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Anatomical study on origin, course and distribution of cranial and caudal mesenteric arteries in the White New Zealand rabbit (*Orycotolagus cuniculus)*

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ABSTRACT

The present study was carried out on fifteen healthy adult White New Zealand rabbit (*Orycotolagus cuniculus)* to clarify the obscure mesenteric arteries, which and their branches which are usually involved in intestinal surgery. The mesenteric artery is a high caliber vessel, 2cm in length dependent on the abdominal aorta, right below the emergence of the vessels destined for the liver and stomach. The animals were sacrificed, injecting diazepam (30 mg/kg) in jugular vein. Cannulation of the abdominal aorta, perfusion with warmed water (40ºC) and stained latex injection (Neoprene 450, Capitol Scientific, Austin, U.S.A, Red carmine stain) were performed, followed by fixation. With formalin (10%) the dissection and photographic documents (Casio Cyber-shot, 12.1 mega pixels) made it possible to systemize the arteries and define the vascular patterns of the viscera. The results prone that the cranial mesenteric artery of the White New Zealand rabbit (*Orycotolagus cuniculus)* arose from the abdominal aorta, at the level of the second lumbar vertebra, entered the cranial mesentery forming its root, then proceeded caudoventrally in the mesojejunum and continued as the last cecal artery. The cranial mesenteric artery gave off: - Caudal pancreaticoduodenal artery to the right lobe of the pancreas and the descending and ascending parts of the duodenum. Middle colic artery, a small vessel (frequently two) arising from the left wall and passing to the transverse colon, Eighteen to twenty jejunal arteries, Ileocecocolic artery to the ileum, cecum, ascending colon, transverse colon and the cranial part of the descending colon. The caudal mesenteric artery arose from the abdominal aorta at the level of the caudal border of the root of the 6th lumbar transverse process, passed caudoventrally in the descending mesocolon, then divided into: left colic artery to the caudal two thirds of the descending colon, and cranial rectal artery to the cranial segment of the rectum. The obtained results were compared with their corresponding in the domestic animals, especially the domestic carnivores and laboratory animals.

Key words: Anatomy; White New Zealand rabbit (*Orycotolagus cuniculus)*; Mesenteric arteries.

INTRODUCTION

The knowledge of anatomical variations is important for radiological and surgical procedures in humans and animals due to its practical and theoretical significance for experimental research and surgical practice in experimental and domestic animals [1, 2]. The mesenteric arteries are responsible for blood supply in the small and large intestine in reptiles, birds and mammals [3] and the digested nutrients are absorbed by the epithelium and transferred to circulation [4]. The mesenteric artery is a unique vessel that comes out of the aortic artery a little caudal to the origin of the celiac artery, as [5, 6, 7, 8].This vessel is responsible for irrigating the largest part of small intestine [9].

While observing by arteriography the anatomy of the abdominal viscera and the lumbar region in caprines, carnivores and swine report that the cranial mesenteric artery, in these species, is originated from the following branches: middle colic artery, the most developed branch, which anastomoses with the left gastroepiploic artery; ileocolic artery, where, in goats and rabbits, it is the first released branch; cranial duodenal pancreatic artery; and several jejunal arteries anastomose themselves, originating arches. The caudal mesenteric artery is a low caliber vessel and is divided into cranial and caudal branches [10]. In dogs, the cranial mesenteric artery originated in the ventral portion of the descending abdominal aorta in all preparations (100%) and released the left adrenal branches and the right pancreatic ones, as well as the caudal pancreaticoduodenal arteries and the middle and left colic, as well as also the ileocolic artery. The caudal mesenteric artery emerged from the ventral portion of the descending abdominal aorta and near to its end releases the cranial rectal arteries and left colic [2]. The relevance of the arterial blood supply of the intestine in surgery necessitates awareness with its branching pattern [11]. As example, the caudal pancreaticoduodenal artery is involved in pancreatic transplantation in dog [12]. Also, the right colic, middle colic and caudal mesenteric arteries are transected during performing colectomy and ileorectal anastomosis due to oncologic causes in canines [13].

Rabbits have been used as an experimental model in many diseases, such as: erectile dysfunction [14, 10], portal hypertension [7, 15] and sepsis [16]. Moreover, they have been used for the study of toxicology, pharmacology and surgery for the veterinary medicine course in many universities. However, some aspects of their macro anatomy need a more detailed description, especially the abdominal and pelvic arterial vascular system, which has a huge variability in distribution and trajectory.

The arterial supply in small intestine and large intestine of the White New Zealand rabbit (*Orycotolagus cuniculus)* was originated from the

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cranial mesenteric artery and caudal mesenteric artery. Therefore, the aim of this study was to describe the behavior of the arterial vessels in the small intestine and large intestine of the New Zealand white rabbit (*Orycotolagus cuniculus)* from the irrigation of the cranial and caudal mesenteric artery to give morphological aid and support for experimental research and for the clinical, radiological and surgical practice of this animal.

MATERIALS AND METHODS

A total of 15 healthy adult White New Zealand rabbit (9 males and 6 females) of both sexes were purchased from the local market (Riasuddin market) of Chittagong district in Bangladesh. Overdose of diazepam (30mg/kg body weight) was injected in external jugular vein to sacrifice those rabbits. Before sacrificed, the physical examinations of the rabbits were performed and the healthy rabbits were selected for anatomical study on origin, course and distribution of cranial and caudal mesenteric arteries. Then skin, fascia and muscles of abdomen were carefully dissected. An opening in the abdominal cavity was performed for identification, isolation and cannulation of the abdominal aorta. Warm-water perfused (40ºC) through abdominal aorta and after 20 minutes stained latex (Neoprene 450, Red carmine stain), was injected through the abdominal aorta. Then sample animals were fixed by 10% formalin for further dissection of the abdominal aorta, cranial and caudal mesenteric arteries. The block containing the viscera was taken out from the interior of the abdominal cavity and dissected, allowing the systematization of the arteries to define the vascular pattern of the viscera and to document it with a camera (Camera Casio Cyber shot, 12.1 megapixels). The obtained results were discussed with those of the other animals such as in carnivores [17], red fox [8], carnivores and ruminants [6], cat [18], dog [19], ox [20], horse [21], and goat [22]. The nomenclature used in this work was that adopted by the Nomina Anatomica Veterinaria [23].

RESULTS

Cranial mesenteric artery:

The cranial mesenteric artery was a stout vessel that arose from the ventral aspect of the abdominal aorta at the level of the caudal border of the arch of the 2nd lumbar vertebra. It entered the cranial mesentery forming its root, being caudal to the transverse colon, flanked by the ascending colon and descending duodenum on the right, and the descending colon and ascending duodenum on the left. It proceeded caudoventrally more centrally situated between the two layers of the mesojejunum, forming a gentle curve with a concavity facing caudodorsally. It continued along the mesenteric border of the cecum as the last cecal artery. Along its course, the cranial mesenteric artery detached the following branches:-

The caudal pancreaticoduodenal artery arises at the same level, but from the right wall. The caudal pancreaticoduodenal artery, a branch of the cranial mesenteric artery, enters the mesoduodenum from the left side and supplies the major portion of the loop. An anterior branch anastomoses with cranial pancreaticoduodenal artery. (Fig.1 and .2)

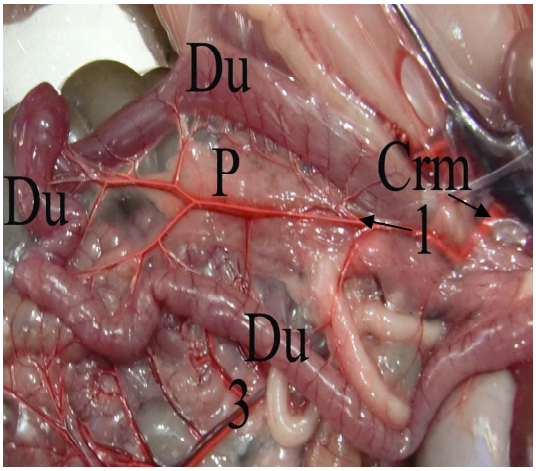

Figure 1. Photograph demonstrating the Duodenum (Du) of small intestine and Pancreas (P) of White New Zealand rabbit (*Orycotolagus cuniculus)* which supplied by Caudal pancreaticoduodenal artery (1)

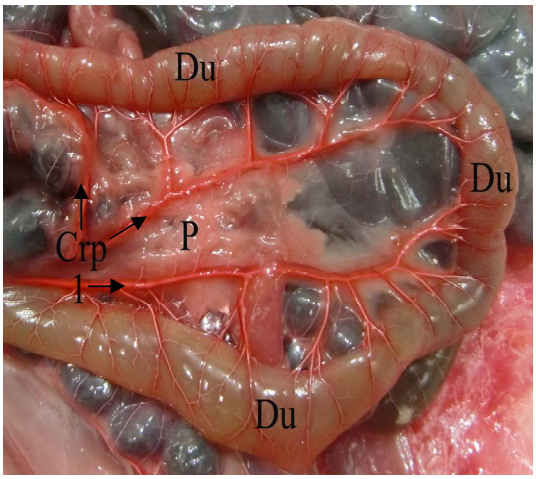

Figure 2. Photograph showing the Duodenum (Du) and Pancreas (P) of White New Zealand rabbit which supplied by Caudal pancreaticoduodenal artery (1) and cranial pancreaticoduodenal artery (Crp).

1- caudal pancreaticoduodenal artery, 2-Middle colic artery, 3- Jejunal artery, 4- Ileocecocolic artery, Crm- cranial mesenteric artery, Ce- Cecum, Co- Colon, Je- Jejunum.

The middle colic artery, a small vessel (frequently two) arising from the left wall and passing to the transverse colon. (Fig.3)

The jejunal arteries, about eighteen to twenty in number, are given off from the cranial mesenteric artery after the ileocaecocolic artery has left it, and

are distributed to the free portion of the mesenterial small intestine. The successive vessels are connected by anastomoses the first connecting also with a branch of the caudal pancreaticoduodenal artery. All but two of the jejunal arteries arise from one side of the cranial mesenteric artery, one forms the end of the latter, and one springs from its opposite side. The last anastomoses forward with a branch of the appendicular artery. (Fig.3, 4 and 5)

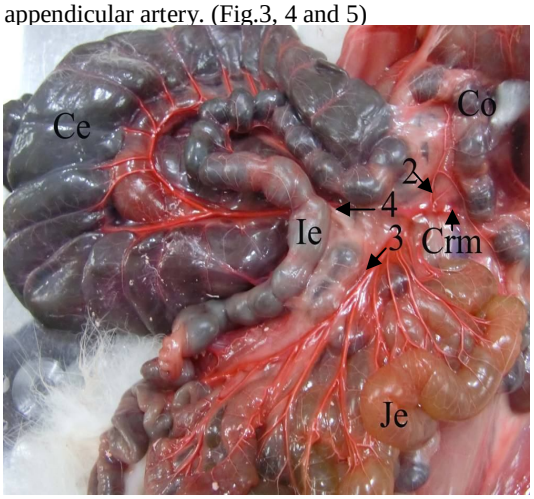

Figure 3**.** Photograph focusing the small intestine, part of large intestine of White New Zealand rabbit and the cranial mesenteric artery (Crm) with its ramifications.

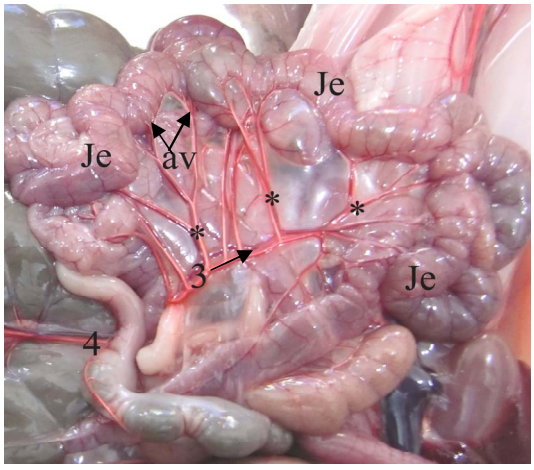

Figure 4. Photograph pointing out the Jejunal arteries(3) of White New Zealand rabbit forming vascular arcs(av) next to messenteric edges of small intestine and its ramifications (*).

The ileocaecocolic artery, a large branch, equalling in size the cranial mesenteric trunk, is distributed to the terminal portion of the ileum, the caecum (including the vermiform process), and the ascending colon. Its branches are arranged in two series, a proximal group being given off near the point of origin of the main vessel, and a distal group, including the terminal portion of the vessel, at about two inches from the point of origin (Fig.6)

The proximal branches of the ileocaecocolic artery include (Fig.6).

(a) Small branches to the third, fourth, and fifth limbs of the ascending colon, each anastomosing with its neighbours, and the last with the middle colic artery.

(b) The appendicular artery to the vermiform process. This vessel also gives off several short branches to the immediately adjacent part of the ileum and a longer branch, arising from the appendicular near its point of origin, passes along the ileum to anastomose with an intestinal branch of the superior mesenteric trunk.

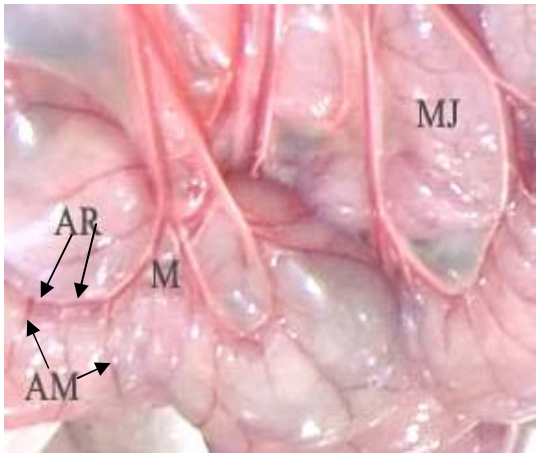

Figure 5. Photograph demonstrating mesojejunum and right angles (AR) of jejunal arteries originating from the vascular arcs inserting itself, in part, the mesenteric edge (M and arrows) and in part, the anti-mesenteric edge (AM and arrows) of the jejunum of the of White New Zealand rabbit.

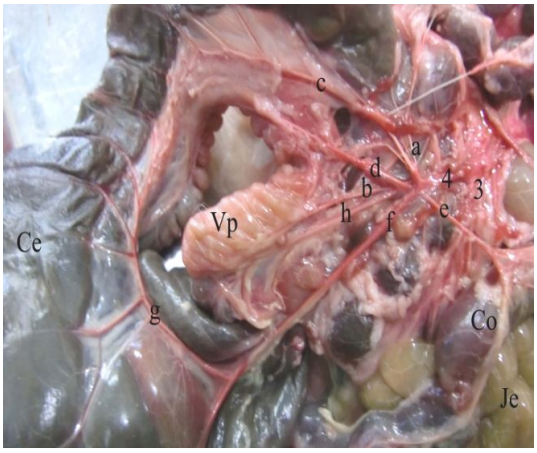

Figure 6. Photograph showing the Ileocecocolic arteries(4) of White New Zealand rabbit which supplies to part of small intestine and large intestine and its ramifications.

4- ileocecocolic artery, a-small branches to third, fourth and fifth limbs of ascending colon, b-appendicular artery, c- anterior ileocecal artery, d-anterior right colic artery, e- posterior right colic artery, f- posterior ileocecal artery, g- cecal artery, h- terminal branches to parts of ileum,cecumand colon. Je- jejunum, Ce- cecum, Co- colon, Vp-vermiform process.

(c) An anterior ileocaecal artery to the terminal fourth (anterior part of the third limb) of the caecum proper and related portion of the ileum.(d) An anterior right colic artery to the flexure uniting the first and second limbs of the ascending colon (e) A posterior right colic artery to the second limb of the ascending colon. This vessel anastomoses with anterior right colic artery and with the special branch to the third limb.

The distal branches of the ileocaecocolic artery include (Fig.6)

(f) A posterior ileocaecal artery to the middle portion of the third limb of the caecum and the adjacent portion of the ileum; anastomosing with anterior ileocaecal artery (g) A caecal artery to the second limb and the posterior end of the third limb of the caecum (h) Terminal branches to the parts of the ileum, caecum, and colon about the sacculus rotundus; anastomosing with anterior right colic artery.

Caudal mesenteric artery

The caudal mesenteric artery arose from the ventral aspect of the abdominal aorta, opposite to the caudal border of the root of the 6th lumbar transverse process. It proceeded caudoventrally within the descending mesocolon for 2-3 cm, then divided into a cranial branch (left colic artery) and a caudal branch (cranial rectal artery).

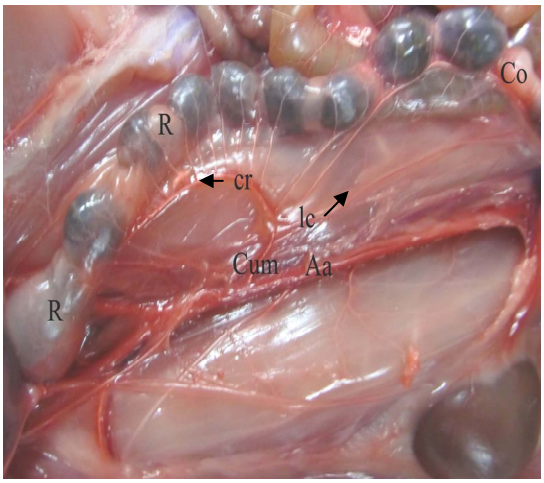

Figure 7. Photograph demonstrating the arterial distribution of caudal messenteric artery(Cum) I of White New Zealand rabbit which supplies to rectum(R) and part of colon (Co) of Large intestine its ramifications.
Aa- Abdominal aorta, cr- cranial rectal artery, Lc- left colic artery

The left colic artery proceeded cranially along the mesenteric border of the descending colon, where it supplied its caudal two thirds and anastomosed with the middle colic artery (Fig.7)

The cranial rectal artery proceeded caudally in the descending mesocolon, then entered the pelvic cavity, where it continued in the mesorectum. It supplied the cranial segment of the rectum and anastomosed with the middle rectal artery of the prostatic or vaginal artery (Fig.7).

DISCUSSION

In this present study cranial messenteric artery of New Zealand White rabbit arises caudal to the origin of the celiac artery by 2 cm .However, it arises caudal to the origin of the celiac artery by 1 cm in the cat [18], 12 cm in the camel [24], and just caudal to the celiac artery and sometimes by a common trunk with it in the ruminants [17].

In accordance with Ghoshal (1975) [21] in carnivores, Hatem Bahgat (2007) [8] in red fox and Schummer and Wilkens (1981) [6] in carnivores and ruminants, the origin of the cranial mesenteric artery in the red fox was at the level of the second lumbar vertebra. On the other hand, it is at the level of the first lumbar vertebra in the dog [19], pig and horse [6] as well as goat [22].

In agreement with Reighard and Jenings (1966) [18] in the cat, Ghoshal (1975) [21] and Schummer & Wilkens (1981) [6] in carnivores, Adams (1986) [19] in the dog and Hatem Bahgat (2007) [8] in red fox, the cranial mesenteric artery proceeded caudoventrally between the layers of the mesentery. It passed more centrally, forming a gentle curve with a concavity facing caudodorsally. Reighard& Jenings (1966) [18] in the cat, mentioned that it forms a curve with the convexity dextrad. Schummer & Wilkens (1981) [6] stated that it runs more centrally in the carnivores and more peripherally in the pig. Levine et al. (1987) [20] in the ox, mentioned that a large collateral branch (Ramus collateralis of the N.A.V., 2005) [23] arises from the proximal segment of the cranial mesenteric artery, and anastomoses with its continuation distally.

In coincidence with Reighard & Jenings (1966) [18]; Hudson & Hamilton (1993) [25] in the cat, Hatem Bahgat (2007) [8] in red fox and Ghoshal (1975) [21] in the horse, the caudal pancreaticoduodenal artery is the first branch that arise from the cranial mesenteric artery. In carnivores, it arises distal to the ileocolic artery [21, 6]. On the other hand, in the camel, it arises from a jejunal artery that supplies the initial part of the jejunum [24], and in the goat, a caudal duodenal artery and pancreatic branches are given separately from the cranial mesenteric artery [22], However, only one pancreaticoduodenal artery that arises from the gastroduodenal artery of the celiac, and anastomoses with the jejunal arteries was described in the sheep [26].

In correspondence with Ghoshal (1975) [21] in carnivores and Hatem Bahgat (2007) [8] in red fox the caudal pancreaticoduodenal artery divided into a right branch that supplied the right lobe of pancreas and the descending duodenum, and a left branch that supplied the ascending duodenum. In this view, it supplies the right lobe of pancreas and the descending duodenum in the cat [25], it is divided into branches that run cranially and caudally on the descending duodenum in the ruminants [17] and supplies the descending, transverse and ascending parts of the duodenum and a small portion of the pancreas in the camel [24]. However, it supplies parts

of pancreas and duodenum in the domestic animals [27].

As seen presently, the New Zealand White rabbit possessed eighteen to twenty jejunal arteries. Their number is 15-19 in carnivores [28], 8 in red fox [8], 15-20 in the horse [21] , 6 or 7 in the camel [24], 18-28 in the sheep[29] and 24 in the goat [22]. However the number of the jejunal arteries varies from species to species [6].

In agreement with Hatem Bahgat (2007) [8] in red fox and Schummer & Wilkens (1981) [6] in the domestic animals except horse, all the jejunal arteries of the New Zealand White rabbit arose from the cranial mesenteric artery, at nearly regular intervals. On the other hand, in carnivores, they form a common trunk or the first jejunal may arise together with the caudal pancreaticoduodenal artery and the last with the ileocolic artery [30].

Concerning the ileocolic artery, the present study revealed that it was the fourth branch that given from the cranial mesenteric artery. Where as it is the second branch in red fox [8] first branch from the cranial mesenteric artery in carnivores [21, 6]. In coincidence with Ghoshal (1975) [21] and Schummer and Wilkens (1981) [6] in carnivores and de Lahunta and Habel (1986) [31] in the dog, the present investigation showed that the ileocolic artery gave off colic branch, right colic artery, middle colic artery, mesenteric ileal branch and continued as the cecal artery.

Regarding the cecal arteries, this study showed that they were represented by 3-4 branches: 2-3 of them arose from -and the last was represented by the continuation of the cranial mesenteric artery. A finding which contradicts with carnivores[21] and red fox [8] where the ileal artery arises as the last branch of the cranial mesenteric artery representing its continuation. Schummer and Wilkens, (1981) [6] stated that the ileal arteries originate from the terminal part of the cranial mesenteric artery in the domestic animals except horse, in which they arise together with the bundle of the jejunal arteries. However, Schaller (1992) [27] in the domestic animals, said that they are variably arising branches of the cranial mesenteric and ileocolic arteries.

In coincidence with Hudson and Hamilton (1993) [25] in the cat, origin of the middle colic artery from the cranial mesenteric artery. On the other hand, both the pancreatic branches that sometimes given from the middle colic artery in the sheep [32, 33], and the possible origin of the middle colic and right colic arteries from the cranial mesenteric artery in carnivores [21].

The present work revealed that the caudal mesenteric artery arose from the abdominal aorta, opposite to the caudal border of the root of the 6th lumbar transverse process. A finding which agrees with Hatem Bahgat (2007) [8] in the red fox and partially agrees with Adams (1986) [19] in the dog who stated that it arises at the level of 5th to 6th lumbar vertebra- and contradicts Ghoshal (1975) [21] and Schummer and Wilkens (1981)[6] in carnivores-who mentioned that it arises at the level of the 5th lumbar vertebra- and Reighard and Jennings (1966) [18] in the cat, who said that it arises about the level of the last lumbar vertebra.

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