

## A macroscopical investigation of the portal veins of the Van cat

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**ABSTRACT:** In this study veins that constituted the portal vein were investigated in eight adult Van cats. The portal vein of the Van cat was composed of five peripheral branches which supplied the abdominal organs and two intrahepatic branches at the hepatic porta. The peripheral branches were cranial mesenteric, splenic, gastroduodenal, right gastric and cystic veins. The cranial mesenteric vein was the largest vessel that joined to the portal vein, and was constituted by the caudal pancreaticoduodenal, ileal, ileocolic and jejunal veins. The splenic vein was formed by the left gastric, left gastroepiploic, pancreatic and short gastric veins. The gastroduodenal vein was formed by the cranial pancreaticoduodenal and right gastroepiploic veins. The right gastric vein separately joined to the portal vein. The caudal mesenteric vein joined to the portal vein either alone or by a common trunk receiving either the caudal pancreaticoduodenal vein or ileocolic vein. The caudal mesenteric vein also opened rarely into the splenic vein. Intrahepatic branches were the right branch which gave off the ramus caudatus and ramus dexter lateralis, and the left branch which gave off the ramus dexter medialis, ramus quadratus, ramus sinister lateralis and ramus sinister medialis.

**Keywords:** portal vein; cat; anatomy

The portal vein drains the blood of stomach, pancreas, spleen and all intestines except for the anus and rectum (Greene, 1963; Hazel and Taylor, 1969; Evans and Christensen, 1979; Zietzschmann et al., 1985; Dursun, 1994).

The peripheral branches of the portal vein are gastroduodenal, splenic, cranial mesenteric and caudal mesenteric veins (Crouch and Lackey, 1969; Hazel and Taylor, 1969) and the right gastric vein in domestic cat (Dursun, 1994). In dog, the portal vein receives cranial mesenteric, caudal mesenteric veins (Kalt and Stump, 1993) and the splenic vein (Evans and Christensen, 1979). In the Kangal dog, the vessel is formed by the cranial mesenteric, caudal mesenteric, splenic, gastroduodenal and right gastric veins. The vessel also receives some thin venous branches from the gall bladder and the cystic duct (Dursun et al., 1994a).

The portal vein shows the same intrahepatic branching as the right and left branches in Angora

goat (Tipirdamaz et. al., 1997), New Zealand rabbit (Nur, 1995), Kangal dog (Dursun et al., 1994a), Akkaraman sheep (Dursun et al., 1994b), dog (Kalt and Stump, 1993), humans (McMinn et al., 1993) and domestic mammals (Dursun, 1994) except the horse, which has the additional middle branch (ramus medius) (Ghoshal et al., 1981).

The domestic cat originates from European (*Felis silvestris silvestris*) and African (*Felis silvestris lybica*) wild cats. The homeland of the Van cat, which has several and important characteristics compared to other breeds, is Buhtamara, Altai Mts. It is a medium-long-haired cat confined to Van, Turkey. It is also known as the odd-eyed cat in the region, that means it has one blue and one orange eye, white patches are scattered on its head, legs and tail (Odabasioglu and Ates, 2000). Investigations into the venous drainage of this cat show some differences in the origin, course, anastomosing and ramification of veins of the thoracic limb (Ozudogru et

al., 2003) and heart (Aksoy et al., 2003) as compared with the domestic cat. Therefore, the present study was aimed to study the distribution of the portal vein of the Van cat, which will presumably help in clinical and other experimental works with this breed.

## MATERIAL AND METHODS

Eight adult Van cats of different sex, weighing 2 000–3 000 g, were used as material in this study. General anaesthesia was induced by xylazine (Rompun) 0.5 mg/kg and cyclohexanone (Ketalar) 10 mg per kg body weight intramuscularly. To prevent the coagulation of the blood, heparin (5 000 IU/ml) was injected into the cranial branch of the lateral saphenous vein before drainage. After obtaining deep anaesthesia the abdominal cavity was opened and the caudal vena cava was cut to allow drainage of blood from the circulation. All animals were then

perfused with sodium chloride (0.9%). The organs in the abdominal cavity were taken out except the kidneys. Then the latex injection was done via the cranial mesenteric vein (Aycan and Bilge, 1984). The latex solution was coloured with fabric blue (for 10 ml latex, 0.5 ml Dekapermanent 20/20 fabric blue colour). Then the material was kept in 10% formaldehyde until dissection.

Dissected veins were photographed with a camera (Coolpix Nikon 995). A dissection microscope (Nikon SMZ-ZT, Euromax) was used during the dissection. Anonymous (1994) was used for the terminology.

## RESULTS

The portal vein (*v. portae*) (Figures 1–3) of the Van cat was composed of five peripheral branches which came from the abdominal organs. The average diameter and length of the portal vein were



Figure 1. Branches of the portal vein. 1 = *v. portae*, 2 = *v. mesenterica cranialis*, 3 = *v. pancreaticoduodenalis caudalis*, 4 = *vv. jejunalis*, 5 = *vv. ilei*, 6 = *v. ileocolica*, 7 = *ramus colicus*, 8 = *v. cecalis*, 9 = *v. colica dextra*, 10 = *v. colica media*, 11 = *v. lienalis*, 12 = *vv. pancreaticae*, 13 = *v. gastrica sinistra*, 14 = *vv. gastricae breves*, 15 = *v. gastroepiploica sinistra*, 16 = *v. gastroduodenalis*, 17 = *v. pancreaticoduodenalis caudalis*, 18 = *v. gastroepiploica dextra*, 19 = *v. mesenterica caudalis*, 20 = *v. colica sinistra*, 21 = *v. rectalis cranialis*, 22 = *v. gastrica dextra*; A = ventriculus, B = pars cranialis duodeni, C = flexura duodeni cranialis, D = pars descendens duodeni, E = flexura duodeni caudalis, F = pars transversa duodeni, G = pars descendens duodeni, I = flexura duodeni jejunalis, J = jejunum, K = ileum, L = cecum, M = colon ascendens, N = colon transversus, O = colon descendens, P = lobus hepatis dexter lateralis, R = lobus hepatis dexter medialis, S = lobus hepatis sinister lateralis, T = lobus quadratus, U = lobus caudatus, V = lien, Y = pancreas (lobus sinister)



Figure 2. Branches of the portal vein. 1 = v. portae, 2 = v. lienalis, 3 = vv. gastricae breves, 4 = v. gastrica sinistra, 5 = v. gastrica dextra, 6 = v. gastroduodenalis, 7 = v. gastroepiploica dextra, 8 = v. pancreaticoduodenalis cranialis, 9 = v. pancreaticoduodenalis caudalis, 10 = v. mesenterica caudalis, 11 = v. rectalis cranialis, 12 = v. colica sinistra, 13 = v. ileocolica, 14 = ramus colicus, 15 = v. colica media, 16 = v. cecalis, 17 = v. colica dextra, 18 = v. mesenterica cranialis, 19 = vv. jejunaes, 20 = vv. ilei; A = ventriculus, B = pars cranialis duodeni, C = flexura duodeni cranialis, D = pars descendens duodeni, E = flexura duodeni caudalis, F = pars transversa duodeni, G = pars ascendens duodeni, I = jejunum, J = ileum, K = cecum, L = colon ascendens, M = colon transversus, N = colon descendens, O-Ö = pancreas, P = lien, R = lobus quadratus, S = lobus hepatis dexter lateralis, T = lobus hepatis dexter medialis, U = ren dexter

about 6 mm and 3.5 cm, respectively. The peripheral branches were the right gastric, cranial mesenteric, splenic, gastroduodenal, and cystic veins.

The right gastric vein (v. gastrica dextra) (Figures 1 and 2) was the first vessel that joined to the portal vein. This vein drained the lesser curvature of the stomach. However, the vein drained the visceral face of the stomach and anastomosed with the left gastric vein.

The cranial mesenteric vein (v. mesenterica cranialis) (Figures 1 and 2) was constituted by the caudal pancreaticoduodenal, jejunal, ileocolic and ileal veins. This vessel was one of the largest vessels, about 3 to 4 mm in diameter and 10 cm in length that joined to the portal vein.

The caudal pancreaticoduodenal vein (v. pancreaticoduodenalis caudalis) (Figures 1 and 2) drained the caudal part of the right lobe of the pancreas and the ascending duodenum. In two specimens (25%), the caudal pancreaticoduodenal vein joined

with the caudal mesenteric vein, then it opened into the portal vein.

The jejunal veins (vv. jejunaes) (Figures 1 and 2) looked like a net on the jejunum. They started initially with 2–3 thin branches that joined each other, then they made 8–10 larger branches and opened into the cranial mesenteric vein. Another branch of the cranial mesenteric vein was the ileocolic vein (v. ileocolica) (Figures 1 and 2) which was about 1.5 to 2 mm in diameter. The ileocolic vein was formed by the colic branch and caecal, right colic and middle colic veins. The colic branch (ramus colicus) (Figures 1 and 2) drained the ascending colon and anastomosed with a branch of the caudal mesenteric vein. The caecal vein (v. cecalis) (Figures 1 and 2) drained the last part of the ileum with 2–3 branches as well as all the caecum with 3–5 branches. The right colic vein (v. colica dextra) (Figures 1 and 2) was constituted by 6–8 branches which drained the initial part of the transverse co-



Figure 3. Intrahepatic branches of the portal vein. 1 = v. portae, 1' = ramus dexter, 1'' = ramus sinister, 2 = ramus caudatus, 3 = ramus dexter lateralis, 4 = ramus dexter medialis, 5 = ramus quadratus, 6 = ramus sinister lateralis, 7 = ramus sinister medialis, 8 = v. cava caudalis, 9 = vv. cysticae; A = lobus caudatus, B = lobus hepatis dexter lateralis, C = lobus hepatis dexter medialis, D = lobus quadratus, E = lobus hepatis sinister lateralis, F = lobus hepatis sinister medialis, G = vesicae fellae, I = ren dexter, J = ventriculus, K = pars cranialis duodeni, L = flexura duodeni cranialis, M = pars descendens duodeni, N = flexura duodeni caudalis, O = pars transversa duodeni, Ö = pars ascendens duodeni, P = flexura duodeni jejunalis, R = ligamentum duodenocolica, S = colon descendens, T = vesica urinaria, U = jejunum, V = ligamentum hepatoduodenale

lon as well as the descending colon. The middle colic vein (v. colica media) (Figures 1 and 2) was constituted by 4–6 branches which drained the last part of the ascending colon and transverse colon. The last branches of the cranial mesenteric vein were the ileal veins (vv. ilei) (Figures 1 and 2). They drained the ileum with 3–4 branches which made a common trunk before opening into the cranial mesenteric vein. While coursing in the mesojejunum they also drained it.

The splenic vein (v. lienalis) (Figures 1 and 2) was about 2.5 to 3.1 mm in diameter and 6 cm long. It was divided into two branches at the hilus lienis before entering to the spleen. The vein drained the greater omentum while coursing in it. The vessel was formed by the left gastric, left gastroepiploic, pancreatic and short gastric veins. The left gastric vein (v. gastrica sinistra) (Figures 1 and 2) was the first vessel that joined to the splenic vein. This vessel was formed by two branches that joined each other before entering to the splenic vein. One of

these branches arose from the cardiac part of the stomach, the other arose from the lesser curvature of the stomach. The left gastric vein also drained the parietal and visceral surfaces of the stomach and anastomosed with the right gastric vein. The left gastroepiploic vein (v. gastroepiploica sinistra) (Figure 1) anastomosed with the right gastroepiploic vein, then it ran along the greater curvature of the stomach and joined to the splenic vein at the distal one third of the spleen. During its course, it received thin branches from the greater and lesser omentum. The pancreatic veins (vv. pancreaticae) (Figures 1) had 2–3 branches which drained the left pancreatic lobe and joined separately to the splenic vein. The short gastric veins (vv. gastricae breves) (Figures 1 and 2) were formed by 4–6 branches which drained the greater curvature of the stomach and made a common trunk before entering to the splenic vein.

The gastroduodenal vein (v. gastroduodenalis) (Figures 1 and 2) joined to the portal vein 3 mm



after the right gastric vein. It was about 1.7 to 2 mm in diameter. This vessel was formed by the cranial pancreaticoduodenal and right gastroepiploic veins. The cranial pancreaticoduodenal vein (*v. pancreaticoduodenalis cranialis*) (Figures 1 and 2) was the continuation of the gastroduodenal vein at the cranial duodenal flexure. The vein drained the descending duodenum and right pancreatic lobe and anastomosed with the caudal pancreaticoduodenal vein. Then the gastroduodenal vein received the right gastroepiploic vein (*v. gastroepiploica dextra*) (Figures 1 and 2) at the cranial duodenal flexure. The right gastroepiploic vein drained the pyloric part of the stomach as well as the greater omentum. While it ran along the greater curvature of the stomach, it received branches from the stomach and anastomosed with the left gastroepiploic vein.

The formation of the caudal mesenteric vein (*v. mesenterica caudalis*) (Figures 1 and 2) was about 2 to 2.2 mm in diameter. The origin of the caudal mesenteric vein showed most variations between the vessels of the portal vein. It was observed that the vessel made a common trunk with the caudal pancreaticoduodenal vein (Figure 2) in two specimens (25%) and with the ileocolic vein in two specimens (25%), then it opened into the portal vein. In two specimens (25%), it opened directly into the splenic vein (Figure 1). In the remaining two specimens (25%), the vessel entered independently into the portal vein. The caudal mesenteric vein was formed by the left colic and cranial rectal veins. The left colic vein (*v. colica sinistra*) (Figures 1 and 2) ran along the descending colon towards the cranial vein and drained the field which it traversed. The cranial rectal vein (*v. rectalis cranialis*) (Figures 1 and 2) drained the last part of the descending colon and the initial part of the rectum.

The cystic veins (*vv. cysticae*) (Figure 3) joined to the portal vein with a few thin branches from the gall bladder and bile duct.

The portal vein divided into two intrahepatic branches. The intrahepatic and lobular branches were very visible. They were the right branch (*ramus dexter*) (Figure 3) which was about 6 mm in diameter and gave off the branches (about 3 to 4 mm in diameter) to the lobus caudatus and lobus dexter lateralis, and the left branch (*ramus sinister*) (Figure 3) which was about 3.5 to 4 mm in diameter and gave off the branches (1.5 to 2.5 mm in diameter) to the lobus dexter medialis, lobus quadratus, lobus sinister lateralis and lobus sinister medialis (see Figure 3).

## DISCUSSION

In the domestic cat, the portal vein is peripherally formed by the gastroduodenal, splenic, cranial mesenteric, caudal mesenteric veins (Crouch and Lackey, 1969; Hazel and Taylor, 1969) and the right gastric vein as well (Ghoshal et al., 1981; Dursun, 1994). On the other hand, Malinovsky and Navratilova (1990a) determined that the portal vein was formed by left gastric, splenic and cranial mesenteric veins. In Van cat, the portal vein was formed by the gastroduodenal, splenic, cranial mesenteric, right gastric and cystic veins. This is the first report expressing that some thin branches from the gall bladder and bile duct open into the portal vein. This means that the portal vein of the Van cat drains more fields than in the other reported cat breeds.

The splenic vein is formed by the left gastric and left gastroepiploic veins in the domestic cat and dog (Ghoshal et al., 1981). This vessel also receives the short gastric vein in the Kangal dog (Dursun et al., 1994a) and domestic cat (Crouch and Lackey, 1969). Another report stated that the splenic vein is formed by the left gastric, left gastroepiploic, pancreatic and short gastric veins in the dog (Evans and Christensen, 1979). In the present study, the composition of the splenic vein was found similar to the data reported by Evans and Christensen (1979).

Although Artico et al. (1998) mentioned the right gastroepiploic vein was a tributary to the splenic vein in the domestic cat, this study indicated it was a tributary to the gastroduodenal vein.

According to Kobayasi and Mendes (1980), the drainage of 2/3 of the right lobe of the pancreas is done by the cranial pancreaticoduodenal vein while the caudal third is drained by the caudal pancreaticoduodenal vein. Conversely, the drainage of the cranial portion of the left lobe is done by venous branches which drain in the gastroduodenal vein or in the portal vein. The caudal portion is drained by a variable number of veins which are tributaries to the splenic vein. Observations in the present study support this finding.

It has been reported that the caudal mesenteric vein joins directly to the portal vein in dog and cat (Ghoshal et al., 1981; Zietzschmann et al., 1985). In Kangal dog, this vessel joins to the cranial mesenteric and splenic veins, then it opens into the portal vein (Dursun et al., 1994a). In domestic cat, it opens into the cranial mesenteric vein (Malinovsky and Navratilova, 1990b). In humans, the caudal me-

senteric vein joins with the splenic vein (McMinn et al., 1993). In the present study, it was found that the caudal mesenteric vein formed a common trunk with the splenic vein in one specimen, with the ileocolic vein in other two specimens and with the pancreaticoduodenal vein in other two specimens, and then it joined to the portal vein. In two specimens, the vessel entered independently into the portal vein. Taken together, the origin of the caudal mesenteric vein may show variations between the species and even in the breed such as Van cat.

The diameters of some large veins of the portal vein in Van cat were found smaller than Ghoshal et al. (1981) measurements done in cat and dog. In Van cat, for example the diameters of the portal, cranial mesenteric, splenic and gastroduodenal veins were 6, 3–4, 2.5–3.5 and 1.7–2 mm, respectively. The diameters of the above-mentioned veins were reported by Ghoshal et al. (1981) as 8–15, 10–12, 5, 3–4 mm, respectively. The values given in the latter report may have been taken from dog but somehow the authors reported them for both cat and dog.

In the Van cat, the portal vein was divided into two intrahepatic branches. They were the right branch, which gave off the branches to the lobus caudatus and lobus dexter lateralis, and the left branch, which gave off the branches to the lobus dexter medialis, lobus quadratus, lobus sinister lateralis and lobus sinister medialis. Previous data have stated that the portal vein has right and left intrahepatic branches in cat and dog (Evans and Christensen, 1979; Ghoshal et al., 1981; Nickel et al., 1981; Dursun et al., 1994a). In addition, Kalt and Stump (1993) reported that the short right branch ramified in the caudate process of the caudate lobe and in the right lateral lobe of the liver. The left branch was essentially the continuation of the portal vein from which successive branches passed to each of the remaining lobes of the liver and the papillary process of the caudate lobe. In this sense, Ghoshal et al. (1981) reported that the portal vein has right, left and middle intrahepatic branches. The right and middle branches go to the right lobe, the left branch goes to the left as well as the quadrate lobes in horse. In humans the right branch goes to the right lobe, the left branch goes to the left, caudate and quadrate lobes (McMinn et al., 1993).

In conclusion, the portal vein was formed by the gastroduodenal, splenic, cranial mesenteric, caudal mesenteric, right gastric and cystic veins in Van cat.

It was found that the constitution of the splenic vein looked like in the dog rather than in the cat. The origin of the caudal mesenteric vein was found as the most changeable vessel of the portal vein in Van cat. It was also found that the caudate lobe of the liver was supplied by the right branch of the portal vein in this breed.

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