ISTANBUL UNIVERSITY CERRAHPAŞA

Circulation of Coronary Artery of Domestic Duck (*Anas platyrhynchos domesticus*) Hearts Living in Kars Region

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Abstract

The aim of this study is to uncover the course, distribution and anastomoses of coronary arteries in Domestic Duck (*Anas platyrhynchos domesticus*) raised at high altitudes and in cold climate conditions in the Kars Region and its neighborhoods. It was found that the arterial nourishment of the heart was provided by the right coronary artery and the left coronary artery in Domestic Duck. Both coronary arteries were divided into two principal branches as the superficial ramus and the profund ramus. It was identified that the interatrial ramus, originating from left coronary, the profund ramus and the superficial ramus of the left coronary, with the profund ramus of the right coronary artery, nourished the interventricular septum. The superficial ramus of the left coronary artery was found as the most potent and thickest branch in Domestic Duck. Numerous anastomoses were observed between the profund ramus of the right coronary artery and the superficial ramus of the left coronary artery. Homocoronary anastomoses were intensively found on the left ventricle, while intercoronary anastomoses were intensively found on the interventricular septum, the apex of the heart, and the atrial surface of the heart. Consequently, the macro anatomical features of Domestic Duck were revealed by using two different techniques.

Keywords: Coronary artery, corrosion cast and latex, domestic duck

Introduction

The consumption of chicken, goose and duck meat as high protein sources is increasing in line with the growing world population. In this regard, the production of duck meat, cheaper than red meat and having a shorter maintenance period, with a high growth rate by turning feed into meat, is increasing day by day (Demir et al., 2010). According to the statistics of the Turkish Statistical Institute, there were 529,000 ducks in Turkey by the year 2017. The farming of duck, primarily for meat and feather products, is extensively practiced in family-run enterprises around Turkey (TÜİK, 2017).

Arterial nourishment for the heart is provided by the right coronary artery and the left coronary artery dissenting from the aorta (Tıpırdamaz, 2007). The right coronary artery arises from the aorta at the level of the valvula semilunaris dextra and splits into two branches as the profund ramus and superficial ramus in wingers. The left coronary artery, originating at the level of the valvula semilunaris sinistra of the aorta, branches into the profund ramus and the superficial ramus. While the superficial ramus gives off smaller branches dispersing to the left atrium and ventricle, the profund ramus continues along the apex of the heart between the dorsal surface of the conus arteriosus and the left ventricle. It provides the septal rami and

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the ventricle rami during its navigation (Baumel, 1975; Nickel et al., 1977).

Although there are studies on the arterial feed of hearts in various winged species (Aslan et al., 2009; Çakmak & Karadağ, 2010; Kuru, 1996; Yoldaş & Gezici, 2011), there is no study on coronary arteries in Domestic Duck (*Anas platyrhynchos domesticus*). To conclude, the aim of this study was to investigate the courses, distributions and anastomoses of coronary arteries in Domestic Duck by using the latex and corrosion cast techniques.

Method

In the study, 20 hearts of Domestic Duck (10 female and 10 male) were gathered from the farm slaughterhouse of Kafkas University Veterinary Faculty on different days to be used as study material. The hearts came from ducks slaughtered at 4 months of age, and they weighed on average 2268 g. The coronary vessels were cleansed with salty water and colored with red fabric dye (Artdeco). Latex (ZPK-582-G by Educational & Scientific Products Ltd, Rustington, West Sussex, UK) was injected into 10 (5 female and 5 male) duck hearts through a catheter placed in the aorta ascendens. The hearts, which were kept in 10% formaldehyde solution for one week, were photographed after they were dissected. To reveal corrosion muscles, a mixture of monomethyl methacrylate and polymethyl methacrylate with red Rotring Ink 831/2 Illumination dye was injected into 10 (5 female and 5 male) duck hearts through a catheter placed in the aorta ascendens. The hearts, immobilized in glass jars with 10% KOH, were kept in an incubator at 37°C for 2 days for maceration (Aycan & Bilge, 1984). The hearts were carefully dissected and photographed with a Kodak M320 camera. The diameters of all vessels were measured from where they originated. Electronic digital calipers (.01, BTS, UK) were used to measure the hearts' characteristics. The Nomina Anatomica Avium (1993) was used for terminology.

Results

It was observed that the right coronary artery originated from the aorta ascendens with 1.72 mm diameter as the single root in all hearts (Figure 1). After 2.18 mm of the origin of the right coronary artery, it gave off the profund ramus, with an average diameter of 1.47 mm (Figures 1b and 3b).

It was observed that the profund ramus divided into three main branches onto the interventricular septum by navigating toward the caudoventral (Figures 1b and 3b). It was then specified that the first of these branches segregated on the surface of the interventricular septum facing the right ventricle, and two others joined the feeding of the superior and middle segments of the interventricular septum (Figure 1b). The profund ramus was divided into two branches of caudal and cranial in the rear spar of the interventricular septum. It was identified that the left coronary artery anastomosed with the circumflex ramus after the branch, navigating toward the cranial, produced a

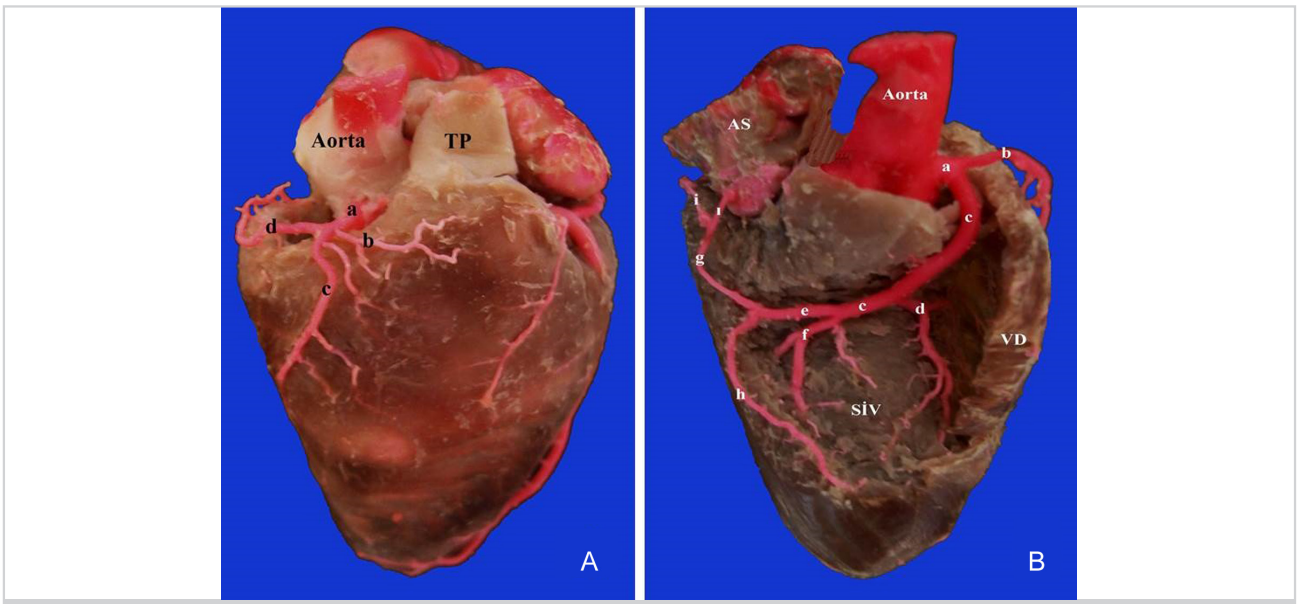

Figure 1
(A) Right Coronary Artery and its Branches (Latex). (a): Right Coronary Artery, (b): Conal Branch, (c): Superficial Ramus of the Right Coronary Artery, (d): Circumflex Ramus of the Right Coronary Artery, TP: Pulmonary Trunk (Right Atrium Removed). (B) Right Coronary Artery and its Branches. (a): Right Coronary Artery, (b): Superficial Ramus of the Right Coronary Artery, (c): Profund Ramus of the Right Coronary Artery, (d–f): Septal Rami, (e, g, h, ı): Superficial Branches of Profund Ramus of the Right Coronary Artery, (i): Anastomosing Branches, AS: Left Atrium, VD: Right Ventricle, SİV: Interventricular Septum.

branch heading to the rear spar of the atrium sinistrum with the trigona fibrosa sinistra (Figure 1b). The branch, coursing toward the caudal, nourished the ventral part of the interventricular septum, and there was intercoronary anastomosis of the left coronary artery with the superficial ramus in the apex of the heart (Figure 1b).

It was revealed that the superficial ramus of the right coronary artery measured on average .78 mm in diameter, and it provided firstly the conal ramus and then the ventricle rami dispersing on the right ventricle. It was observed that the right superficial ramus then continued as the right circumflex ramus in the coronary groove with an average .49 mm diameter (Figure 1a). There was intercoronary anastomosis between the right conal ramus and the conal ramus originating from the left coronary artery of the superficial ramus. The conal ramus of the left coronary artery was more powerful than the conal ramus of the right coronary artery. It was revealed that 3–4 atrial branches originated from the circumflex of the right coronary artery. In addition, 5–6 ventricle rami dispersed on the upper part of the right ventricle by diverging from the right circumflex ramus. It was found that the right coronary artery of the right circumflex then continued as the subsinuosal interventricular ramus and is dispersed on the right ventricle before reaching the apex of the heart. The profund ramus of the right coronary artery had more powerful arterial circulation than the profund ramus of the superficial ramus.

It was determined that the left coronary artery originated from aorta ascendens as a single root, with an average diameter of 2.03 mm, and it first gave off the interatrial ramus with a diameter of .44 mm in all hearts. The interatrial ramus ended with a division into two branches dispersing toward the interatrial septum and trigona fibrosa dextra (Figure 3a). The left coronary artery generated the left profund ramus after 11.04 mm and it continued as the left superficial ramus (Figure 2b). It was also identified that the superficial ramus of the left coronary artery had more branches and arterial circulation than the profund ramus.

The profund ramus of the left coronary artery dispersed on one-third of the interventricular septum navigating a ventral course following its origin and some of its last branches ended with homocoronary anastomosis with the interventricular paraconal ramus and the left ventricle (Figure 2b).

It was detected that the average diameter of the left superficial ramus, a follow-up of the left coronary artery, was 1.35 mm. It was then observed that the left superficial ramus divided into the conal ramus, the left circumflex ramus, and its

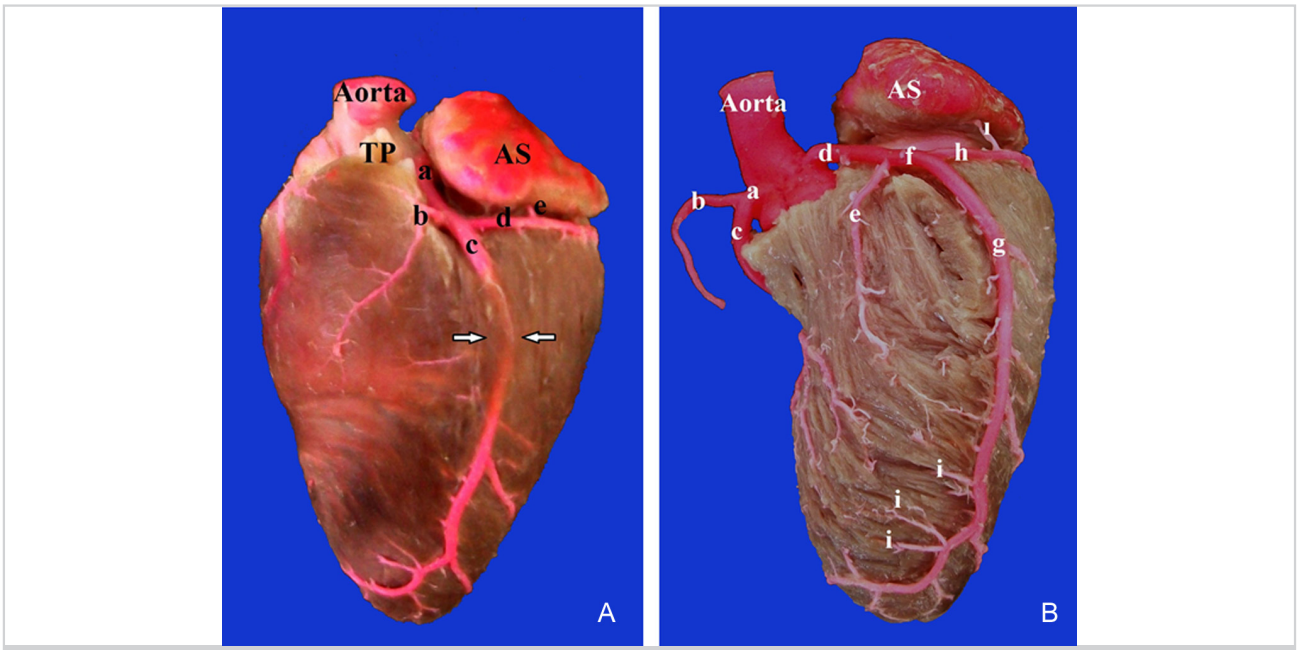

Figure 2
(A) Left Coronary Artery and its Branches (latex). (a): Left Coronary Artery, (b): Conal Branch, (c): Superficial Ramus of the Left Coronary Artery, (d): Circumflex Ramus of the Left Coronary Artery, (e): the Thickest Atrial Branch, TP: Pulmonary Trunk, AS: Left Atrium. (B) Left Coronary Artery and its Branches (Latex) (a): Right Coronary Artery, (b): Superficial Ramus of the Right Coronary Artery, (c): Profund Ramus of the Right Coronary Artery, (d): Left Coronary Artery, (e): Profund Ramus of the Left Coronary Artery, (f): Superficial Ramus of the Left Coronary Artery, (g): Interventricular Paraconal Ramus of the Left Coronary Artery, (h): Circumflex Ramus of the Left Coronary Artery, (ı): Atrial Branch, (i): The Thickest Atrial Branch, ⇛ ⇚: Myocardial bridge.

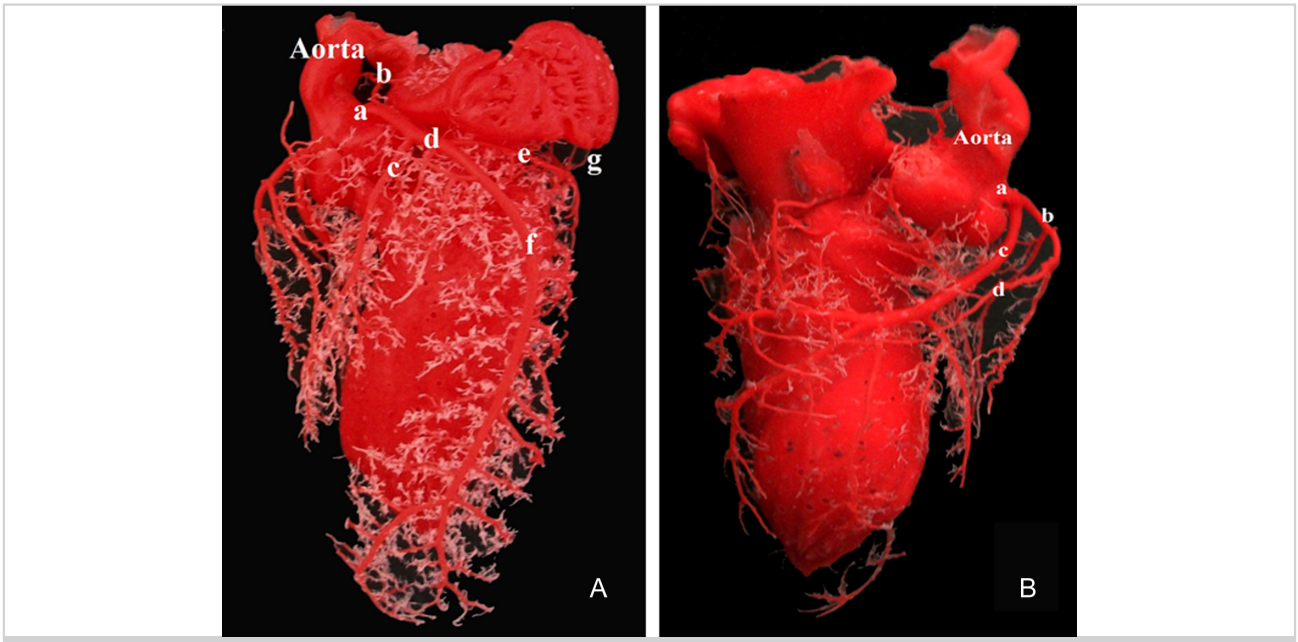

Figure 3
(A) Left Coronary Artery and its Branches (Corrosion Cast) (a): Left Coronary Artery, (b): Interatrial Branch, (c): Profund Ramus of the Left Coronary Artery, (d): Superficial Ramus of the Left Coronary Artery, (e): Circumflex Ramus of the Left Coronary Artery, (f): Interventricular Paraconal Ramus of the Left Coronary Artery, (g): Atrial Branch. (B) Right Coronary Artery and its Branches (Corrosion cast) (a): Left Coronary Artery, (b): Superficial Ramus of the Left Coronary Artery, (c): Profund Ramus of the Left Coronary Artery, (d): Circumflex Ramus of the Left Coronary Artery.

follow-up, the interventricular paraconal ramus, respectively (Figure 2a).

The circumflex ramus of the left coronary artery generated 3–4 atrial branches of which two were strong (Figures 2, and 3a). It was also observed that 6–7 ventricle rami, originating from the left circumflex ramus, dispersed above one-third of the left ventricle. The diameters of the atrial and ventricular branches originating from the left circumflex ramus were larger than the diameters of the branches of the right circumflex ramus. It was observed that the interventricular paraconal ramus, with an average diameter of 1.22 mm, reached out to the apex of the heart by producing many branches dispersing on the left ventricle, and there were many intercoronary anastomoses of the profund ramus of the right coronary artery with the terminal branches on the atrial surface of the heart.

Discussion, Conclusion, and Recommendations

It was specified that the right coronary artery and the left coronary artery, originating from the aorta ascendens, provide the arterial nourishment of the heart in Domestic Duck, in line with the related literature (Baumel, 1975; Nickel et al., 1977; Smith et al., 2000; Tıpırdamaz, 2007). Homocoronary anastomoses intensified on the left ventricle, between the profund ramus of the left coronary artery and the interventricular paraconal ramus, while intercoronary anastomosis increased on the interventricular septum, the atrial face of the heart, and the apex of the heart, between the superficial ramus of the left coronary artery and the profund ramus of the right coronary artery. Equality between the left coronary artery and the right coronary artery was reported by Bezuidenhout (1984), with regard to dimension and circulation spaces, and by Yoldaş and Gezici (2011), with regard to distribution ratios. Our study revealed that the left coronary artery, originating from the superficial ramus, the interatrial ramus, and the left circumflex ramus, had a broad arterial circulation; and the left coronary artery had more distribution space than the right coronary artery.

Although Yoldaş and Gezici (2011) indicated that the interatrial ramus originated from the left lateral wall of the right coronary artery with a ratio of 28%, our study revealed that the interatrial ramus originated from the left coronary artery in all hearts for Domestic Duck. This study also revealed that the conal ramus, originated from the right and left coronary artery of the superficial ramus, when they anastomosed with each other. However, Aslan et al. (2009) reported the lack of the conal ramus in the goose, and its origin from the right coronary artery of the superficial ramus in turkey.

Çakmak and Karadağ (2010) indicated that the right circumflex ramus gave off not only ventricular branches but also the septal rami. In this regard, our study suggested that the right

circumflex ramus did not join the nourishment of the interventricular septum but there were ventricular and atrial branches.

Lindsay and Smith (1965) for the chicken, Bezuidenhout (1984) for the ostrich, and Aslan et al. (2009) for the goose, reported that there was an anastomosis between the circumflex ramus of the right and left coronaries. Aslan et al. (2009) did not identify any anastomosis between these two branches for the turkey and neither we found for Domestic Duck.

Although Aslan et al. (2009) mentioned the existence of 1–2 profund rami originating from the superficial ramus of the left coronary artery for the goose, Lindsay and Smith (1965) reported 1–3 profund rami originating from the left coronary artery for the chicken, and Bezuidenhout (1984) indicated 1–4 profund rami originating from the left coronary artery for the ostrich, Aslan et al. (2009) reported that the profund ramus originated from the left coronary artery as a single root for the ostrich, Çakmak and Karadağ (2010) stated the same for the white ostrich. We specified that the profund ramus originated from the left coronary artery as a single root in this study, for Domestic Duck.

To conclude, the superficial ramus of the left coronary artery was found as the most potent and thickest branch in the female and male Domestic Duck, and the course of coronary arteries, their dispersion, and anastomoses were identified by using two different techniques. The differences and similarities by comparison of Domestic Duck with other winged species were revealed.

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