, pneumatizing it and adjacent parts of the ilium and opened into the pericloacal diverticulum **(fig. 1\6c)** of the abdominal air sac.

1.1.2. Diverticula interpulmonaris (fig. 5\2b): it was arose as a caudal prolongation of the central cavity and extended ventral to the ventral crest of the notarium, between the two lungs, for about 4.5-5 cm where it tapered caudally.

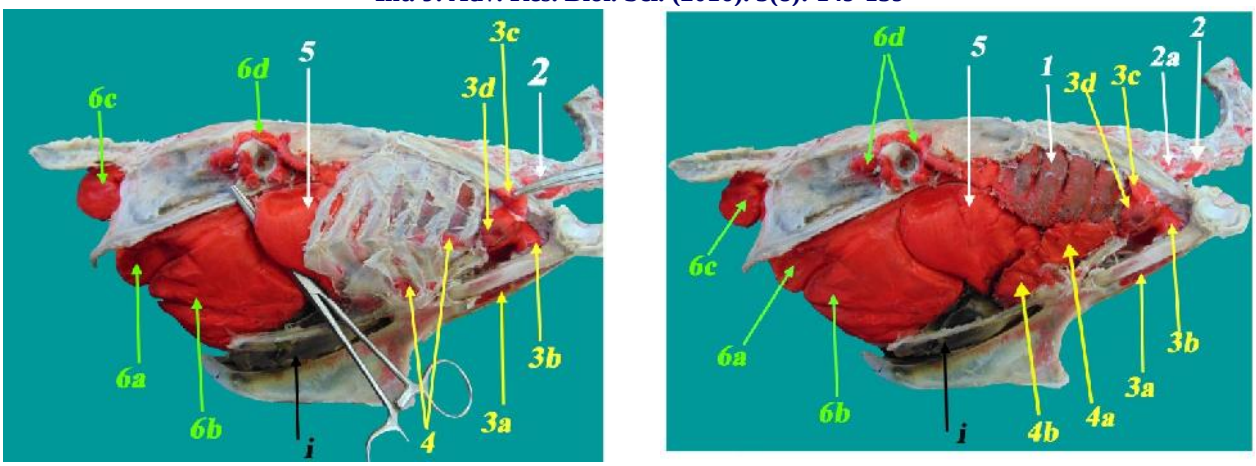
1.2. Pars clavicularis; was bilaterally present. Each connected, dorsomedially, with the respective side of the central cervical chamber and presented extrathoracic and intrathoracic diverticula.

1.2.1. Extrathoracic diverticula comprised a **cranioventral diverticulum (figs 3, 4 & 5\3a)** and three lateral diverticula. The former occupied the thoracic inlet ventrally and extended between the clavicle and coracoid bones. On both sides, they were converged ventrally and diverged dorsally forming a V-shaped enlargement that embraced dorsally the trachea, oesophagus, blood vessels and nerves as well as the cervical part. It aerated the coracoid bone **(fig.7\C)** as well as the clavicle **(fig.7\E)**. The lateral diverticula comprised **the axillary diverticulum (fig. 1\3b)** just caudal to the shoulder joint, the **subscapular diverticulum (fig. 1\3c)** and the **pectoral diverticulum (fig. 1\3d)**, between the scapula and the thoracic cage, they entered between the muscles of the shoulder joint and the thoracic cage.

1.2.2. Intrathoracic diverticula; were represented by the sternocardiac diverticula. The cranial part of each sternocardiac diverticulum extended on the respective side of the heart forming **the cardiac diverticulum (figs 1, 2&5\4a),** while its caudal part, **the sternal diverticulum (figs 1, 2 &5\4b)** was thin, leaf – like in shape, proceeded caudomedial on the dorsal aspect of the sternum and medial aspect of the sternal ribs pneumatizing them **(figs 7\A&B)** and connected medially with that of the other side.

II. Saccus clavicularis medialis (fig. 5\8)

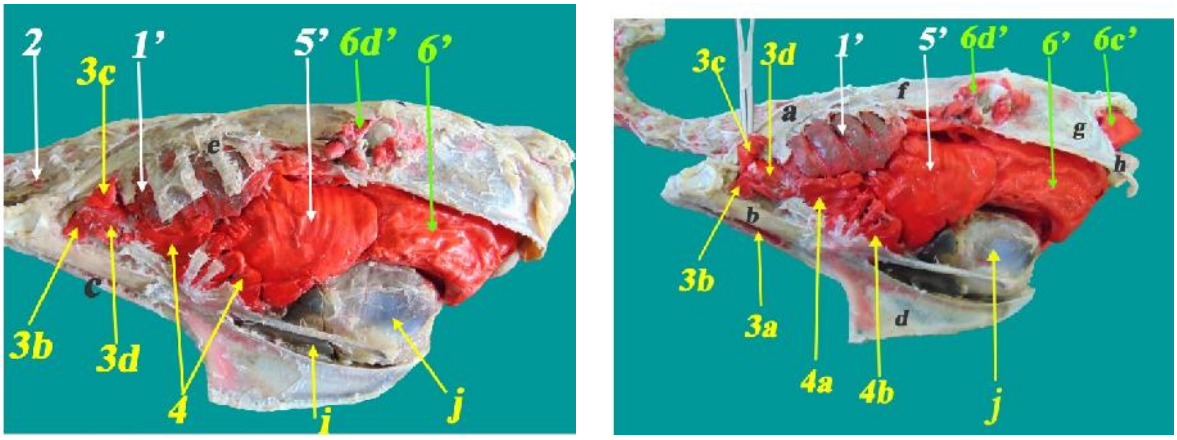
The right and left medial clavicular air sacs presented the smallest ones in the turkey. They were similar in size and quadrilateral in shape, each one connected to the septal surface of the lung, a little caudal to its hilus by a common ostium with the thoracic air sac. The medial clavicular sac **(fig. 5\8)** was situated completely within the thoracic cage related dorsally to the extrapulmonary part of the respective primary bronchus and the base of the heart, cranially and ventrally to the sternocardiac diverticulum of the cervicoclavicular sac and caudally to the thoracic air sac. The medial clavicular sac was entirely excluded from the direct contact with the thoracic wall because it was covered laterally by the cervicoclavicular sac as well as the liver which surrounded the heart. It was noted that the medial clavicular air sac connected through 5-6 delicate tubes **(fig.5B)** with the cardiac diverticulum of the cervicoclavicular air sac. Moreover, it had no diverticula and aerated no bone.



A **B**

Fig. (1) The right lung and its associated air sacs in situ. they were filled by coloured latex injected mass
A. The first rib and the soft tissue of the thoracic wall were removed partly
B. All the ribs were removed

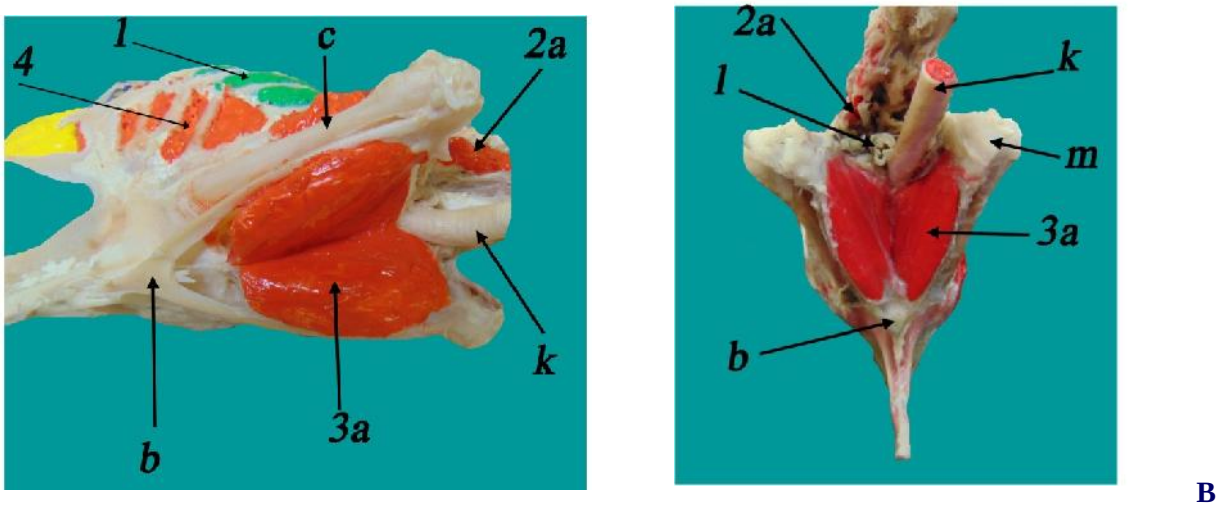
1.1'. Right& Left Lungs; 2. Cervical part of cervicoclavicular air sac, 2a. Vertebral divericulum; 3. Extrathoracic diverticula of clavicular part of cervicoclavicular air sac; 3a.cranioventral diverticulum, 3b. Axillary diverticulum 3c. Subscapular diverticulum, 3d. Pectoral diverticulum; 4. Intrathoracic diverticulum of clavicular part of cervicoclavicular air sac (sternocardiac diverticulum); 4a. Cardiac diverticulum ,4b. Sternal diverticulum; 5. 5'. Right& Left Thoracic air sac, 6. 6'. Right & Left abdominal air sac, 6a. Caudodorsal portion, 6b. Caudoventral portion, 6c.6c'. Rt and lt Pericloacal diverticulum, 6d.6d'. Rt & Lt Femoral diverticulum; i. Liver



A **B**

Fig. (2) The left lung and its associated air sacs in situ. They were filled by coloured latex injected mass
A. The soft tissue and the sternal ribs were removed partly, **B.** The thoracic wall and its associated ribs and muscles were removed

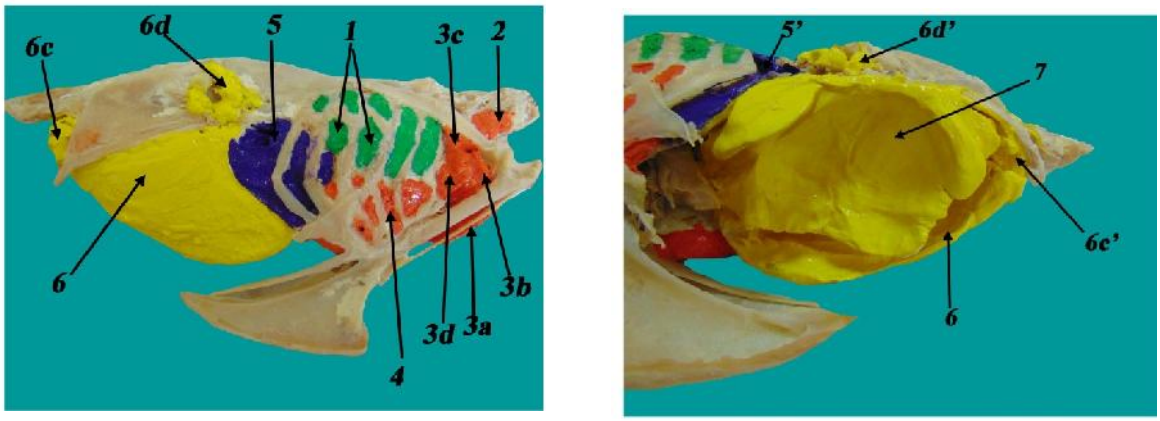
1.1'. Right& Left Lungs; 2. Cervical part of cervicoclavicular air sac, 2a. Vertebral divericulum,3. Extrathoracic diverticula of clavicular part of cervicoclavicular air sac; 3a.cranioventral diverticulum, 3b. Axillary diverticulum 3c. Subscapular diverticulum, 3d. Pectoral diverticulum; 4. Intrathoracic diverticulum of clavicular part of cervicoclavicular air sac (sternocardiac diverticulum); 4a. Cardiac diverticulum , 4b. Sternal diverticulum
5. 5'. Right& Left Thoracic air sac, 6. 6'. Right & Left abdominal air sac, 6a. Caudodorsal portion, 6b. Caudoventral portion, 6c.6c'. Rt and lt Pericloacal diverticulum, 6d.6d'. Rt & Lt Femoral diverticulum; i. Liver; j. Gizzard



A **B**

Fig. (3) The inlet of the thoracoabdominal cavity partialy closed by the cranioventral diverticulum of the cervicoclavicular air sac.A. Coloured Epoxy injected specimen
B. Red Latex injected specimen

2. Cervical part of cervicoclavicular air sac, 2a. Vertebral divericulum
3. Extrathoracic diverticula of clavicular part of cervicoclavicular air sac, 3a.cranioventral diverticulum
4. Intrathoracic diverticulum of clavicular part of cervicoclavicular air sac (sternocardiac diverticulum)
b. Clavicle, c. Coracoid; k. Trachea, l. Esophagus, m. Shoulder joint



A **B**

Fig. (4)The lung and its associated air sacs in situ. filled by colored epoxy injected mass.
A; Right side
B; Left side

1.1'. Right& Left Lungs; 2. Cervical part of cervicoclavicular air sac, 2a. Vertebral divericulum3. Extrathoracic diverticula of clavicular part of cervicoclavicular air sac; 3a.cranioventral diverticulum, 3b. Axillary diverticulum 3c. Subscapular diverticulum, 3d. Pectoral diverticulum; 4. Intrathoracic diverticulum of clavicular part of cervicoclavicular air sac (sternocardiac diverticulum); 4a. Cardiac diverticulum ,4b. Sternal diverticulum
5. 5'. Right& Left Thoracic air sac, 6. 6'. Right & Left abdominal air sac, 6c.6c'. Rt and lt Pericloacal diverticulum, 6d.6d'. Rt & Lt Femoral diverticulum; i. Liver; j. Gizzard, 7. Gizzard impression on left abdominal air sac

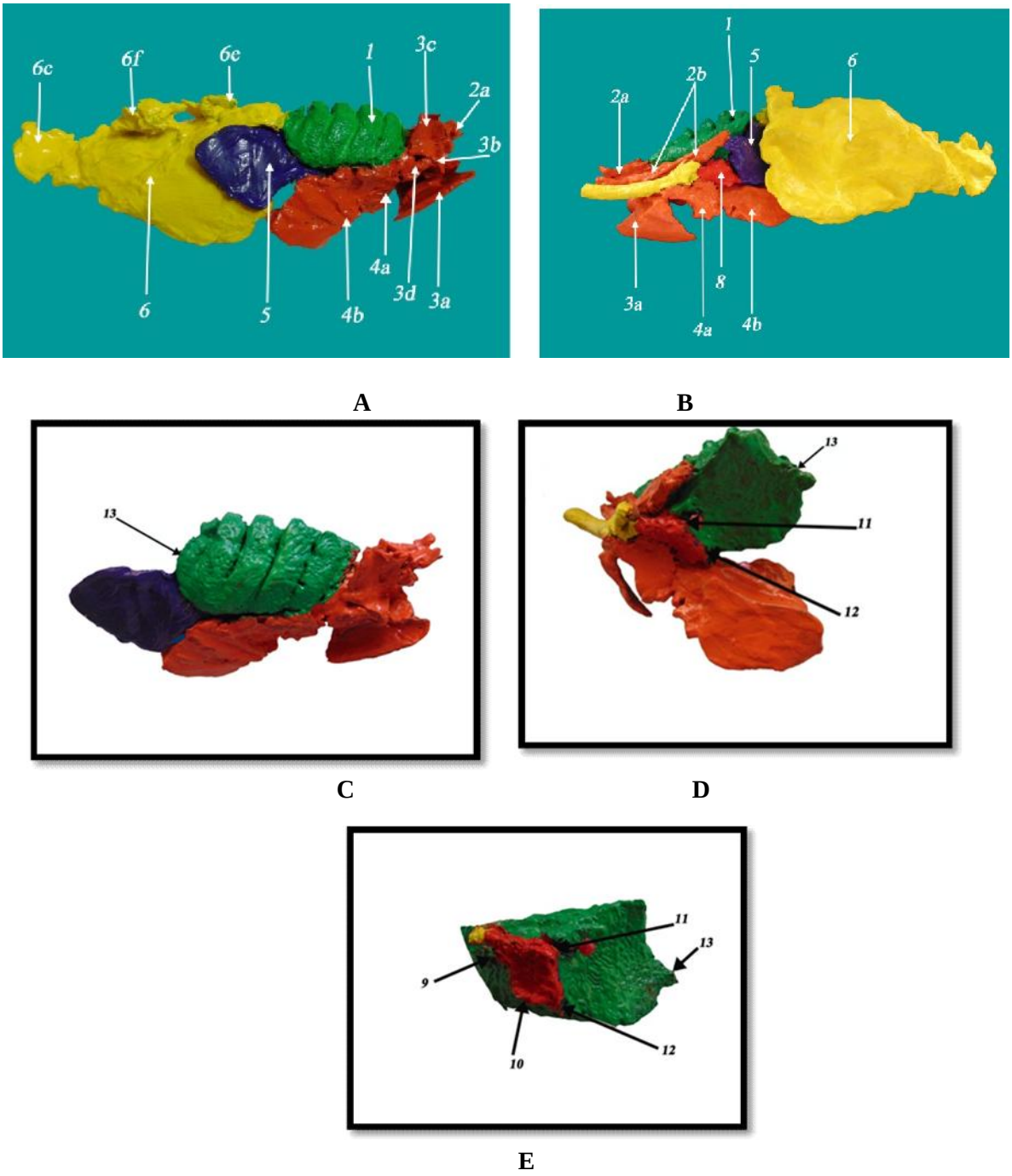


Fig. (5) The right lung and its associated air sac system coloured latex injected specimen (isolated cast)

A. Lateral view; **B.** Medial view; **C.** Lateral view after the removal of the abdominal air sac; **D.** Medial view, after the removal of the thoracic and abdominal air sacs- not the connection; **E.** Medial view, after the removal of cervicoclavicular, thoracic and abdominal air sacs

1.1'. Right& Left Lungs; 2. Cervical part of cervicoclavicular air sac, 2a. Vertebral divericulum3. Extrathoracic diverticula of clavicular part of cervicoclavicular air sac; 3a.cranioventral diverticulum, 3b. Axillary diverticulum 3c. Subscapular diverticulum, 3d. Pectoral diverticulum; 4. Intrathoracic diverticulum of clavicular part of cervicoclavicular air sac (sternocardiac diverticulum); 4a. Cardiac diverticulum ,4b. Sternal diverticulum, 5. 5'. Right& Left Thoracic air sac, 6. 6'. Right & Left abdominal air sac, 6a. Caudodorsal portion, 6b. Caudoventral portion, 6c.6c'. Rt and lt Pericloacal diverticulum, 6d.6d'. Rt & Lt Femoral diverticulum i. Liver; j. Gizzard, 8. Medial clavicular air sac, 9,10. Ostia of cervicoclavicular air sac, 11. Ostium of medial clavicular and thoracic air sacs, 12. Ostium of thoracic air sac, 13. Ostium of abdominal air sac

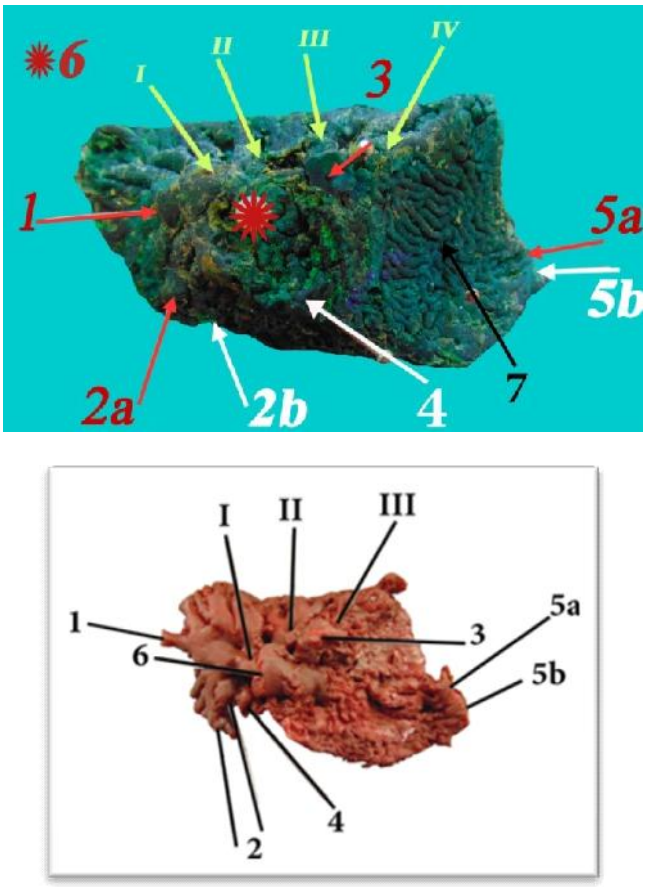


Fig. (6) Corrosions of latex injected right lungs, showing:

I. First medioventral secondary bronchus **II. Second medioventral secondary bronchus** **III. Third medioventral secondary bronchus** **IV. Fourth medioventral secondary bronchus**	**1. First ostium;** direct connection between cervical part of cervicoclavicular air sac and I.**2. Second ostium;** 2a. Direct and 2b indirect connection between clavicular part of cervicoclavicular air sac and I.**3. Third ostium;** direct connection between medial clavicular as well as thoracic air sac with III.**4. Fourth ostium;** indirect connection -saccobronchus- between I and the thoracic air sac.**5. Fifth ostium;** 5a direct, 5b indirect connection between the termination of the primary bronchus and the abdominal air sac.6. Primary bronchus7. Parabronchial loops connect the secondary bronchi with each other.

III. Saccus thoracicus (figs 1-5\5)

The paired thoracic air sacs were similar in size, roughly rectangular in shape and symmetrical in position. The cranial part of the sac was situated within the thoracic cage, between the last two ribs laterally and the liver, heart, oesophagus and proventriculus medially. The caudal part of the sac was interposed between the abdominal wall laterally and the abdominal sac medially. The craniodorsal part was related to the septal surface of the lung as well as the medial clavicular air sac, while its cranioventral part was related to the dorsal aspect of the sternal diverticulum of the cervicoclavicular air sac. Caudodorsally and caudoventrally the sac was related to the lateral aspect of the abdominal air sac as well as the gizzard on the left side **(fig. 4\7)**. In well injected specimen it was found that the sac extended from the fifth intercostal space cranially to the level of the hip joint caudally. The thoracic sac had no diverticula and aerated no bones.

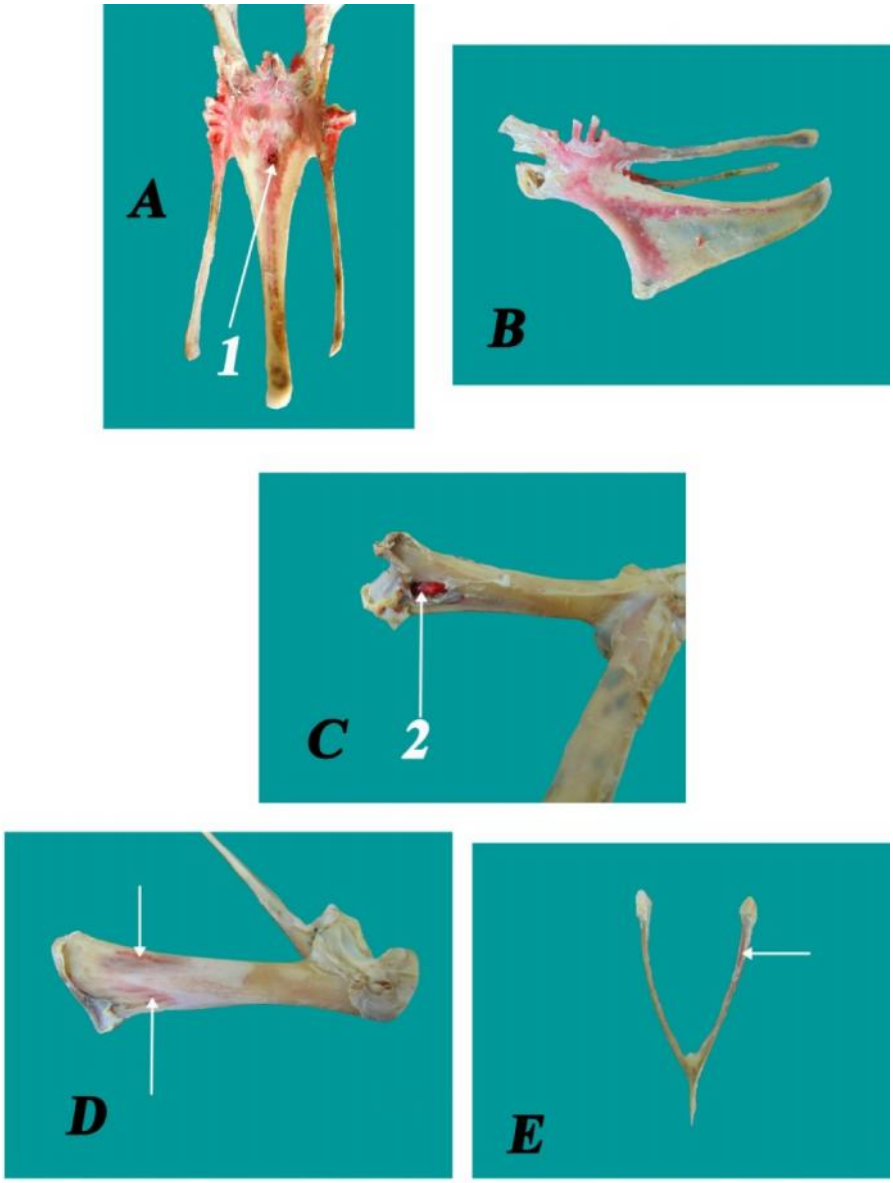


Fig. (7) Showing the pneumatized bones in adult baladi turkey
A. The sternum, dorsal view, showing the prominent pneumatic foramen (1) **B.** The lateral view of pneumatized sternum **C;** The coracoid bone with its pneumatic foramen (2) **D.** The pneumatized coracoid bone (arrows) **E.** The pneumatized clavicle (arrow)

IV. Saccus abdominalis(figs 1-5 \6)

The abdominal air sacs were the largest ones in the turkey. They occupied the caudodorsal portion of the abdominal cavity and extended from the end of the lungs to the cloaca. Dorsally they were in contact with the kidneys. The cranial part of each sac was covered laterally by the thoracic sac, while most of the lateral surface was related to the abdominal and the pelvic walls. The medial surface of the two sacs enclosed the intestine and genital organs. The gizzard **(fig. 2\j)** interposed between the ventral aspect of the left sac and the sternum thus the right abdominal sac was relatively the larger, moreover its caudal part showed its partial division into a caudodorsal **(fig. 1\6a)** and a caudoventral **(fig. 1\6b)** portion.

Several diverticula were released from the dorsal wall of each abdominal sac. They comprised the femoral, perirenal, iliolumbar and pericloacal diverticula. **The femoral diverticula (figs 1, 2, 4 &5\6d)** distributed around the acetabulum but did not aerate the femur. **The perirenal diverticula (fig. 5\6f)** extended between the renal lobes and aerated the ilium. **The iliolumbar diverticulum (fig. 5\6e)** erupted at the end of the notarium as reinforcing duct which communicated with the vertebral diverticulum of the cervicoclavicular sac that continued caudally through the lumbosacral canal of the synsacrum and opened into the **pericloacal diverticulum (figs 1,2,4&5\6c)** . The latter appeared as a small roughly rounded diverticulum from the most dorsocaudal part of abdominal sac and surrounded the cloaca dorsolaterally. The abdominal air sac with the vertebral diverticulum aerated the synsacrum and adjacent parts of the ilium.

Discussion

The turkey had almost unique features of the avian air sacs; the cervical and lateral clavicular air sacs were fused forming a large composite cervicoclavicular sac. The paired smallest medial clavicular air sacs were remained separate and excluded from direct contact with the lateral thoracic wall. The paired thoracic sacs were related to the last two ribs but most of it was situated caudal to the thoracic cage. The caudal thoracic air sacs were entirely absent. The right abdominal sac was much larger, as the gizzard occupied most of the ventral aspect of the left abdominal sacs.

The fusion of the cervical and lateral clavicular air sac to form a composite cervicoclavicular air sac in the present investigation was similar to the description of ***king*** and ***Atherton (1970)*** in turkey and ***Onuk et al (2009)*** in geese.

The present work revealed that the cervical part of the cervicoclavicular sac gave off a tube like vertebral diverticula which proceeded cranially through the transverse foramina on either side of the cervical vertebrae and extended caudally along the notarium. A result which was in accordance with the observation of ***king (1975)*** and ***Dyce et al. (2002)*** in chicken**,** ***O' Malley (2005***) in birds, ***Demirkan et al. (2006)*** in ducks and ***Onuk et al. (2009)*** in geese. Moreover, the present investigation was inagreement with ***Cover, 1953c*** in turkey that the vertebral diverticula extended caudally along the vertebral column up the fourth caudal vertebra; however, the present work revealed that the latter tube received reinforced connecting tube, the iliolumbar diverticulum, from the abdominal air sacs. In addition, it was well observed that each vertebral diverticulum opened most caudally with the pericloacal diverticulum of the abdominal air sac. This condition was not recorded in the other birds and unique to the turkey.

Kurtul et al. (2004) demonstrated that, the cervical sac of the rock partridge has a caudally pointed diverticulum located between the lungs. A condition which simulated the present study in that the cervical enlargement in the turkey gave off the interpulmonary diverticulum. However, ***Onuk et al.(2009)*** in goose described that the latter diverticulum was connected to the clavicular part of the cervicoclavicular sac.

In the turkey, the extrathoracic diverticula of the clavicular part of the cervicoclavicular air sac comprised the cranioventral diverticulum, associated with the coracoid bones, the axillary, subscapular and pectoral diverticula which spread between the muscles and bones of the thoracic girdle and shoulder joint. The intrathoracic diverticula presented the cardiac and sternal diverticula. Similar observations were given by ***King (1966, 1975), Duncker (1971), O' Malley (2005), Demirkan et al. (2006)*** and ***Onuk et al. (2009)*** but they described also the humeral diverticulum which aerate the humerus. In this respect, exactly in not one case of the investigated specimens the humeral diverticulum and the pneumatic foramen were noticed even in well injected air sacs specimens. In Japanese quails, also the humerus and sternum were not aerated ***(Demrkan, 2006)***. However, most of the relevant literatures as well as the present study recorded the aeration of the coracoid and clavicle bones, sternal ribs and the sternum from the clavicular part.

Similar to the description of ***King*** and ***Atherton (1970)*** and ***King*** and ***Mclelland (1984)*** in turkey, the medial clavicular air sacs remained small but separated, and each one enclosed the primary bronchus of its respective side. Moreover, the present investigation recorded that each sac was communicated by 5-6 delicate tubes with the cardiac diverticulum of the cervicoclavicular air sac. A result which was not recorded by ***Cover (1953c)*** or ***King*** and ***Atherton(1970)*** in the turkey, and simulated the connections observed in the pigeon by ***El-Mahdy (2005)*** between the cranial thoracic air sacs with the interclavicular sac, cervical sacs and caudal thoracic sacs. ***El-Mahdy*** added that, this might facilitate the air flow in them.

Most of the relevant publications described a pair of cranial thoracic and a pair of caudal thoracic air sacs. Also, they were inagreement that the cranial thoracic sacs were entirely situated within the rib cage in most species, but may be extended a little ventrally in some species, while the caudal thoracic sacs were related totally to the lateral abdominal walls except their communication with the ventrocaudal part of the lung. On the other hand, ***King*** and ***Atherton (1970)*** described a pair of cranial thoracic air sacs but never mentioned the presence of caudal thoracic air sacs. In this respect, the present work in the turkey revealed a right and a left thoracic sac; they were similar in size, shape and position. Only the cranial part of each sac was related to the last two ribs while most of it was situated caudal to the thoracic cage, in relation to the lateral abdominal wall. The thoracic sacs described in the present work simulated the caudal thoracic sacs in most species of birds in its position and relation but it was connected to the third medioventral secondary bronchus as the origin of the cranial thoracic in other birds, therefore the present study termed it the thoracic air sac and pointed out that it was connected also to the first medioventral secondary bronchus by a large saccobronchus. A result which was confirmed with that documented by ***Crespo et al. (1998)*** that, the turkey had single thoracic sacs in 90% of the examined specimens and connected to the lungs by two ostia, but they described also a pair of cranial and a pair of caudal thoracic sacs in the other 10%. This result was not observed in all the investigated specimens. Moreover and similar to that recorded by ***Nickel et al***. (***1977)*** and ***Dyce et al. (2002)*** also in the turkey, the thoracic air sacs had no diverticula and aerated no bones.

Concerning the largest abdominal air sacs in turkey our results revealed that their extensive lateral surfaces were in close contact with the abdominal and pelvic walls while their medial surfaces where molded the organs enclosed in between. Moreover, each sac detached the femoral and perirenal diverticula. A result which was in accordance with ***King (1975), Nickel et al. (1977), Dyce et al. (2002), El –Mahdy (2005), Demirkan et al. (2006)*** and ***Onuk et al. (2009)*** in other birds. Moreover, the cranial part of its dorsal aspect released iliolumbar diverticula, each connected with the corresponding vertebral diverticulum of the cervicoclavicular sac along its caudal course with the synsacrum. This result was simulated with that recorded by ***King (1975)*** in chicken.

The present work recorded some unique features of the abdominal sac; the most dorsocaudal portion of each sac gave off the characteristic pericloacal diverticulum, in addition it was noticed that, the partial division of the right abdominal sac into caudodorsal and caudoventral portions. However, ***Demirkan et al. (2006)*** recorded the division of left sac into cranial and caudal portions.

The abdominal air sac aerates the synsacrum and the pelvic girdle but never aerate the femur or any other bone of the leg ***(King, 1975; Nickel et al. 1977, Dyce et al. 2002*** and ***El –Mahdy 2005),*** a result which confirmed the present investigation.

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