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# Macroanatomic investigations on the course and distribution of the celiac artery in domestic fowl (*Gallus gallus domesticus*)

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The aim of this study was to investigate the course and distribution of the celiac artery macroanatomically in the domestic fowl. A total of eight (four males, four females) domestic fowls (*Gallus gallus domesticus: Galliformes*) were used in the study. The materials were injected with red colored latex and corrosion casted with mono and polymethylmethacrylate (takilon) through the descending aorta in the domestic fowl. The branching pattern and distribution of the celiac artery were documented. The celiac artery arose from laterally to the right wall of the descending aorta in the domestic fowl. It was detected that it gave off the esophageal artery, dorsal proventricular artery and terminated by diverging into the left and right branches. It was observed that the branches and distribution of the celiac artery were not gender dependent and differed from the other aves and mammals.

**Key words:** Arterial vascularization, celiac artery, domestic fowl (*Gallus gallus domesticus*).

## INTRODUCTION

The celiac artery is the first branch of the descending aorta. It originates from the right lateral surface of the descending aorta 5th – 6th (Baumel, 1975; Franz and Salomon, 1993; Kurtul and Hazirolu, 2004; Levinsohn et al., 1984; Silva et al., 1997) thoracal vertebrae ventrally at the level of esophagus passing by glandular stomach in the fowl (Malinovsky and Novotna, 1977). It gives off the esophageal artery (Nickel et al., 1977) and dorsal proventricular artery just before dividing into the left and right branches of celiac artery (Baumel, 1975; Franz and Salomon, 1993; Kurtul and Hazirolu, 2004; Malinovsky and Novotna, 1977; Silva et al., 1997) in the fowl. The dorsal proventricular artery lies on the dorsal surface of the proventriculus. The dorsal gastric artery is the continuation of the dorsal proventricular artery on the surface of the ventriculus (Baumel, 1975; Levinsohn et al., 1984).

The left branch of the celiac artery is directed on the left and caudally. It goes on till the coalescence of the proventriculus and ventriculus (Baumel, 1975; Franz and Salomon, 1993; Malinovsky and Novotna, 1977). In its course, it gives off the ventral proventricular artery, ventral gastric artery and left gastric artery (Baumel,

1975; Baumel et al., 1993; Franz and Salomon, 1993; Malinovsky and Novotna, 1977). The ventral proventricular artery disperses into the glandular stomach ventrally (Baumel, 1975; Malinovsky and Novotna, 1977; Miladinovic et al., 1986). The ventral gastric artery is distributed to the muscular stomach ventrally (Baumel, 1975; Franz and Salomon, 1993; Malinovsky and Novotna, 1977). It gives off the left hepatic artery, dispersing to the left lobe of the liver (Baumel, 1975; Franz and Salomon, 1993; Malinovsky and Novotna, 1977; Nickel et al., 1977). The left gastric artery runs into sulcus, situated between the cranial sac and ventriculus (Baumel, 1975). It gives off a few vessels to the left surface of muscular stomach and sacs (Malinovsky and Novotna, 1977). Its branches pierce to centrum tendineum (Baumel, 1975; Franz and Salomon, 1993; Nishida et al., 1969).

The right branch of the celiac artery runs through the spleen and the right lobe of the liver (Baumel, 1975; Franz and Salomon, 1993; Malinovsky and Novotna, 1977). In its course it gives off the splenic arteries, right hepatic artery, right gastric artery, gastroduodenal artery, ileocecal arteries, ileal artery and pancreaticoduodenal

artery (Baumel, 1975; Baumel et al., 1993; Fukuta et al., 1969, Silva et al., 1997). The splenic arteries are the branches separate to spleen of the celiac artery (Baumel, 1975; Franz and Salomon, 1993; Fukuta et al., 1969; Malinovsky and Novotna, 1977; Nickel et al., 1977; Silva et al., 1997). The spleen may receive a branch of the right hepatic artery (Baumel et al., 1993; Fukuta et al., 1969). The right hepatic artery is distributed to the left lobe of liver (Baumel, 1975; Franz and Salomon, 1993; Nickel et al., 1977). It gives off the vesical artery to the gall bladder (Baumel, 1975; Franz and Salomon, 1993; Malinovsky and Novotna, 1977), duodenojejunal artery and jejunal artery to jejunal flexure (Baumel, 1975; Franz and Salomon, 1993; Silva et al., 1997).

The right gastric artery arises from the right branch of the celiac artery between the cranial edge of ascending part of the duodenum and at the level of the last part of duodenal flexure. It gives off the gastroduodenal artery to the pyloric region (Baumel, 1975; Franz and Salomon, 1993). The duodenojejunal artery is the continuation of the right branch of the celiac artery between the ascending and descending part of the duodenum (Baumel, 1975; Franz and Salomon, 1993; Malinovsky and Novotna, 1977). In its course, it gives off one to five the ileocecal arteries (Baumel, 1975; Malinovsky and Novotna, 1977; Nickel et al., 1977; Silva et al., 1997). The pancreaticoduodenal artery supplies to the pancreas and duodenum with its numerous collaterals. It gives off 1 - 4 ileocecal arteries to ileum and cecum (Silva et al., 1997). According to available literature, there was not any adequate information about the celiac artery in the domestic fowls. Therefore, current study was performed to be a highlight for the arterial vascularization of the celiac artery in this animal.

## MATERIALS AND METHODS

Eight adult domestic fowls (*Gallus gallus domesticus: Galliformes*) (four males, four females) provided from Central Anatolia were used in the study. Deep anesthesia of the animals was induced by intramuscular injections of xylazine HCl (3 mg/kg i.m.) and following by ketamine HCl (50 mg/kg i.m.) in fowls. Following the washing of the blood vessels by means of the injections of the descending aorta with the physiological saline, latex colored with red dye and corrosion casted with takilon was injected. The prepared material was kept at +4°C for 14 h so as to ensure the freezing of latex and, and stored in 10% formalin until dissection. The corrosion cast was made with the monomethylmethacrylate (60 cc), polymethylmethacrylate (15 gr) and red dye (5 gr). Takilon injected material was kept for 24 h in the tap water and placed 30% potassium hydroxide solution. After removing soft tissues, material was washed in the tap water and dried in the fresh air. The course and distribution of celiac artery were examined and digital pictures were taken and entitled the anatomical terminology used conforms to the Nomina Anatomica Veterinaria Avium (Baumel et al., 1993).

## RESULTS

In the domestic fowls examined, the celiac artery (Figures

1 and 2) was determined to be the first main visceral branch of the descending aorta. It was the common root of the vessels supplied blood to initial part of the stomach, liver, spleen, pancreas and small intestine. It was seen to arise from laterally to the right wall of the descending aorta, ventrally in the fifth thoracic vertebra, at the level of esophagus passing by at the level of glandular stomach in the domestic fowl. It was determined to extend between the right lobe of the liver and proventriculus caudoventrally. Before it diverging into two the last branches, called the left branch of the celiac artery and the right branch of the celiac artery, it gave off the esophageal artery and dorsal proventricular artery.

### Esophageal artery (*arteria esophagealis*)

This artery (Figure 1), was derived after 6 - 7 mm from the origin of the celiac artery as the first branch from its the left side. After average 4 mm running, it ended dispersing on the last part of esophagus. The branches dispersing to the thoracic portion of the esophagus anastomosed with the esophageal ramus, the branch of the esophagotracheobronchial artery, whereas the branches dispersing to the part of the esophagus passing by proventriculus anastomosed with the proventricular artery of the left branch of the celiac artery.

### Dorsal proventricular artery (*arteria proventricularis dorsalis*)

This artery (Figure 1), was given off from the left wall of the celiac artery, at an average distance of 4 mm from the origin of the esophageal artery, between the medial one of the third and cranial one of the third of the proventriculus. While it was coursing on the proventriculus dorsally, it distributed 1 - 2 branches to the esophagus, named esophageal branches, 1 - 2 sub-branches to the proventriculus, and to the isthmus gastris. The dorsal proventricular artery was terminated by distributing to the dorsal side of ventriculus under the name of the dorsal gastric artery. It was determined that the dorsal proventricular artery, at the distance of 5 mm after its origin, gave off one branch to the spleen dorsally in one of the example (12.5%). This branch reached to the spleen after coursing nearly 1.5 cm.

### Dorsal gastric artery (*arteria gastrica dorsalis*)

This blood vessel was offset of the dorsal proventricular artery on the muscular stomach dorsally (Figure 1). The branches distributed to the craniodorsal tenuis and caudodorsal crassus muscles anastomose with the right and left gastric artery on the right and left side, respectively.

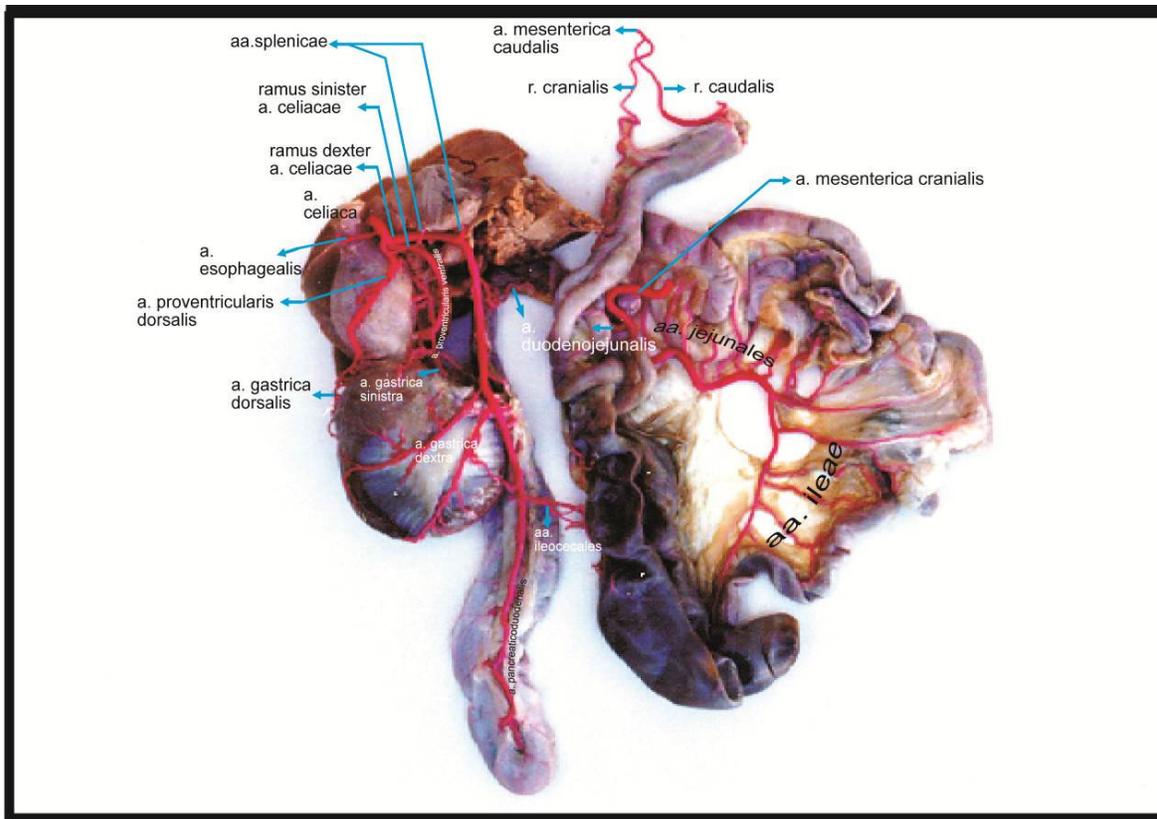


Figure 1. Celiac artery and its branches in the domestic fowl.

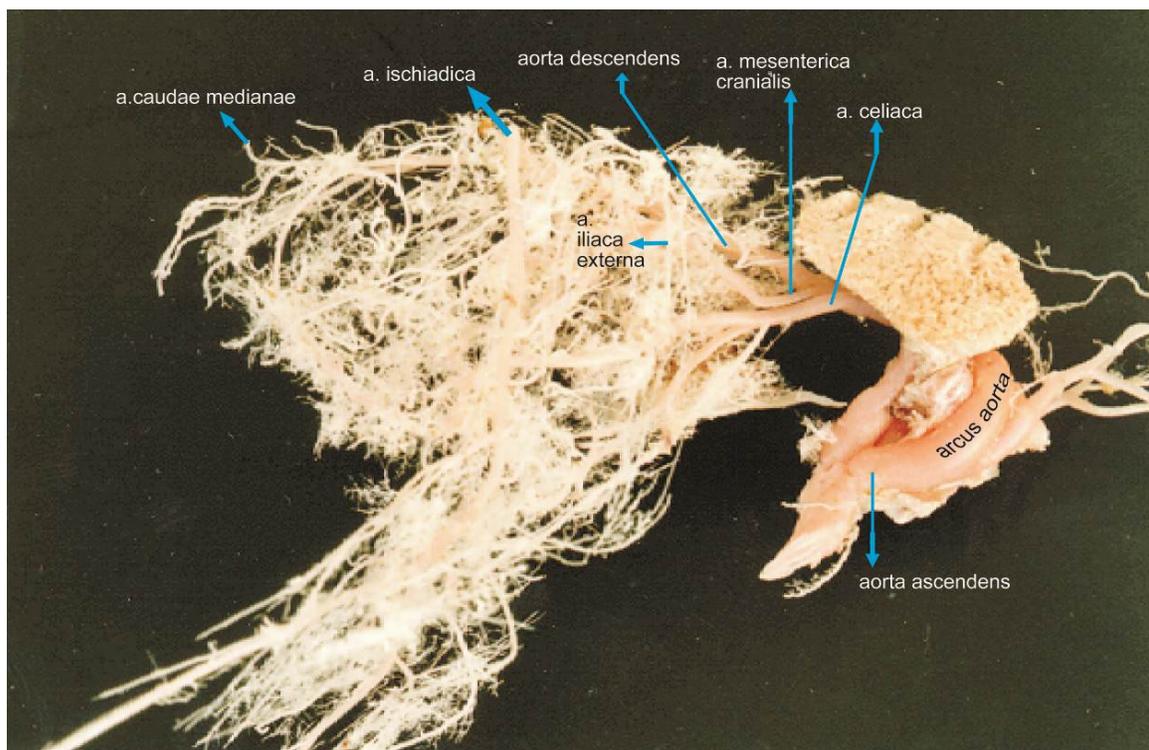


Figure 2. Origin of celiac artery in the domestic fowl (corrosion cast).

The celiac artery, after nearly 2-4 cm, giving off the proventricular artery at the level spleen cranially divided into two branches, one of which was thicker the left and right branches.

#### **Left branch of the celiac artery (ramus sinister arteriae celiacae)**

This blood vessel was seen directed to the left and caudally where the right side of proventriculus (Figure 1). It went until coalescence between the proventriculus and the ventriculus. It was observed to terminate giving off its the last branch, known the left gastric artery on the left side of ventriculus. During its course, it distributed into the ventral proventricular artery and the ventral gastric artery.

#### **Ventral proventricular artery (arteria proventricularis ventralis)**

This artery was arisen from the origin of the left branch of the celiac artery after approximately 2 cm between the left lobe of the liver dorsally and the proventriculus (Figure 1). After a short coursing it dispersed to ventral of the proventriculus.

The left branch of the celiac artery gave off 2-3 unnamed branches to the gastric isthmus and craniodorsal tenuis muscle at the level of the isthmus gastric.

#### **Ventral gastric artery (arteria gastrica ventralis)**

This artery was originated from the left branch of the celiac artery after approximately 1 cm from the beginning of the ventral proventricular artery. It gave off the left hepatic artery dispersing to the left lobes of the liver just after its origin, and the others 2 - 3 branches to the cranioventral crassus muscle While it was running on the ventriculus ventrally, it anastomosed with the right and left gastric artery on the right and the left side.

#### **Left hepatic artery (arteria hepatica sinistra)**

It was indicated that the left hepatic artery originated from the ventral gastric artery, at the distance of 5 mm before its origin in one of the example (12.5%), and 2 mm after its origin with the common root of the left and right hepatic artery in one of the example (12.5%).

#### **Left gastric artery (arteria gastrica sinistra)**

This blood vessel was the continuity of the left branch of the celiac artery after giving off the ventral gastric artery (Figure 1). It run on the sulcus cranialis to the left of ventriculus. It divided into two branches, dorsal and

ventral nearly at the level of central tendon of diaphragm. Its side branches dispersed to the craniodorsal tenuis and cranioventral crassus muscles, before splitting off dorsal and ventral branches on the different level. Dorsal branch was distributed to the craniodorsal tenuis, caudodorsal and cranioventral crassus muscles. The side branches on the level of cranial sac anastomosed with the dorsal gastric artery on the margin of the ventriculus and the ventral branch, originating from the left gastric artery. Ventral branch supplied caudoventral tenuis, cranioventral crassus muscles and central tendon of diaphragm. It anastomosed with the dorsal branch at the level of caudal sac and the ventral gastric artery along the right border of the ventriculus.

#### **Right branch of the celiac artery (ramus sinister arteriae celiacae)**

This artery was demonstrated to lie through to the right and caudal into the caudal sulcus between the right lobe of the liver and spleen (Figure 1). It was terminated to distribute branches called the splenic arteries, right hepatic, right gastric, gastroduodenal artery, ileocecal, ileal arteries and pancreaticoduodenal artery.

#### **Splenic arteries (arteriae splenicae)**

This artery were observed to separate into branches to the spleen, at the distance of nearly after 5 mm and 1.5 cm to the origin of the left branch of the celiac artery (Figure 1). The cranial branch was somewhat thicker than the caudal. It was determined the other thin third branch went into to the spleen between the cranial and caudal branches in the one of the example (12.5%).

#### **Right hepatic artery (arteria hepatica dextra)**

This blood vessel was originated from the right branch of the celiac artery at the level of caudal branch of spleen. It gave off the branches named the artery of gall bladder, duodenojejunal artery, jejunal artery and unnamed one branch to the ascending part of the duodenum near at the level of the duodenojejunal flexure. It was terminated dispersing to the right lobe of the liver.

#### **Artery of gall bladder (arteria vesicae fellae)**

This artery of gall bladder was dispersed to the gall bladder.

#### **Duodenojejunal artery (arteria duodenojejunalis)**

This artery was arisen from of the right hepatic artery

about 2 - 3 mm after its origin (Figure 1). It was dispersed to the duodenojejunal flexure and it ended anastomosing to the similar branch of the cranial mesenteric artery on this level.

#### **Jejunal artery (arteria jejunalis):**

It was determined that this artery was as an independent branch in the one of the example (12.5%). It was originated from the right hepatic as the same level of the duodenojejunal artery.

#### **Gastroduodenal artery (arteria gastroduodenalis)**

This artery was a short vessel, originating from the left wall of the right branch of the celiac artery at about the level of the right gastric artery. It was distributed to the pylorus and craniodorsal tenuis muscle. It was defined that the gastroduodenal artery originated from 4 mm after beginning of the right gastric artery in one of the example (12.5%).

#### **Right gastric artery (arteria gastrica dextra)**

The right gastric artery was arisen from the right branch of the celiac artery at the level of the ascending part of duodenum and the last part of the duodenojejunal flexure (Figure 1). It was seen to run along to the dorsally on the first part of duodenum. It was divided into two branches oriented dorsally and ventrally just after its origin. Dorsal branch contributed subbranches to the craniodorsal tenue muscle, central tendon of diaphragm and caudodorsal crassus muscle. It was anastomosed with the dorsal gastric artery at the level of the cranial sac and caudodorsal crassus muscle, by anostomosing with the ventral branch at the level of the caudal sac. Ventral branch run into caudal sulcus. It gave off the subbranches to the central tendon of diaphragm, cranioventral crassus and caudoventral tenue muscles. It anastomosed with the ventral gastric artery on the right border of ventriculus, the left gastric, coming from the left surface of it at the level of caudal sac and, the ventral branch belongs to it. It was determined that the right gastric artery originated as two branches (Figure 1) in the two of the examples (25%). These arteries were as the same as the dorsal and ventral branches of the right gastric artery.

#### **Pancreaticoduodenal artery (arteria pancreaticoduodenalis)**

This artery was observed as a continuity of the right branch of the celiac artery after giving off the right gastric

artery (Figure 1). It run to duodenal ansa between the ascending and descending part of the duodenum till the duodenal fold. In its course, it gave off the subbranches named arteries of the pancreas and duodenum and ileocecal arteries.

#### **Arteries of the pancreas and duodenum (rami pancreatici and rami duodenales)**

These blood vessels were arisen from the pancreaticoduodenal artery at the different level and dispersed to the corresponding organs.

#### **Ileocecal arteries (arteriae ileocecales)**

These arteries were given off from the pancreaticoduodenal artery, approximately 1 and 2.5 cm, after its starting point as two branches (Figure 1). The first ileocecal artery lied into the ansa supraduodenalis. It anastomosed with the branches of the cranial ramus, the branch of the caudal mesenteric artery. The other branch run through the apex of cecum into meso combining the left cecum and ileum along the left part of ileum. It dispersed to the distal 2/3 of the cecum and ileum. It anastomosed with the ileal arteries, the branches of the cranial mesenteric artery at the level of the apex of the cecum. It was determined that there was the third ileocecal artery just after the origin of the pancreaticoduodenal artery in one of the domestic fowl (12.5%) and, one ileocecal artery, originating from the right branch of the celiac artery just after the origin of the right gastric artery in two of the domestic fowls. The latter dispersed to the left cecum and ileum.

## **DISCUSSION**

In this study, in agreement with the reports of literatures (Aslan and Takci, 1998; Fowler, 1991; Gezici and Dursun, 1999; King and Mc Lelland, 1984; Kurtul and Hazioglu, 2002; Lauper et al., 1975; Silva et al., 1997) was demonstrated that the celiac artery, the common root of the vessels supplied blood to the initial part of the stomach, liver, spleen, pancreas and small intestine. The celiac artery arises from laterally to the right wall of the descending aorta in the 5th – 6th thoracic vertebra ventrally, at the level of esophagus passing by at the level of glandular stomach in the domestic fowl. In the domestic fowl, as observed in the present study, these results were similar to literatures (Dursun, 2002; Franz and Salomon, 1993; Miladinovic et al., 1986; Lauper et al., 1975; King and Mc Lelland, 1984; Kurtul and Hazioglu, 2002). It is reported that the celiac artery separates into 9 branches in the eagle owl (Aycan and Duzler, 2000) as the esophageal artery, dorsal

proventricular artery, duodenojejunal artery, splenic arteries (arteriae lienales), hepatic artery, ventral proventricular artery, ventral gastric artery, dorsal gastric artery, pancreaticoduodenal artery.

Aycan and Duzler (2000); Chiasson (1964) have reported that the celiac artery does not bifurcate. In contrast to these studies in the red falcon (Haligur and Duzler, 2010), the celiac artery is determined to split into the left branch of the celiac artery and right branch of the celiac artery in between the proventriculus and gaster, in agreement with previous reports (Kurtul, 2002; Kurtul and Hazirolu, 2002; Malinovsky and Novotna, 1977; Pinto et al., 1998). In the present study which was carried out in the domestic fowl, the celiac artery was determined to bifurcate after the origin of the superior proventricular artery and cranial to the lien.

It is emphasized that the celiac artery sends a vessel, called the cardiac artery, found in 20% of the birds (Silva et al., 1997). However, cardiac artery was not observed in this study.

In the literatures (Kurtul and Hazirolu, 2004; Silva et al., 1997) the first branch of the celiac artery is the dorsal proventricular artery in rooster, drake, pigeons and geese. However, numerous reports (Aycan and Duzler, 2000; McLeod et al., 1964; Malinovsky, 1965; Nickel et al., 1977) the first branch to ramify from the celiac artery is reported to be the esophageal artery. Haligur and Duzler (2010) also determined the esophageal artery to be the first branch of the celiac artery in two of the red falcons. Silva et al. (1997) reported that the esophageal artery originate from celiac artery 30% in the domestic fowl. Similarly, in domestic fowl examined in the present study, the esophageal artery was the first branch of the celiac artery and dispersed to the esophagus.

The vessel, stated as the right glandular gastric artery by Nishida et al. (1969), but this vessel is decelerated as the dorsal proventricular artery by Nomina Anatomica Avium N.A.A. (Baumel et al., 1993).

In this study, similar to the reports of Aslan and Takci (1998); Aycan and Duzler (2000) the dorsal gastric artery lies on the dorsal side of ventriculus. It is emphasized that the dorsal gastric artery is observed as a continuity of the pancreaticoduodenal artery in birds (Silva et al., 1997), while in the present study it was seen as a continuity of the right branch of the celiac artery after giving off the right gastric artery and it gave off the sub-branches named the rami pancreatici to the pancreas, rami duodinales to the duodenum, ileocecal arteries to the cecum and ileum.

Reports exist that the left hepatic artery arises from the left branch of the celiac artery in domestic avian species (Baumel et al., 1993), ducks (Nickel et al., 1977), chickens (Malinovsky and Novotna, 1977) and red falcons (Haligur and Duzler, 2010). In a Eurasian eagle owl (Aycan and Duzler, 2000) the indicated artery has been reported to stem from the celiac artery. The left hepatic artery was reported to be a branch of the inferior

gastric artery in the domestic fowls examined in the present study is in agreement with the findings of previously conducted studies (Dursun, 2002; Kurtul, 2002; Malinovsky and Visnanska, 1975).

The right branch of the celiac artery gives off the splenic arteries, right hepatic artery, right gastric artery, gastroduodenal artery, ileocecal arteries, ileal arteries and pancreaticoduodenal artery (Aslan and Takci, 1998; Baumel, 1975; Franz and Salomon, 1993; Silva et al., 1997). According to the results of the present study the branches of the right branch of the celiac artery are consistent with the results of literature mentioned above. In various avian species, the splenic artery is known to stem from either the right branch of the celiac artery (Aslan and Takci, 1998; Baumel et al., 1993; Doguer and Erencin, 1964; Dursun, 2002; Malinovsky et al., 1973) or directly from the celiac artery (Aycan and Duzler, 2000; Baumel et al., 1993; Chiasson, 1964; Haligur and Duzler, 2010). Furthermore, in a study carry out in three different chicken breeds (Malinovsky and Visnanska, 1975) the lien is determined to be vascularised by one or more branches arising from the right hepatic artery in 6 - 15%, left branch of the celiac artery in 15%, and superior proventricular artery in 27 - 57% of the animals examined. In the above investigation, the origin of the splenic artery from the right branch of the celiac artery is observed in 100% of the birds examined, and the rate of the vascularization of the lien by the splenic artery stemming from only the right branch of celiac artery was seen in 69 - 87% of the chickens examined. In one of the red falcons (Haligur and Duzler, 2010) two short branches originating from the celiac artery and the right branch of the celiac artery are determined to extend to the lien and in seven falcons, the splenic arteries are determined to have their origin at the celiac artery. In the domestic fowls examined in the present study, the first branches of the right branch of the celiac artery were splenic arteries; this finding is also in compliance with previous researches (Doguer and Erencin, 1964; Dursun, 2002; Malinovsky, 1965; Malinovsky et al., 1973; Malinovsky and Visnanska, 1975; Malinovsky and Novotna, 1977; Nickel et al., 1981; Kurtul, 2002).

In the domestic fowls examined, the right hepatic artery was ascertained to spring from the right branch of the celiac artery. This is in agreement with the findings of previously conducted studies (Aslan and Takci, 1998, Baumel et al., 1993; Dursun, 2002; McLeod et al., 1964; Malinovsky, 1965; Malinovsky et al., 1973; Malinovsky and Visnanska, 1975; Malinovsky and Novotna, 1977; Nickel et al., 1981; Kurtul, 2002) have reported the right hepatic artery to originate from the right branch of the celiac artery. In contrast to this, in the literature (Haligur and Duzler, 2010) have indicated the right hepatic artery is determined to spring from the left branch of the celiac artery.

The ileocecal artery arises from the cranial mesenteric artery and supplies corresponding regions in the pigeon

(Kurtul and Hazirolu, 2002). Anastomoses in this region different from the rooster and drake and the literatures (Aslan and Takci, 1998; Baumel, 1975; King and Mc Lelland, 1984; Kurtul and Hazirolu, 2002; Nickel et al., 1977). The ileocecal artery supplies to the ileum in the pigeon (Silva et al., 1997; Kurtul and Hazirolu, 2002). Although, in the present study indicated that ileocecal artery arose from pancreaticoduodenal artery as a two branches and while the first branch anastomoses with the ramus ilei of the ramus cranialis of the cranial mesenteric artery and the second branch anastomoses the ileal arteries of the cranial mesenteric artery.

In conclusion, this study was performed to determine macroanatomic structure of the celiac artery in the domestic fowls, belonging to the class aves to contribute to present knowledge in this field. The data reported here differed from findings in other aves, domestic mammals, rodents.

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