



Macroscopic morphology and arterial vascular supply of thymus in fowls (*Gallus gallus domesticus*) of Red Bro Cou Nu lineage

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ABSTRACT. Twenty-eight fowls (*Gallus gallus domesticus*) of the Red Bro Cou Nu lineage were studied. They were about 35 days old and had their arteries filled with Neoprene Latex 450[®], aqueous solution at 50%, stained with specific pigment (Globo S/A, Tintas e Pigmentos), and then fixed in aqueous solution of formaldehyde at 10%. The present study aimed to quantify the thymic lobes and identify the main arteries responsible for the blood supply of these lobes and their frequencies. The number of thymic lobes on the right antimere varied from two to 11, with a greater frequency of 8 lobes; and the left antimere showed a variation from one to eight, with a greater frequency of five lobes. The arteries destined to the thymus were composed by direct and indirect branches of the following arteries: left and right common vagus nerve, left and right cranial thyroid, left and right caudal thyroid, left and right ascending esophageal, right ingluvial, left and right cutaneous, and right common carotid. The right thymic lobes, regardless their origin, received from eight to 27 vascular branches, and the left thymic lobes, from eight to 24 branches.

Keywords: anatomy, irrigation, *Gallus gallus*.

Morfologia macroscópica e suprimento vascular arterial do timo em aves (*Gallus gallus domesticus*) da linhagem Red Bro Cou Nu

RESUMO. Foram estudadas 28 aves (*Gallus gallus domesticus*) da linhagem Red Bro Cou Nu, com aproximadamente 35 dias de idade, que tiveram suas artérias preenchidas com Látex Neoprene 450[®], solução aquosa a 50%, corado com pigmento específico (Globo S/A, Tintas e Pigmentos) e em seguida foram fixadas em solução aquosa a 10% de formol. O objetivo do presente estudo foi quantificar os lobos tímicos e identificar as principais artérias responsáveis pelo suprimento sanguíneo arterial e suas frequências. No antítmero direito cada cadeia tímica apresentou de dois a 11 lobos tímicos, com maior frequência de oito lobos. O antítmero esquerdo apresentou de um a oito lobos tímicos, sendo que a maior frequência foi de cinco lobos. O suprimento arterial do timo das aves da linhagem Red Bro Cou Nu do presente estudo era composto por ramos diretos e indiretos oriundos das artérias: comum do nervo vago direita e esquerda, tireóide cranial direita e esquerda, tireóide caudal direita e esquerda, esofágica ascendente direita e esquerda, ingluvial direita, cutânea direita e esquerda e carótida comum direita. Os lobos tímicos direitos receberam independentemente de suas origens, de oito a 27 ramos vasculares e os lobos tímicos esquerdos receberam de oito a 24 ramos.

Palavras-chave: anatomia, irrigação, *Gallus gallus*.

Introduction

Body immunity has always been associated to activities related to lymphomyeloid organs and their cells; being that the lymphatic system is compounded by a network of diffuse defense. In birds we find dispersed lymphoid tissues and absence of lymph nodes (ROSE, 1979).

According to the function and development, the lymphomyeloid organs can be classified into primary or central organs (SZENBERG, 1976), and secondary or peripheral organs (GLICK, 1978).

The primary lymphomyeloid organs are producers of lymphocyte precursors and include the bone marrow and the thymus in several animal species. In birds, include the yolk sac and cloacal bursa, so that the humoral immune responses are mainly centralized in these structures and in the thymus, in young birds (KENDALL, 1980).

On the other hand, secondary organs promote the maturation of cells of the lymphatic system, besides functioning as sites of immune responses

and correspond to the spleen, caecal tonsils, third eyelid gland, palatine tonsils and intestinal lymphoid tissues (ROSE, 1979).

The regulatory mechanisms of thymus development, as well as the lymphocytopoiesis, are not definitively clarified. It should be noted that this organ has been subject of thorough studies (SCALA et al., 1984), but the morphology is poorly addressed and the circumstances involved in its regression are not elucidated. Furthermore, the vascular components that promote the blood supply have received little attention and have been approached in a generic way (CARVALHO et al., 2004; GONÇALEZ et al., 2000; PEREIRA et al., 2008; SANTANA et al., 2000, 2001, 2008; SILVA et al., 2001).

The goal of the present study was to address in fowls (*Gallus gallus domesticus*) of the Red Bro Cou Nu lineage, the morphological aspects of thymus and those specific about the origin, number and distribution of arteries that promote the blood supply.

Material and methods

We examined 28 exemplars, 14 males and 14 females, of fowls (*Gallus gallus domesticus*) from the Red Bro Cou Nu lineage, with about 35 days old, coming from breeding farms located at Federal District, transferred after natural death.

The arterial vascular system of the animals were filled with Neoprene Latex 450" in aqueous solution at 50% (Du Pont do Brasil S/A, Indústria Química), stained with specific pigment of red coloration (Globo S/A, Tintas e Pigmentos) through cannulation of the left sciatic artery, and injection in cranial direction.

Afterwards, we proceeded the fixation of the animals, through aqueous solution, of formaldehyde at 10% (Labsynth, Produtos para Laboratório Ltda.) by deep applications intramuscular, subcutaneous and intracavitary, and subsequent immersion in the same solution. After 72 hours, we dissected the arteries responsible for the blood supply of the thymus.

For the dissection, we made a ventral midline incision of the skin at the cervical region, followed by a dilatation of the subcutaneous connective tissue, and then we removed the tissues adjacent to the thymic lobes.

In order to better understand and interpret the findings, we built schematic models of vascular supply of the referred organ (Figure 2), recording the origin, number and arrangement of arterial branches, as well as photographic records of the more peculiar arrangements (Figure 1).

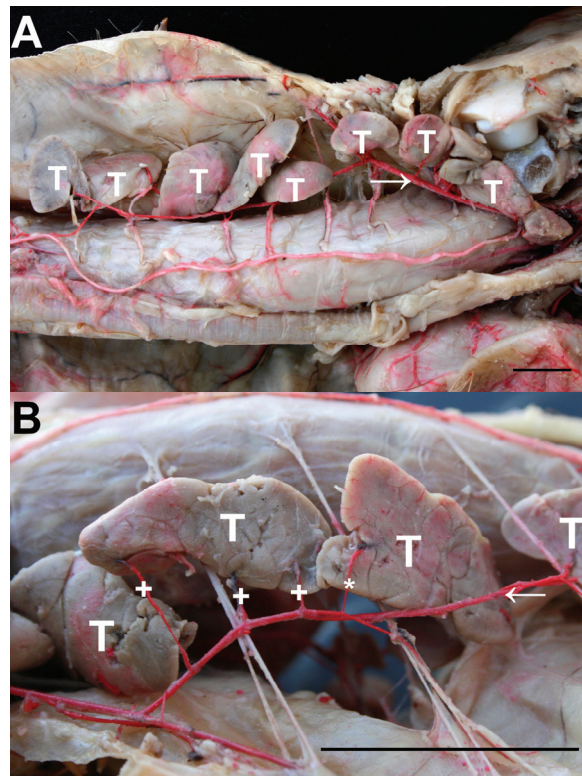


Figure 1. Arterial vascular supply for the thymic lobes (T), of the left (A) and right (B) antimeres, of fowls from the Red Bro Cou Nu lineage, from the left and right common artery of the vagus nerve (→), bifurcate into branches direct (+) and indirect (*). Scale bars = 1 cm.

Results

We verified from two to 11 thymic lobes in the right antimere, besides that, the cases with five to eight lobes represented the largest portion of the sample, totaling 82.15% of the cases.

The occurrence of two, three, four, nine and 11 thymic lobes accounted for 3.57% in the examined animals. Thus, 21.43% represented five lobes; 28.57%, six lobes; 17.86%, seven lobes, and 14.29%, eight lobes.

At the left antimere, we found from one to eight lobes, so that the specimens with four and five lobes represented the majority of the sample, totaling 64.3% of the cases. Only one thymic lobe occurred in 3.57%, the same percentage observed for those presenting seven lobes. The animals with two, three, six and eight thymic lobes, at this antimere, represented 7.14% each one from the total of studied animals. Four thymic lobes were equivalent to 17.87% of all animals, in the same way, those with five lobes represented 46.43 of cases.

Both in the right and left antimere, we recorded from one to two thoracic lobes. In both antimeres, the chain of thymic lobes of these animals were arranged linearly, parallel and laterally in the cervical region, in all cases (Figure 2).

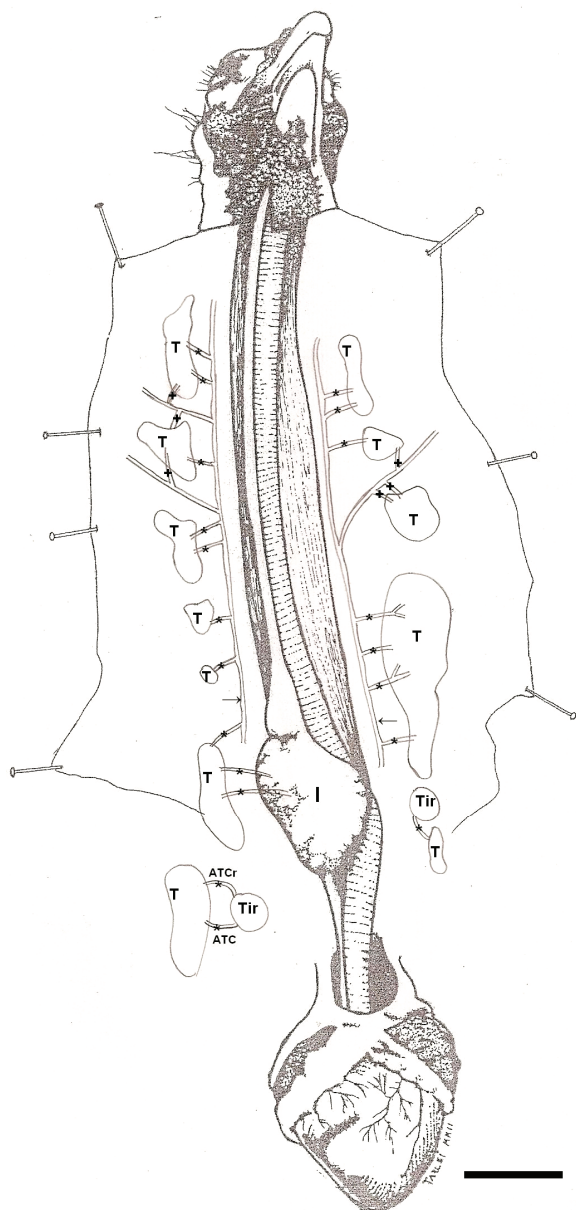


Figure 2. Schematic drawing representative of arterial vascular supply of thymic lobes (T) of left and right antimere of fowls from the Red Bro Cou Nu lineage, illustrating the branches direct (*) and indirect (+) from the arteries: left and right common vagus nerve (→), caudal thyroid (ATC), cranial thyroid (ATCr) and ingluvial (I). Scale bar = 1 cm.

The thymic lobes of right antimere received, regardless their origin, from eight to 27 arterial branches; being that eight, 11, 13, 20, 21, 25, 26 and 27 branches were observed in one case each (3.57%); 14, 17, 19 and 23 branches in two cases each (7.14%); 22 branches in three cases (10.73%), 15 branches in four cases (14.29%), and 16 in five cases (17.86%).

The thymic lobes of left antimere received, regardless their origin, from eight to 24 arterial branches; being that nine, ten, 11, 15, 20 and 24

branches were verified in in one case each (3.57%); 12 and 16 branches in two cases each (7.14%); 18 branches in three cases (10.72%), 13 and 17 branches in four cases (14.29%), and 14 branches in five cases (17.86%).

The arterial vascular supply of fowls from the Red Bro Cou Nu lineage showed in the right antimere a total from eight to 27 branches. The direct branch of the right common artery of the vagus nerve presented the highest frequency (48.71%), followed by the frequency of 22.66% of the branches of cutaneous arteries; 13.32% of them originated from indirect branches of ingluvial artery; 6.36% of cranial thyroid artery; 6.16% of the indirect branches of the common artery of the vagus nerve; 1.79% of the branches came from the caudal thyroid artery; 0.4% arose from the common carotid artery; 0.2% were indirect branches of the ascending esophageal artery, and with similar frequencies the direct branches of the same artery and the direct branches of the left common artery of the vagus nerve.

At the left antimere we registered a total from eight to 24 arterial branches per fowl, among these, 45.43% were direct branches of the common artery of the vagus nerve; 33.58% were branches of cutaneous arteries; 9.88% indirect branches of the common artery of the vagus nerve; 8.40% branches of the cranial thyroid artery; 2.47% branches of caudal thyroid artery, and 0.25% indirect branches of ascending esophageal artery.

In the right antimere, the branches ranged from five to 14 direct of the common artery of the vagus nerve, with predominance of five branches in 17.86% of cases; six and eight branches for 14.29% of the branches each; followed by the frequency of 10.71% of cases for those presenting nine branches, as well as, were recorded similar frequencies for those presenting 11 or 12 branches; 7.14% of cases presented ten and 14 branches each; and the frequency of 3.57% of cases presented seven or 13 branches.

On the left antimere, the branches varied between two and 11 direct of the common artery of the vagus nerve, with predominance of four, seven or eight branches in 14.28% of the cases each; followed by five, six, nine or ten branches in 10.71% of the cases each; two branches in 7.14% of cases; and three or 11 branches in 3.57% of cases.

The indirect branches of the common artery of the vagus nerve occurred in both right and left antimere, in 60.7% of the fowls, ranging from one to four branches by antimere.

In this study, we observed that, in the right antimere, 53% of the fowls that presented indirect branches of the common artery of the vagus nerve

had only one branch. In 24% of the studied fowls, we verified two branches, and three or four branches were at the frequency of 12% each.

In the left antimere, 35% of fowls presented thymic lobes supplied by a single indirect branch of the common artery of the vagus nerve; 29% by four branches, 24% by two branches and 12% by three of these branches.

The cranial thyroid artery contributed for the supply in the right antimere with one direct branch, in 13 cases; two direct branches, in six cases; three direct branches in one case; and four branches in one case. On the other hand, the cranial thyroid artery in the left antimere, contributed with a single direct branch in 21 cases, two direct branches in five cases, and three branches in one case.

The caudal thyroid artery contributed for the thymic supply in the right antimere with branches in only 28.57% of the animals, among them, seven cases with one direct branch and one case with two direct branches. In relation to the left antimere, 35.7% of animals presented a direct branch of the caudal thyroid artery, with no case in which more than one branch, stemming from the caudal thyroid artery, has supplied the thymic lobes on the left antimere.

The esophageal artery was present in only three cases, among them, two branches in the right antimere, one direct and another indirect, and one indirect branch in the left antimere.

The common carotid artery contributed with only one direct branch in the right antimere, in 0.4% of the fowls, we did not find participations from this on the left antimere.

The branches of cutaneous arteries were observed in all animals and on both antimeres, exhibiting frequency lower only in relation to the common artery of the vagus nerve.

On the right antimere, the number of branches of cutaneous artery ranged from one to nine, presenting cases with one branch in 11%; two branches in 14%; three branches in 21%; four branches in 11%; five branches in 18%; six branches in 14%; seven, eight and nine branches in 4% each one. In the left antimere, the number of branches varied between one and 12, being more abundant the cases with three branches, in 29%; five branches in 21%, two branches in 14%; seven branches in 11%; 12 branches in 7%, and four, six, eight and ten in 4% each.

The ingluvial artery contributed for the blood supply from one to 11 branches in 23 animals, all on the right antimere; in nine cases, only one branch was given; in five cases, two branches; in two cases, three branches; in two cases, six branches, in three

cases, five branches; in one case, four branches; and in one case, 11 branches. In one case we found a thoracic lobe of the right antimere, supplied by the left common artery of the vagus nerve.

Discussion

Our results are in agreement with those from Gonzalez et al. (2000), for fowls from the Peterson lineage, Pereira et al. (2008), with fowls from Hubbard lineage, Santana et al. (2000, 2001, 2008) with the lineages Avian Farms, NPK and Paraíso Pedrês, Miranda et al. (2008) for the fowls of the Bovans Goldline lineage, and Lima et al. (2009) with the fowls of the Master Gris Cou Plumé lineage, concerning the location and arrangement of thymic lobes, when they were arranged laterally in the cervical region and maintained a close relationship with the vagus nerve and jugular vein of both antimeres.

As described by Santana et al. (2001) for the fowls of the NPK lineage and Lima et al. (2009) with the fowls of the Master Gris Cou Plumé lineage, the animals of the present study also presented thymic lobes arranged in the thoracic region.

According to the findings from Santana et al. (2000, 2001, 2008), Gonzalez et al. (2000), Pereira et al. (2008) and Lima et al. (2009) with the fowls of the present study, the thymic lobes of both antimeres, in all cases, presented sizes and shapes, as well as number of lobes quite variable. Thus characterizing that, in birds, the thymus despite its particularities presented an arrangement pattern for *Gallus gallus*.

In the fowls of the Red Bro Cou Nu lineage, the number of thymic lobes ranged from one to eight in the left antimere, and from two to 11 on the right antimere, mostly presenting five and six lobes, respectively. In the fowls of the Master Gris Cou Plumé lineage, in accordance to descriptions of Lima et al. (2009), the number of thymic lobes varied between four and nine in the left antimere, and between three to seven in the right antimere. Birck et al. (2008) considered that the fowls of the Cobb 500 lineage presented from three to five lobes in both antimeres, with greater number in the left antimere. Otherwise, Santana et al. (2008) with fowls of Paraíso Pedrês lineage, reported the existence of two to ten lobes in the left antimere, and from three to eight lobes in the right antimere. In fowls of the Hubbard lineage, Pereira et al. (2008) described the existence of three to 11 lobes, with higher frequency of six lobes, on the left antimere, and of four to 13 lobes, with greater frequency of six

lobes in the right antimere. Meanwhile Miranda et al. (2008) mentioned that the laying hens of the Bovans Goldline lineage, the number of thymic lobes ranged from two to six in both antimeres.

Given this and the observed in the fowls of the present study, it was possible to verify a great variety in the number of lobes, thus characterizing the representation of peculiarities existing among the different lineages of *Gallus gallus*.

According to age, the thymus tends to decrease in volume and numbers of lobes suggesting, in this way, the trend of younger individuals present a greater number or larger size of these lobes. Nevertheless due to differences in studied lineages, as well as different ages, it was not possible to built this association, since in the studies performed by Birck et al. (2008), Miranda et al. (2008), Pereira et al. (2008), Santana et al. (2008) and Lima et al. (2009), the examined fowls had approximately: 35 to 42, 105, 70, 77 and 42 days and the number of lobes did not change uniformly with age.

In the fowls of the Red Bro Cou Nu lineage, the common artery of the vagus nerve frequently collaborated with the vascular blood supply of thymic lobes, since it gave direct and indirect branches. On the right antimere, gave 55% of the branches for the thymus, and in the left antimere, was responsible for 55.31% of the branches that supplied this gland. This fact can be explained by the syntopy between the thymic lobes and the vagus nerve, as described by Santana et al. (2008) and Lima et al. (2009).

We also registered direct and indirect branches of the left and right cranial thyroid artery; left and right caudal thyroid artery; left and right ascending esophageal artery; right ingluvial; and cutaneous, corroborating the studies from Santana et al. (2000, 2001, 2008), González et al. (2000), Pereira et al. (2008) and Lima et al. (2009).

Unlike reported for the fowls of the Máster gris Cou Plumé lineage (LIMA et al., 2009), in the present study, we did not find the occipital artery supplying the thymic lobes, evidencing the diversity and variety of arteries that can supply the thymus regarding *Gallus gallus*.

Particularly in the present study and in a different way to described by Santana et al. (2000, 2001, 2008), González et al. (2000), Pereira et al. (2008) and Lima et al. (2009), the fowls of the Red Bro Cou Nu lineage, presented a crossing of arterial branches between opposite antimeres, when was visualized a direct branch of the left common artery of the vagus nerve, supplying the thoracic lobe of the thymus of the contralateral antimere, indicating the particular arrangement of this finding for the fowls in question.

The great quantity of thymic lobes and their vascular richness may be justified by the importance of this organ for birds, being responsible for the humoral immune responses, acting on the production and differentiation of precursor T-cell.

Conclusion

It was found the presence of thymic lobes on both sides of all fowls analyzed. The number of lobes varied from animal to animal, existing a higher incidence of five to eight lobes in the right antimere and four and five lobes in the left antimere. The principal arterial branches responsible for the vascularization of this organ were originated by the common artery of the vagus nerve and cutaneous arteries, also being found directly or indirectly branches from the cranial and caudal thyroid arteries, ascending esophageal and ingluvial.

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