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The Gross Anatomy of the syrinx of the turkey

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Abstract

The syrinxes of twelve mature turkey weighting 3.5-5.5 Kg were examined. The syrinx was tracheobronchial type and formed by tracheosyringeal and bronchosyringeal cartilages. The tracheosyringeal cartilages were single, constituted the cranial median part of the syrinx and arranged in threegroups; the tympanum was the most cranial and formed by the last three tracheal, simple and complete cartilaginous rings, the second group formed by two characteristic and unique rings, incomplete dorsally, followed the tympanum, the last group was the pessulus which was a wedge-shape osseous ridgesituated at the junction of the two primary bronchi. The bronchosyringeal cartilages were formed by a pair of three half rings, constituted the caudal divided part of the syrinx and proceeded the stem primary bronchi**.** In addition to the hard structure, the syrinx had a pair of medial and a pair of lateral tympaniform membrane. The medial tympaniform membrane was well developed and constituted the primary vibrating membrane essential for producing the sound.

Keywords: Turkey, Syrinx, Morphology.

Introduction

The syrinx is the bird voice box, and is analogous to the mammalian larynx except that it lacks the vocal cords which vibrate with air currents, it is rudimentary in some species like vultures and ostriches ***(king 1989)***.

According to the ***Baumel et al. (1993)***, the veterinary anatomists recorded three types of syrinxes; tracheal, tracheobronchial and bronchial, depending on the deviation of the cartilages of the larynx from either the trachea or the bronchi. The tracheal elements laid cranial to the bifurcation of the airway, while the bronchial elements laid at the most cranial part of the right and left primary bronchi. The tracheobronchial syrinx has both tracheal and bronchial elements.

The great majority of birds were described as having a tracheobronchial syrinx, located at the bifurcation of the trachea ***(Hodges, 1974, king*** *and* ***Mclelland, 1984*** *and* ***O'Malley, 2005)***

In most species of birds, the syrinx consisted of series of modified cartilages and two vibrating tympaniform membranes. These hard and soft structure were combined to form both the median part of the syrinx cranially and the subdivided part caudally ***(king 1975****, and* ***king*** *and* ***Mclelland, 1984).***

The skeleton of syrinx was formed by four cartilaginous compartments; the tympanum (cranial cartilages), the tracheosyringeal (intermediate cartilages), the bronchosyringeal (caudal cartilages) and the pessulus, at the tracheal bifurcation. The vibrating membranes presented the paired medial and the paired lateral tympaniform membranes ***(king*** *and* ***Molony, 1971***; ***king 1975***; ***Mclelland,1990*** *and* ***Dyce et al 2002,*** in chicken and ***Khaksar et al. 2012*** in

turkeys). On the other hand, ***Nickel et al (1977)*** described that the term tympanum comprised the first three cartilaginous groups, and they added that it was constricted laterally in the fowl and slightly dilated in ducks and goose. However, ***O'Malley (2005***) recorded that the tympanum applied only the cranial and the intermediated cartilages.

King *and* ***Mclelland (1984)*** recorded that in the male domestic duck, the syrinx is extensively modified to form an asymmetrical dilation on the left side, the osseous bulla thatarouse from the widening of the bronchial syringeal cartilages. In the shelduck, the bulla occurred on the right side of the syrinx, while in other species the dilation is bilaterally symmetrical.

Materials and Methods

Twelve specimens from turkey of both sexesand different weight were examined and dissected. Birds were euthanized by combination of ketamine Hcl (60 mg/kg) and Xylazine (4 mg/kg), as reported by ***Onuk (2010),*** then the birds exsanguinated through the *Aa. Comes nervivagi* which appeared subcutaneously. After opening the body cavity, the topographical position of the syrinx was observed, and the tracheal region containing the syrinx was removed. Six specimens were dissected fresh and then fixed in 10% formalin. The syrinxes of other six specimens were left in 1% methylene blue solution for 15 min then passed through 70% alcohol for two hours for the cartilages to become more evident and then photographed. ***Nomina Anatomica Avium*** (***1993)*** was used for nomenclature.

Results

The syrinx was located within the celomic cavity ventral to the second intercostal space and dorsal to the base of the heart. It was formed from the terminal part of the trachea and the first part of the two main bronchi. According to its location, at the tracheal bifurcation, it was considered as a tracheobronchial type where both the tracheal and bronchial cartilaginous elements shared in its formation.

The syrinx consisted of three groups of modified cartilaginous rings, in addition to the pessulus at the tracheal bifurcation. Beside this, there were two pairs of vibrating tympaniform membranes.

The Tympanum (cranial cartilaginous group) (Figs 1,2,3,6 &7 &3) presented the median and cranial part of the syrinx, just before the tracheal bifurcation. It was formed from the last three tracheal rings, firmly attached together by annular ligaments, to form a short rigid cylinder whose diameter was slightly lesser than the preceding tracheal rings (Figs 1, 2, 4&7\1).

The Tracheosyringeal(intermediate group) (Figs 1,2,3,4&6\4) was formed by two C-shaped rings, opened dorsally, situated at the point of tracheal bifurcation. The first one, the smaller, converged centrally, fused with the second ring and then diverged laterally. The second ring was the largest ring, mostly ossified, projected ventrolaterally in the form of a prominent bony ridge between the tracheal and bronchial elements. The gaps between the free ends of the two rings were closed by tracheosyringeal membrane which attached them to the pessulus, and continued with the medial vibrating membranes (Figs4 &5\10).

The bronchosyringeal (caudal cartilaginous group)(Figs 1, 2, 3&6\5) was composed of three half rings, on each side of the syrinx. They were narrower and smaller than the C-shaped bronchial rings which follow them caudally. They were placed ventrolaterally, while their free ends directed dorsomedially and supported by the medial vibrating membrane.

The pessulus (Figs 4, 5& 8\9) was a small median, wedge- shaped osseous ridge, placed sagittally between the two openings leading into the primary bronchi. Its pointed apex directed cranially through the lumen of syrinx while its broad base directed caudally and attached with the medial tympaniform membranes.

There was a pair of lateral and a pair of medial vibrating tympaniform membranes in the wall of the syrinx.

The lateral tympaniform membrane(Figs 2&3\11) was represented by transverse series of thin transparent strips stretched in between the last tracheosyringeal and the three bronchosyringeal as well as the first bronchial cartilaginous rings. It formed with the preceding cartilages, the lateral aspect of the syrinx.

The medial tympaniform membrane (Figs 4&5\10) constituted the most dorsomedial aspect of the divided part of the syrinx where it was attached with the free ends of the bronchosyringeal rings. It was continued cranially with the caudal border of the pessulus and caudally with the interbronchial ligament(Figs 2& 4\12). In, the turkey, the syrinx did not extend laterally to form neither osseous nor membranous syringeal bulla.

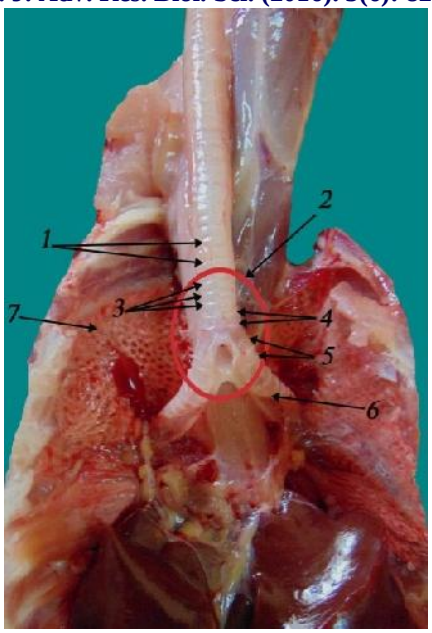

Fig. (1) showing the syrinx of turkey in the ventral view of the opened thoracoabdominal cavity

1.Last tracheal rings **2.** Syrinx **3.** Cranial cartilaginous group (tympanum) **4.** Intermediate group (Tracheosyringeal)	**5.** Caudal cartilaginous group (bronchosyringeal) **6.** Primary bronchi **7.** Lung

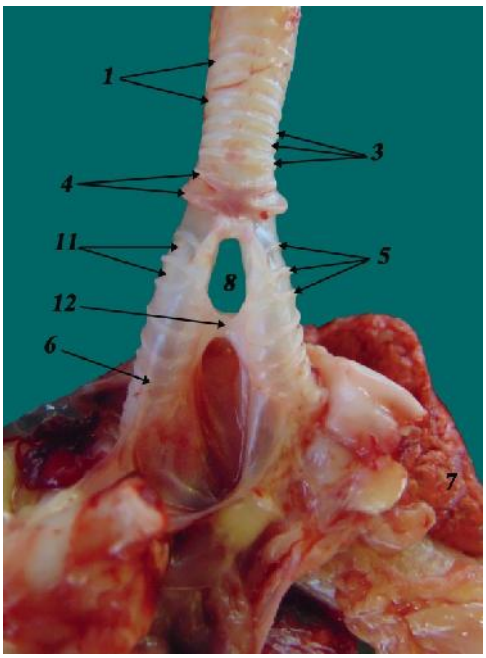

Fig. (2) showingthe whole syrinx of mature turkey attached with the respiratory tract, in a fresh state , ventral view.

1.Last tracheal rings **3.** Cranial cartilaginous group (tympanum) **4.** Intermediate group (Tracheosyringeal) **5.** Caudal cartilaginous group (bronchosyringeal) **6.** Primary bronchi	**7.** Lung **8.** Subpessular space **11.** Lateral (external) tympaniform membrane **12.** Interbronchial ligament

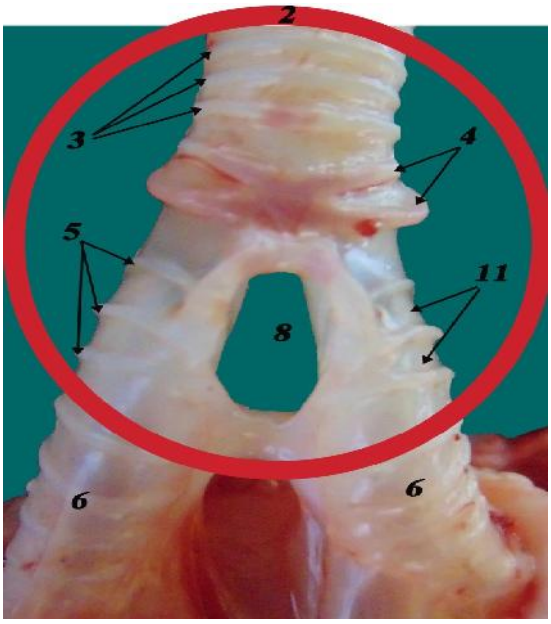

Fig.(3) showing magnifiedventral view ofturkey syrinx in fresh state, where the red circle encloses the whole syringeal parts.

2. Syrinx **3.** Cranial cartilaginous group (tympanum) **4.** Intermediate group (Tracheosyringeal) **5.** Caudal cartilaginous group (bronchosyringeal)	**6.** Primary bronchi **8.** Subpessular space **11.** Lateral (external) tympaniform membrane

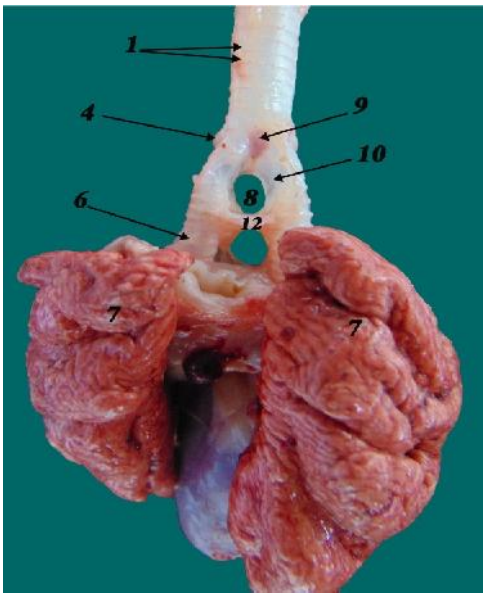

Fig. (4) showingthe whole syrinx of mature turkey attached with the respiratory tract, in a fresh state , dorsal view.

1.Last tracheal rings **4.** Intermediate group (Tracheosyringeal) **6.** Primary bronchi **7.** Lung	**8.** Subpessular space **9.** Pessulus **10.** Medial (internal) tympaniform membrane **12.** Interbronchial ligament

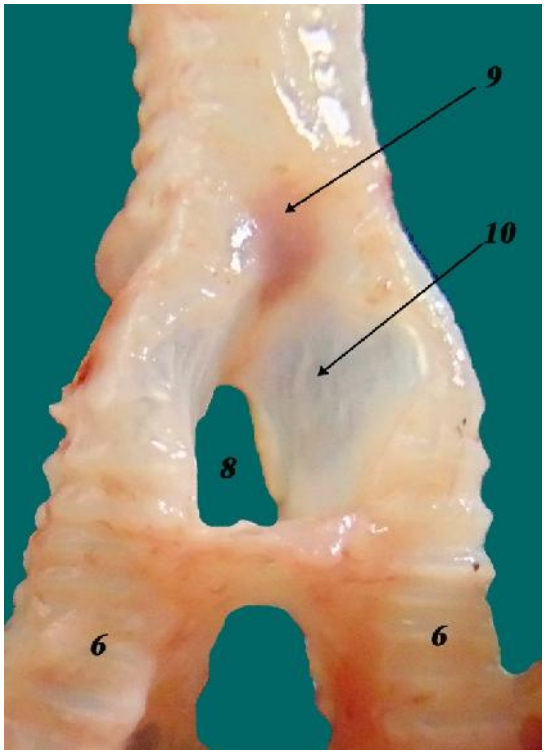

Fig.(5) showing magnifieddorsal view of turkey syrinx in fresh state.

6. Primary bronchi **8.** Subpessular space	**9.** Pessulus **10.** Medial (internal) tympaniform membrane

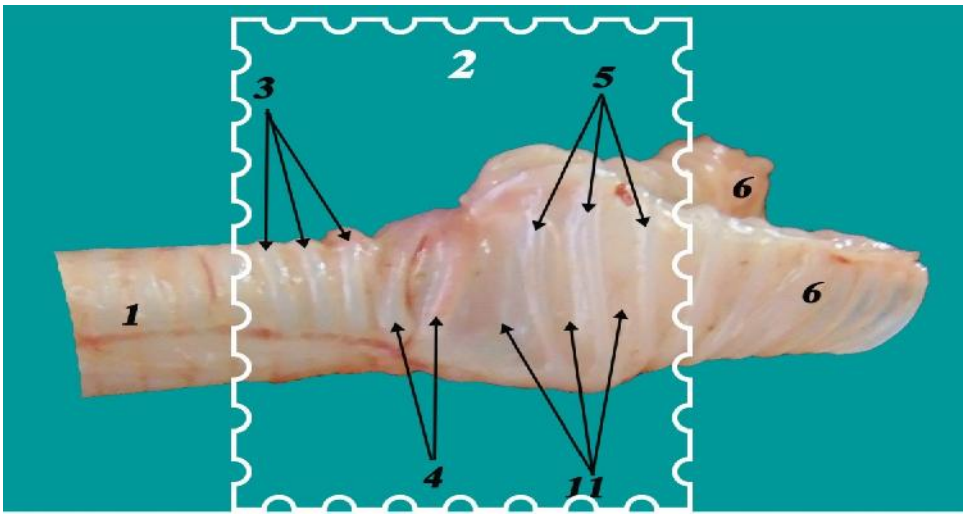

Fig. (6) showing dorsolateral view of isolated turkey syrinx in fresh state.

1.Last tracheal rings **2.** Syrinx **3.** Cranial cartilaginous group (tympanum) **4.** Intermediate group (Tracheosyringeal)	**5.** Caudal cartilaginous group (bronchosyringeal) **6.** Primary bronchi **11.** Lateral (external) tympaniform membrane

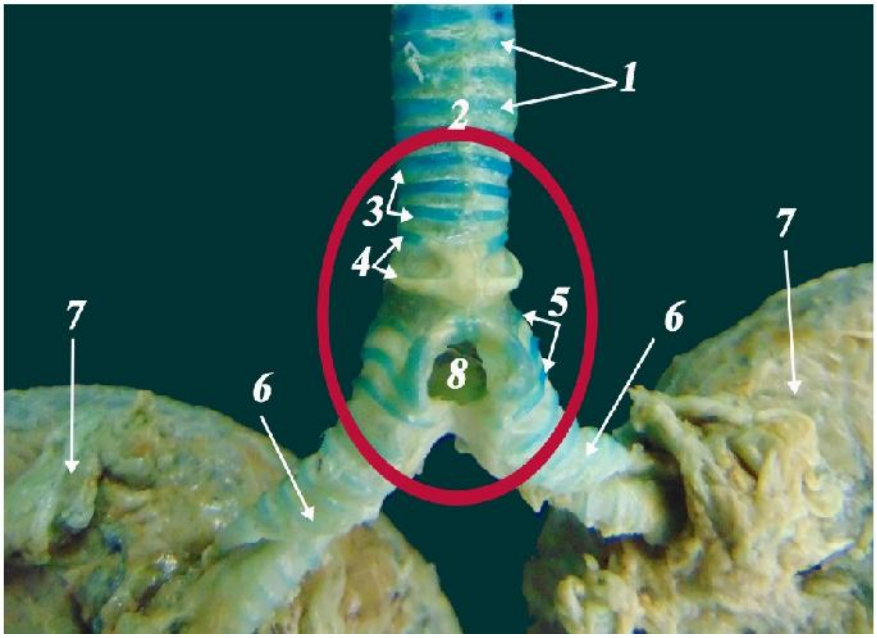

Fig. (7) showing turkey syrinx (ventral view) attached with the respiratory tract stained with methylene blue 1%.

1.Last tracheal rings **2.** Syrinx **3.** Cranial cartilaginous group (tympanum) **4.** Intermediate group (Tracheosyringeal)	**5.** Caudal cartilaginous group (bronchosyringeal) **6.** Primary bronchi **7.** Lung **8.** Subpessular space

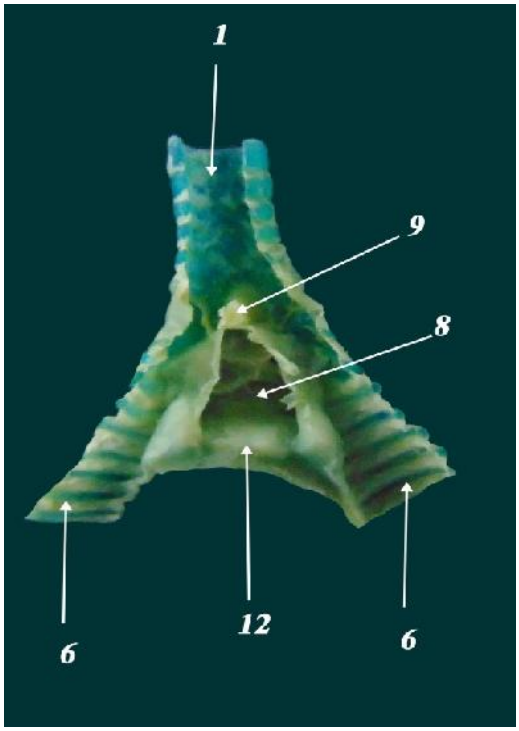

Fig. (8) showing longitudinal section of isolated turkey syrinx (ventral view) stained with methylene blue 1%.

1.Last tracheal rings **6.** Primary bronchi	**8.** Subpessular space **9.** Pessulus **12.** Interbronchial ligament

Discussion

Khaksar et al. (2012) recorded that the tympanum in turkeys was formed from two tracheal cartilaginous rings. A condition which dissimilar with the present work where the tympanum was represented by three complete tracheal rings closely attached to each other, Moreover, ***(king, 1975; Nickel et al. 1977; Mclelland, 1990; Kabak et al. 2007*** *and* ***Cevik-dermikan et al. 2007)*** in the chicken***,(Bettina*** *and* ***Pablo, 2001)*** in new world turkeys***, (Deeming, 1999)*** in ostrich and ***(Yildiz et al. 2005)*** in the pigeon, described that the tympanum was represented by four complete tracheal rings.

The present results revealed that the tympanum showed lesser diameter than the proceeding tracheal rings and the tracheosyringeal rings which follow it caudally. However, ***Nickel et al. (1977)*** described that the term tympanum included the first three cartilaginous groups of the syrinx and it was constricted laterally in the fowl and slightly dilated in ducks and goose. On the other hand, ***King*** *and* ***Mclelland (1984)*** recorded that, in the fowl and many others, the tympanum had a slightly increased diameter.

The present investigation in turkeys recorded two characteristic and highly modified tracheosyringeal (intermediate) C-shaped rings, opened dorsally and attached to the pessulus. The second one; showed a prominent semicircular osseous ridge, while the first cartilage connected to the latter one centrally and then diverged laterally. That was different from the description of ***Khaksar et al. (2012)*** as they described two complete similar rings. However, and as recorded in chicken, songbirds, ostrich and pigeon, there were four C- shaped cartilaginous rings, on either side of the syrinx, attached to the pessulus at their ventral and free at its dorsal ends (***King, 1975; King*** *and* ***Mclelland, 1984*** *and* ***Mclelland, 1990).***

Khaksar et al. (2012) recorded four C-shaped bronchosyringeal rings on each side and they were not attached to the pessulus. That was dissimilar to the present work where three half rings were present on each side and bore the medial tympaniform membrane on its dorsomedial aspect, Moreover, in chicken, three C-shaped bronchosyringeal rings were also constituted lateral wall of the divided part of the syrinx ***(King, 1975)***.

In the present investigation, the pessulus was represented by a wedge shaped osseous ridge situated between the two openings leading to the primary bronchi. Similar observation was also recorded in songbirds ***(Warner, 1972*** *and* ***Hartley*** *and* ***Suthers, 1990)***.It was cartilaginous in chickens ***(king*** *and* ***Mclelland, 1984; Nickel et al., 1977; Dyce et al. 2002)***. On the other hand the pessulus was represented by a soft connective tissue structure in turkey ***(Bettina*** *and* ***Pablo, 2001*** *and* ***Khaksar et al. 2012)*** and in ostrich ***(Yildiz et al. 2005)*** as well as in the pigeon ***(Mclelland, 1990,*** *and* ***El-Mahdy 2005). Khaksar et al.*** explained that the connective tissue structure of the pessulus was probably due to the fact that the turkey was not a singing bird and thus neither osseous nor cartilaginous structure was needed to keep the pessulus tight.

The reduction of the lateral vibrating tympaniform membrane into series of transparent strips, on the lateral wall of the syrinx, between the bronchosyringeal rings and their attachments with the tracheosyringeal and bronchial rings as described in the present study was similar to that revealed in songbirds by ***king*** *and* ***Mclelland (1984)*** *and* ***Mclelland (1990).*** They added that, in chickens, the lateral tympanic membrane was consisted of a relatively extensive sheet between the last tracheosyringeal and the first bronchosyringeal cartilage. Moreover, and as also recorded by ***King (1975)****and* ***Nickel et al***. (***1977)*** that the inward curve of that membrane gave the syrinx its characteristic appearance in domestic fowl.

The present study pointed out that the medial vibrating tympaniform membrane was well developed and modified in the turkey. It formed most of the dorsomedial aspect of the divided part of the syrinx and stretched between the free ends of the bronchosyringeal cartilages. A result which simulated the description of ***king (1975)***, ***Nickel et al***. (***1977),*** *and* ***Goller*** *and* ***Larsen (1997, 2002)*** in turkey and songbirds*and* ***Dyce et al. (2002)*** in chicken.

Mclelland (1990) explained that sound was produced only in expiration when the air from the lungs and air sacs forces the tympaniform membranes into the lumen of the syrinx. In this respect, the present study considered the medial tympaniform membrane was well developed and constituted the primary vibrating membrane essential for producing sound in turkey, while the lateral membrane was supported by the bronchosyringeal cartilages and thus it had no ability to produce vibration and sound. A result which was simulated nearly the observation of ***Khaksar et al. (2012).***

King** and **Mclelland (1984) and ***Dyce et al. (2002)*** as well as ***Pierko (2010)*** a syringeal bulla was recognized in the male duck. However, in the present work and as also reported in turkey by ***Khaksar et al. (2012)*** and in chicken by ***king (1975)***, ***Mclelland (1990)*** and ***Dyce et al. (2002)***and in the true swans and geese by ***King** and **Mclelland (1984)*** , the syringeal bulla was not present neither osseous nor membranous in all the investigated specimens.

King (1989) described the interbronchial ligament as a connective tissue bridge joining the right and left primary bronchi in most but not all birds. The interbronchial ligament was present in all examined turkey specimens. Moreover, the present study was in accordance with ***King** and **Mclelland (1984)*** in chicken that the interbronchial foramen was represented by the space between the bifurcation of the trachea and the interbronchial ligament. The latter foramen was termed by ***Warner (1971)*** as the subpessular air space.

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