The Arterial Supply of the Intestinal Tract of the Domestic Turkey Fowl (*Meleagrisgallopavo*)

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Abstract

The aim of this study was to investigate the arterial supply of the intestinal tract of the domestic turkey. Ten apparently healthy birds of both sexes were used in the study. The specimens were injected with red colored latex through the descending aorta. The origin, branching pattern and distribution of the different arteries supplying the small and large intestines were documented. The intestinal tract of the domestic turkey received its arterial supply through four main sources namely; the right branch of the celiac artery, the cranial mesenteric, caudal mesenteric and internal iliac arteries. The right branch of the celiac artery was contributed to the blood supply of the duodenum and pancreas and the initial portion of the jejunum, ileum and left cecum. The cranial mesenteric artery supplied the terminal portion of the duodenum, jejunum, ileum and right cecum. The caudal mesenteric artery supplied the rectum and the cranial portion of the cloaca. The internal iliac artery supplied the cloaca and cloacal bursa.

The obtained results were photographed, described and discussed with those of authors who performed earlier studies in other bird species. The nomenculature used were adopted according to the NominaAnatomicaAvium (1993).

Keywords: Arterial supply, Intestinal tract, Domestic turkey (*Meleagrisgallopavo*).

Introduction

The turkey is a large bird in the GenusMeleagris. One species, Meleagrisgallopavo, commonly known as the wild turkey, is native to the forests of North America. The domestic turkey is a descendant of this species (Donald and James, 1971). Turkeys are classed in the taxonomicorder of Galliformes. They are

among the largest birds in their ranges. Male (tom or gobbler) have a distinctive fleshy wattle or protuberance that hangs from the top of the beak, called a snood and is larger and much more colorful than the female (hen).

The major arterial branches of the descending aorta, and their supply to the abdominal viscera in the domestic turkey were previously studied by Gadhoke et al. (1975).The distribution of the cranial and caudal mesenteric arteries to the intestinal tract was described by Santana et al (2001) and Campos et al (2006) in the fowl, Pinto et al (1998) in the duck.

This study was undertaken to extend knowledge on the arterial supply of the intestinal tract of the turkey which may be helpful for avian surgery in the intestinal approaches to repair an accidental enterotomy created during a ventral midline celiotomy or to debride necrotic bowel secondary to constrictions or adhesion as well as the use of the intestinal feeding tubes used in the avian practice as duodenostomy and enterostomy tubes.

Material and Methods

Ten adult domestic turkeys (*Meleagrisgallopavo*) five males, five females were used in the study. The specimens were obtained from turkey farms around Giza. Before exsanguinations, the turkeys were anaesthetized by IM injection of 0.5 cc of 2% xylazine HCL(3 mg/kg), followed by the injection of heparin (Cal Heparin, 5000 I.U.) in the wing vein to prevent blood clotting.

Each specimen was then exsanguinated through the common carotid arteries and left to bleed for five minutes. The breast muscles and sternum were carefully removed to expose the heart. A Nelaton catheter of size 8F to 10F (Ma Medical company) was introduced into the descending aorta and legated using cotton thread to prevent leakage. The injection mass comprised of 60% of latex neoprene colored using red Rottring ink. The specimens were then kept at +4°C for 24 hrs. to ensure the freezing of latex and then preserved in 10% formalin 4% phenol and 1% glycerin three days before dissection.

The specimens were photographed using Olympus digital camera SP-600UZ 12 mega pixel. The nomenclature used in this study was that given by the NominaAnatomicaAvium (Baumel et al., 1993).

Results

The intestinal tract of the domestic turkey received its arterial supply

through four main sources namely; the right branch of the celiac artery, the cranial mesenteric, caudal mesenteric and internal iliac arteries.

R. dexterarteriaeceliacae

The right branch of the celiac artery (Fig 1/3) represented the direct continuation of the stem vessel after releasing the left branch on a level with the cranial pole of the spleen. It proceeded along the right side of the proventriculus in a caudoventral direction to the junction of the gizzard with the duodenum. Prior to reaching the site of the indicated junction, the right branch of the celiac artery gave rise to the right hepatic artery, 3-5 splenic arteries (Fig 1/4) as well as the duodenojejunal artery. On reaching the indicated junction the right branch of celiac artery terminated into four vessels; the dorsal right gastric (Fig 1/6), ventral right gastric (Fig 1/7), and gastroduodenal and pancreaticoduodenal arteries.

The branches of the right gastric artery that contributed to the blood supply of the duodenum were represented by the A. duodenojejunalis, A. gastroduodenalis and A. pancreaticoduodenalis.

A. duodenojejunalis

The duodenojejunal artery (Fig 1/5 and Table 1/1) was detached from the right branch of the celiac artery on a level with the caudal pole of the spleen. It proceeded caudally to reach the duodenojejunal flexure where it ramified into 3-4 small branches supplying the latter flexure as well as the distal portion of the ascending duodenum and anastomosed with the corresponding branches of the cranial mesenteric artery.

A. gastroduodenalis

The gastroduodenal artery (Fig 1/8 and Table 1/2) was represented by a short stem vessel that erupted as a one of the terminal branches of the right branch of the celiac artery .It soon divided into three to four small branches that distributed to the pylorus and M. tenuiscraniodorsalis of the muscular stomach as well as to the proximal region of the descending limb of the duodenum.

A. pancreaticoduodenalis

The pancreaticoduodenal artery (Fig 1/9 and Table 1/3)arose as one of the terminals of the right branch of the celiac artery. It gave off the ***ileocecal artery*** then traveled on the dorsal side of the duodenal loop partially embedded in pancreatic tissue, giving off on each side twelve or more collateral branches, the***Rami duodenales***(Fig 1/10) to both limbs of the duodenum, and

ended in the concavity of the duodenal loop. Each of these rami penetrated through the pancreatic tissue, supplying it, and continued to the mesenteric border of the duodenum, where it gave fine twigs around each side of the duodenum.

A. ileocecalis

The ileocecal artery (Fig 1/11and Table 1/4) originated as a single vessel from the pancreaticoduodenal artery. It proceeded caudally in the mesocolon combining the left portion of the cecum and ileum along the left aspect of the latter. It detached a series of branches that supplied the distal two thirds of the left cecum and adjacent ileum and anastomosed with ileal arteries of the cranial mesenteric artery.

A. mesentericacranialis

The cranial mesenteric artery (Fig 2, 3/13) originated from descending aorta (Fig 2/12) about 1.2 cm caudal to the origin of the celiac artery on a level with the last vertebral rib. It proceeded between the spleen and right lobe of the liver then continued caudoventrally in the mesentery forming a semicircular curve that ended near the mesentery of the ileum. Along its course the cranial mesenteric artery released; a colic branch, ileocecal, duodenojejunal, jejunal and ileal arteries.

R. colicus

The colic branch(Fig 2, 3/15and Table 1/5) emitted from either the cranial mesenteric artery (Five specimens) or ileocecal artery (Five specimens). It passed in a caudal direction giving 4-5 branches that distributed to the cranial portion of the colon (rectum) and anastomosed with the cranial branch of the caudal mesenteric artery.

A. ileocecalis

The ileocecal artery (Fig 2, 3/14and Table 1/6) was represented by a short vessel arising from the A. mesentericacranialis near its commencement. It gave off the colic branch (Five specimens) then bifurcated into two branches; cranial and caudal.

The cranial branch(Fig 2, 3/16)proceeded cranially in the mesocolon combining the right cecum and ileum along the right aspect of the latter giving twigs to the cranial two thirds of the ileum and right cecum and anastomosed with the ileal arteries.

The caudal branch(Fig 2, 3/17)extended caudally between the ileum and right cecum giving twig to the caudal third of the ileum and two ceca and terminated at the ileocecal junction by anastomosing with the cranial branch of the caudal mesen-

teric artery as well as the colic branch of the cranial mesenteric artery.

Aa. duodenojejunales

The duodenojejunal arteries (Fig 2,3/18and Table 1/7)were represented by two (in 7 specimens) or one (in three specimens) relatively large vessels that arose from the A. mesentericacranialis and ramified in the beginning of the jejunum and duodenojejunal flexure and anastomosed with the same named vessel arising from of the celiac artery.

Aa. Jejunales

The jejunal arteries (Fig 2, 3/19and Table 1/8)constituted 10-14 vessels that arose from the convex aspect of the cranial mesenteric artery at short intervals and extended in the mesojejunum to the mesenteric border of the jejunum. On reaching the latter border each jejunal artery was divided into two primary branches that anastomosed with the corresponding branches of the adjacent arteries forming the intestinal arches (Fig.2/20).From these arches fine numerous collateral twigs were detached to supply both sides of the jejunal wall.

Aa. ileales

The ilealarteries (Fig 2/21and Table 1/9) comprised 4-6 vessels that originated from the terminal portion of the cranial mesenteric artery. These vessels were distributed to the proximal portion of the ileum as well as the expanded blind ends of the intestinal ceca and anastomosed with the caudal ileocecal artery.

A.mesentricacaudalis:

The caudal mesenteric artery (Fig 3, 4, 5 and 6/22) was given off from the descending aorta just caudal to the caudal lobe of the kidney. It was in the form of short stem vessel about 1.2 cm in length and soon divided into cranial and caudal branches.

The cranial branch (Fig 2/23and Table 1/10) passed cranially alongside the dorsal wall of the colon and anastomosed with the colic branch of the cranial mesenteric artery. Along its course it released 4-7 twigs supplying the cranial portion of the colon.

The caudal branch (Fig 2/24 and Table 1/11) extended caudally on the dorsal aspect of the colon and gave off 3-5 colic branches that distributed to the caudal portion of the colon and 2-4 cloacal branches that ramified in the cranial portion of the cloaca and anastomosed with the internal pudendal artery.

The arterial supply of the cloaca and cloacal bursa (Bursa of Fabricius)

A. iliacainterna

The internal iliac arteries (Fig 4, 5 and 6/25) originated by the bifurcation of the descending aorta on a level with the 6thsynsacral segment. In between the latter two vessels arose **the median caudal artery**(Fig 4, 5 and 6/31).The internal iliac artery extended caudolaterally for about 1.8 cm and gave off the **internal pudendal artery** (Fig 4, 5 and 6/27). Moreover a **cloacal artery** (Fig 4, 5, 6/26 and Table 1/12) was given off from either the left (in seven specimens) or right (in three specimens) that ramified in the cranial portion of the cloaca and anastomosed with the caudal branch of the caudal mesenteric artery. From both the right and left internal pudendal arteries arose the **right and left bursocloacal**arteries (Fig 4, 5, 6/28 and Table 1/13) respectively. Each of these arteries gave off a **bursal branch**(Fig 4, 5 and 6/29) and a **cloacal branch** (Fig 4, 5 and 6/30) to the corresponding aspect of the cloacal bursa as well as the adjacent caudal portion of the cloaca respectively. Moreover the median caudal artery gave off a bursal branch (Fig 4/32 and Table 1/14) that ramified into fine twigs supplying to the dorsal wall of the bursa.

Discussion

In agreement with Haligurand Duzler (2010) in red falcon the right branch of the celiac artery contributed to the blood supply of the intestinal tract through the duodenojejunal, gastroduodenal and pancreaticoduodenal arteries. The present study and Kuru (2010) in the domestic fowl recorded that the duodenojejunal artery was arisen from of the right hepatic artery, dispersed to the duodenojejunal flexure and ended by anastomosing to the similar branch of the cranial mesenteric artery. On the other hand Baumel (1975), Franz and Salomon (1993) and Malinovský and Novotná (1977) mentioned that in the fowl, the duodenojejunal artery was the continuation of the right branch of the celiac artery between the ascending and descending part of the duodenum. According to the present study as well as those Pinto et al. (1998) in domestic duck such continuation was designated as the pancreaticoduodenal artery. Kuru (2010) in the domestic fowl revealed that the gastroduodenal artery was a short vessel, originating from the right branch of the celiac artery and was distributed to the pylorus and craniodorsaltenuis muscle. The same observations were confirmed in the present study and added that the gastroduodenal artery was also dis-

tributed to the proximal region of the descending limb of the duodenum.

In accordance with NominaAnatomicaAvium (1993) two duodenojejunal arteries supplied the termination of the duodenum, the duodenojejunal flexure as well as the commencement of the jejunum. The former one of these arteries arose from the right branch of the celiac artery while the second was represented by 1-2 vessels detached from the A. mesentericacranialis. Similarly, twoileocecal arteries were also recorded. The former one arose from the A. pancreaticoduodenalis and the second one from the A. mesentericacranialis. Nishida et al. (1969) in the domestic fowl designated these two arteries as the cranial and caudal ileocecal arteries respectively.

The current investigations revealed that the cranial mesenteric artery was detached from descending aorta caudal to the origin of the celiac artery the same as mentioned by Nickel et al., (1977) and Campos et al. (2006) in the fowl and Pinto et al. (1998) in the domestic duck. In this connection both celiac and mesenteric arteries arose by common trunk called the celiacomesenteric artery as mentioned by Santos et al. (2007) in fish. In turkey the cranial mesenteric artery gave off the ileocecal, duodenojejunal, jejunal and ileal arteries. Nickel et al. (1977) in fowl mentioned that the first vessel arising from cranial mesenteric artery was the A. ileocecalis then continued as the truncusjejunalis from which numerous vessels, the rami jejunales, were detached. Pinto et al. (1998) in the domestic duck described the cranial mesenteric artery as dividing into three main branches. The first of these branches supplied the colorectum, forming an anastomosis with the caudal mesenteric artery. The second branch formed a trunk giving the jejunal arteries and finally the third one was distributed to the final portion of the right cecum and ileum.

In the turkey, the cranial mesenteric artery detached 10-14 jejunal and 4-6 ileal arteries. Pinto et al. (1998) in the domestic duck recorded 8-20 jejunal arteries, Santana et al. (2001) in the fowl mentioned 6-11 jejunal and 1-4 ileal arteries, Cardoso et al. (2002) in bumpkin chickens recorded 4-11 jejunal and 5-13 ileal arteries. It is to add that the marginal artery mentioned by Baumel (1986) in fowl that formed by the anastomosis of the terminal branches of the jejunal and ileal arteries along the antimesenteric border could not be ascertained in the present study.

The current investigations revealed that a colic branch was detached from either the cranial mesenteric artery or ileocecal artery. This branch passed in a caudal direction giving 4-5 branches that distributed to the cranial portion of the colon and anastomosed with the cranial branch of the caudal mesenteric artery. The latter branch was not recorded in any of the available literatures. Ebada et al. (2006) in the ostrich recorded a proper colic artery arising from the cranial mesenteric artery and added its division into an ascending and a descending branch. However, the latter proper colic artery could be matched with the ileocecal artery mentioned in the present study.

Concerning the pattern followed by the caudal mesenteric artery, we observed that it was originated from the aorta as a single vessel, next to the caudal lobe of the kidneys. In all observed samples the caudal mesenteric artery was divided into two branches cranial and caudal .Similar findings were recorded by Pinto et al. (1998) in the domestic duck, Santana et al. (2001), Campos et al. (2006) in the fowl. On the other hand Ebada et al. (2006) in the ostrich mentioned that the caudal mesenteric artery gave off 10-12 long branches and added that each of these branches provided four subdivisions before reaching the mesenteric border of the colon.

According to the present study the anastomosis between the cranial and caudal mesenteric arteries was established through the colic branch of the former and the cranial branch of the later one. However the colic branch was emitted at equal percent from either the cranial mesenteric artery or the ileocecal artery. In this connection Santana et al. (2001) in the fowl recorded that the anastomosis between the cranial and caudal mesenteric arteries occurred at 100% through the ileocecal artery. On the other hand Pinto et al. (1998) in the domestic duck recorded that the caudal mesenteric artery anastomosed with one of the three main branches arising from the cranial mesenteric artery.

In turkey the internal pudendal artery was given off from the internal iliac artery. On the other hand Nickel et al. (1977) in the fowl described it as a paired vessel arising directly from the aorta immediately caudal to the origin of the caudal mesenteric artery. The present study also recorded a cloacal branch arose from either the left or right internaliliac artery and ramified in the cranial portion of the cloaca.
In agreement with Santana et al. (1999) and Gomes et al. (2009) in

fowl the cloacal bursa received its arterial supply from both right and left bursocloacal arteries arising from the A. pudenda interna and ramified in the corresponding aspect of the bursa as well as the adjacent caudal portion of the cloaca. Moreover the median caudal artery gave off a bursal branch that ramified into fine twigs supplying to the dorsal wall of the bursa.

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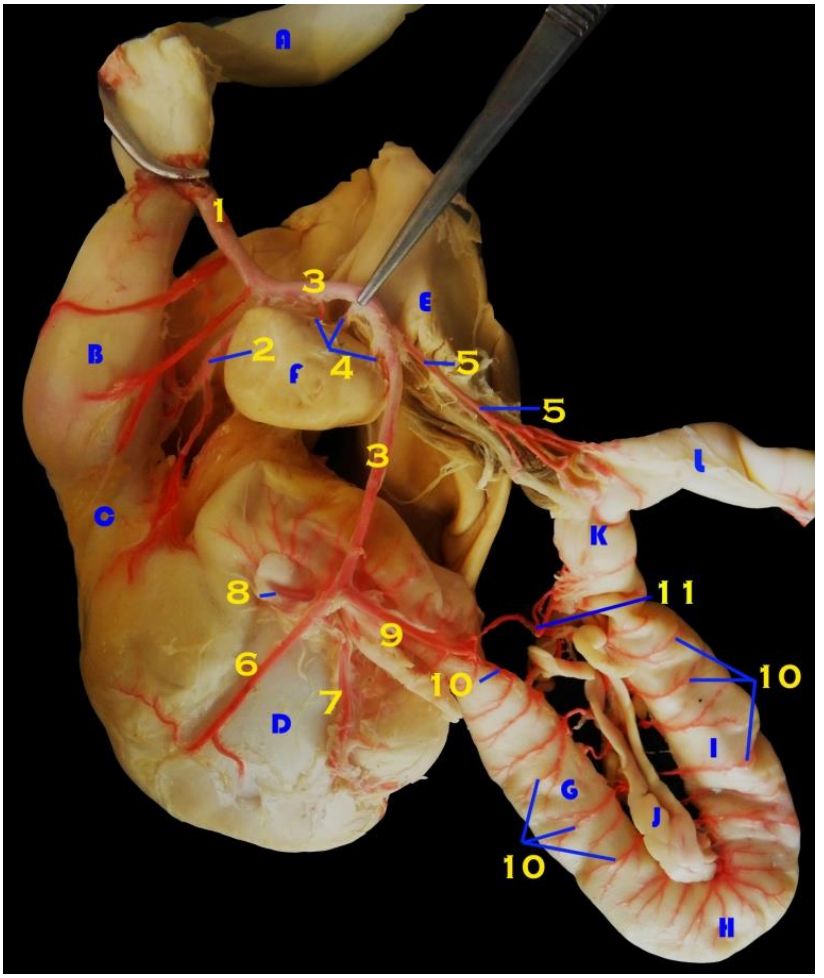

Fig (1): A photograph showing the branches of the right branch of the celiac artery in turkey (Right view)

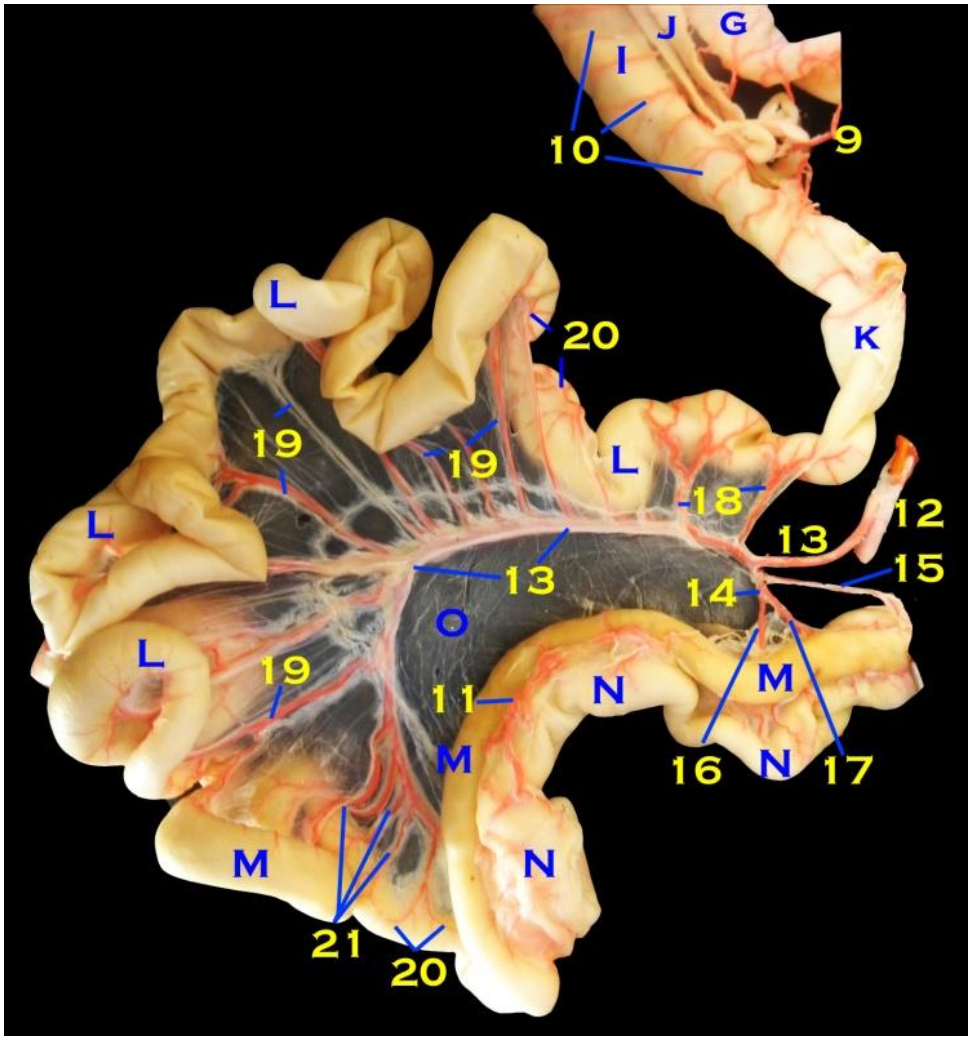

Fig (2): A photograph showing the branches of the cranial mesenteric artery of turkey (Left view)

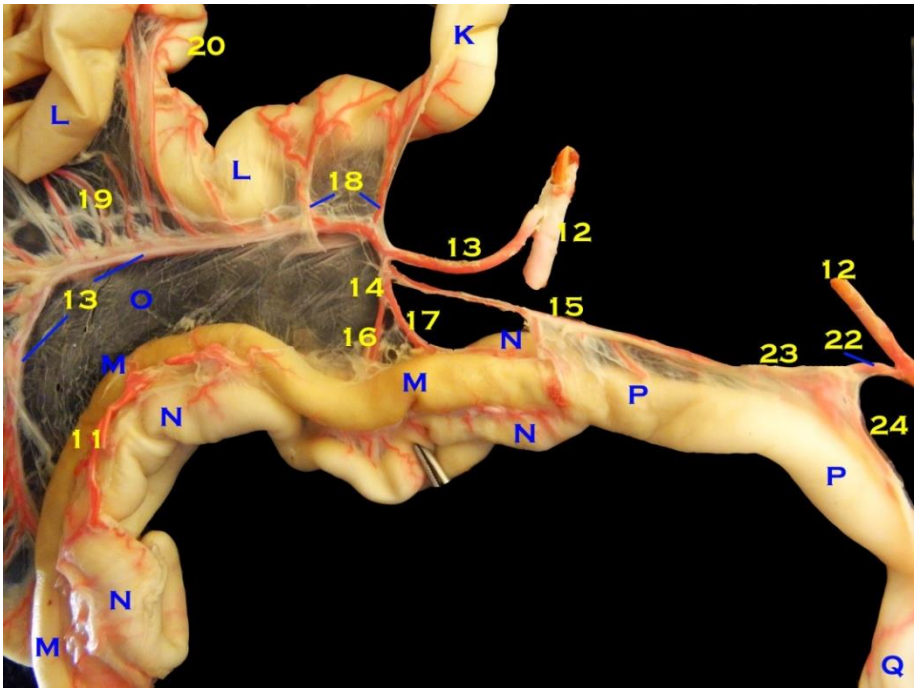

Fig (3): A photograph showing the branches of the cranial and caudal mesenteric arteries of turkey (Left view)

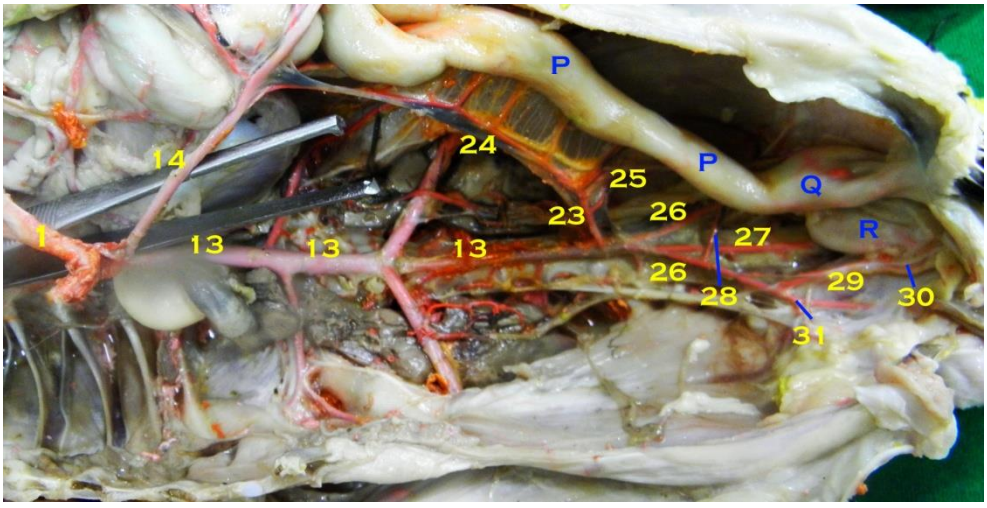

Fig (4): A photograph showing the origin of the different arteries supplying the intestinal tract (the cloaca was raised to show the cloacal bursa).

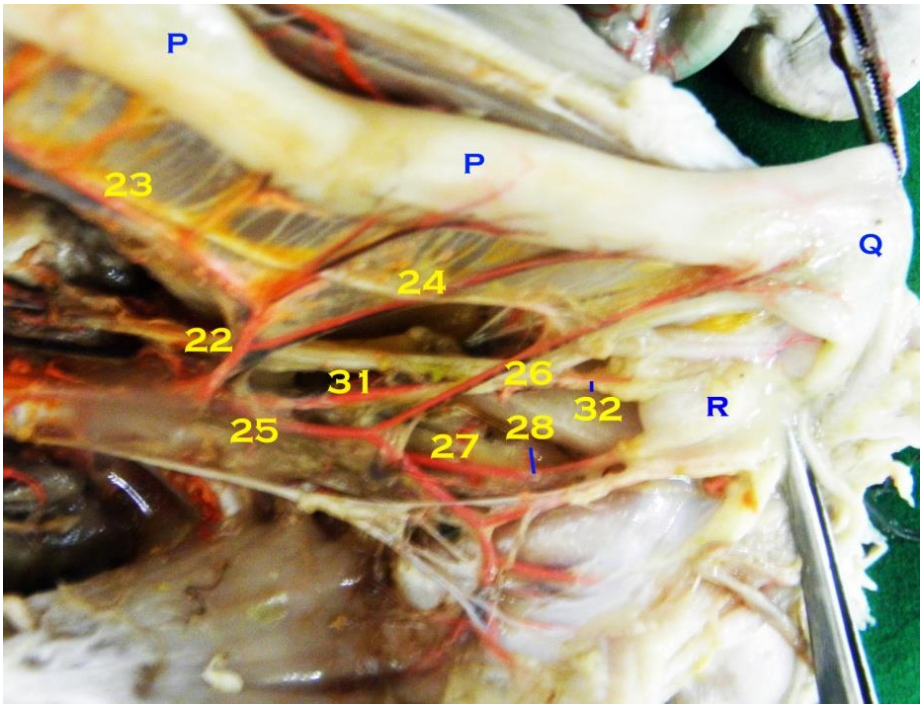

Fig (5): A photograph showing the branches of the caudal mesenteric and internal iliac arteries (ventral view)

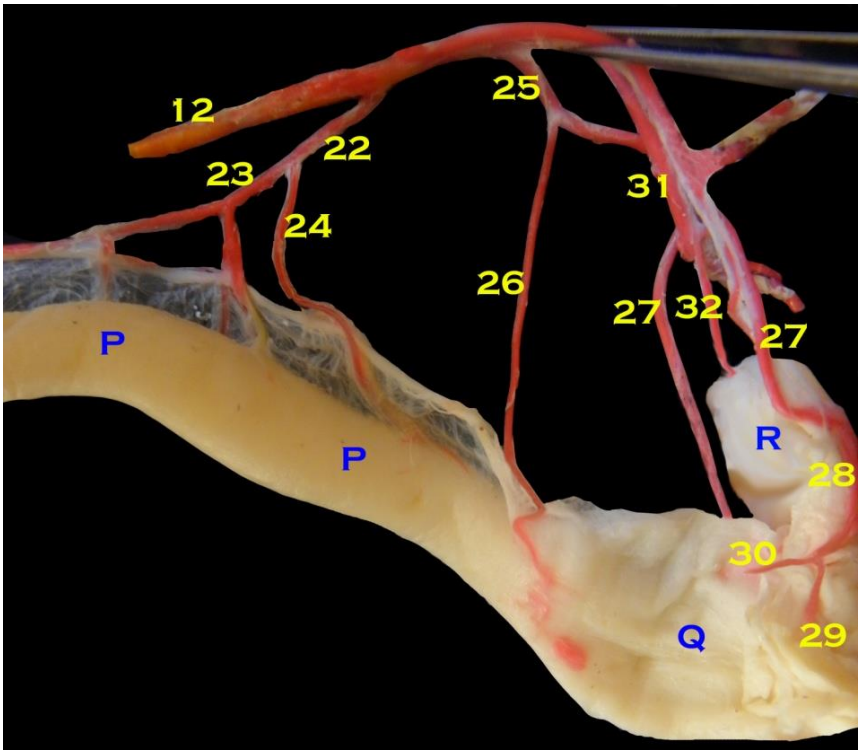

Fig (6): A photograph showing the branches of the caudal mesenteric and internal iliac arteries

Legend for the figures from 1-6

1A. celiaca, 2 R. Sinsterarteriae of , 3R. dexterarteriae of 1, 4 A. lienalis, 5 A. duodenojejunalis of 3, 6 A. gastricadextradorsalis of 3, 7 A. gastricadextraventralis of 3, 8 A. gastroduodenalis of 3,9 A. pancreaticoduodenalisof 3, 10 Rr. duodenales of 9, 11 R. ileocecalis of 9, 12 Aorta descenedens, 13 A. mesentericacranialis, 14 A. ileo-cecalis of 13, 15 R. colicus of 13, 16 R. Cranialis of 14, 17 R.Caudalis of 14, 18 Aa. duodenojejunales of 13, 19 Aa. Jejunales, 20 Arcusintestinalis, 21Aa. ileales, 22 A. mesentricacaudalis, 23 R. cranialis of 22, 24 R. caudalis of 22, 25A. iliacainterna, 26
A. cloacalis of 25, 27 A. pudenda interna, 28 A. bursocloacalis of 27, 29 R. bursalis of 28, 30 R. cloacalis of 28, 31 A. caudalismediana, 32 R. bursalis of 31.

A Esophagus, A Esophagus, B Proventriculus, C Isthmus, D Ventriculus (Gizzard), E Hebar (Liver), F Lien (Spleen), G Pars descendensduodeni, H Flexuraduodeni, I Pars ascendensduodeni, J Pancreas, K Flexuraduodenojejunalis, L Jejunum, M Ileum, N Cecum, O Mesojejunum, P Rectum(Colon), Q Cloaca, R Cloacal bursa.

Table (1): Showing the arteries supplying the intestinal tract of the turkey, their origin and area of destination.

Artery	Origin	Destination
1- Duodenojejunal artery	Right branch of Celiac artery	1-Distal portion of the ascending duodenum. 2-Duodenojejunal flexure.
2- Gastroduodenal artery	Right branch of Celiac artery	Pylorus. Craniodorsaltenuis muscle. Proximal region of the descending limb of the duodenum
3- Pancreatico-duodenal artery	Right branch of Celiac artery	1-Duodenum 2-Pancrease
4- Ileocecal artery	Pancreaticoduodenal artery	1-Distal (cranial) two thirds of the left cecom and adjacent ileum
5- Colic branch	Cranial mesenteric artery	1- Cranial portion of the colon
6- Ileocecal artery	Cranial mesenteric artery	1-Cranial branch: cranial two thirds of the Ileum and right cecom. 2-Caudal branch: caudal third of the ileum and two ceca
7- Duodenojejunal Artery (ies) (1-2)	Cranial mesenteric artery	1- Beginning of the jejunum 2- Duodenojejunal flexure
8- Jejunal arteries (10-14)	Cranial mesenteric artery	1- Jejunum
9- Ileal arteries (4-6)	Cranial mesenteric artery	1- proximal portion of the ileum 2- Blind ends of the intestinal ceca (apex)
10- Cranial branch	Caudal mesenteric artery	1- Cranial portion of the colon
11- Caudal branch	Caudal mesenteric artery	1-Caudal portion of the colon 2- Cranial portion of the cloaca
12- Cloacal artery	Internal iliac artery	1- Cranial portion of the cloaca
13- Bursocloacal Arteries (two)	Internal pudendal Artery	1- Bursal branch: Cloacal bursa(lateral aspect) 2- Cloacal branch: caudal portion of the cloaca
14- Bursal branch	Median caudal Artery	1- Cloacal bursa (dorsal aspect)