

ANATOMICAL STUDY ON INTRAHEPATIC BRANCHES OF PORTAL VEIN IN ONE HUMPED CAMEL (*Camelus dromedarius*)

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ABSTRACT

The gross anatomy of the portal vein of 10 adult one humped camels by using corrosion casting and gross dissection by coloured fluid injection was studied. At the hepatic porta, the portal vein divided into 4 major branches. The right branch ramified in all different parts of the right lobe. The left branch passed to most part of liver such as right lobe, quadrate lobe, left lobe and papillary process of caudate lobe. But the caudal branch of portal vein supplies caudate process of caudate lobe and a part of right lobe and the dorsal branch of portal vein supplies a part of caudate process of caudate lobe and papillary process of caudate lobe.

Key words: Camel, corrosion cast, gross dissection, intrahepatic branches, portal vein

There are some studies in the literature devoted to the anatomy of the portal vein in man (Gupta *et al*, 1977 and Yamane *et al*, 1988) and domestic animals such as sheep by Heath (1968), cat and rabbit by Heath and House (1970), dog by Kalt and Stump (1993) and Carlisle *et al* (1995) and cow by Williamson (1967). Since there is no information about the intrahepatic branching patterns of portal vein in one humped camel, this report describes the manner of ramification of portal vein in the liver of camel.

Materials and Methods

Ten adult camel livers (Fig 1) were obtained fresh from the slaughter house and portal vein of each liver was perfused with normal saline. Then 2 methods of anatomical investigation were employed:

1. Corrosion casting: 5 livers selected and portal vein of each liver was injected with resin prepared from Rodopas with a suitable amount of blue microlite. After hardening the resin, the specimen were macerated in potassium hydroxide solution to produce vascular casts of the portal vein.

2. Gross dissection: In the portal vein of the remaining 5 livers a preserving fluid was injected.

After a suitable interval, coloured gelatin was injected in the portal vein and kept submerged in fixative for 72 hours. Then the branches of portal vein in the liver was dissected.

Results

The portal vein in the camel, at the porta, divided into two major right and left branches that lied for the most part close to visceral surface of liver and distributed its secondary branches to different lobes of the liver. The other major branches of portal vein were the caudal and dorsal branches that passed deeply towards diaphragmatic surface of liver (Figs 2 and 9).

The right branch of portal vein was short but wide trunk that passed from the right caudolateral aspect of portal vein. The right branch of portal vein at its course towards ventral border of the right lobe gave off a number of both large and small branches and finally bifurcates into two terminal branches. The first of these branches is right caudal branch that is a stout branch and supplied caudal part of right lobe. Two small slender branches descend towards quadrate lobe and they partly supplied right lobe next to quadrate lobe. Two more larger branches, namely the dorsal lobar branch and the ventral

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lobar branch extend to small process like lobes on the visceral surface of right lobe of liver. The right ventral branch is another very prominent branch, which run towards caudal border of right lobe and supplies caudoventral area of right lobe. Two large terminal branches are termed the cranioventral branch and the caudoventral branch that subsequently divide into two branches. Their tributaries ramified in the parenchyma of cranioventral and caudoventral part of right lobe (Figs 2, 3 and 9).

The left branch of portal vein was large and the main continuation of portal vein. The left branch of portal vein contained 2 portion namely pars umbilicalis and pars transversus whose branches supplied the most part of liver including left, right, quadrate and papillary process. The pars umbilicalis ran ventrally and then abruptly curved to the left describing an angle of nearly 90 degrees and formed the pars transversus. The length of umbilical portion was 12.2 cm, lie between the right lobe and caudate lobe and give rise to 9 different branches of varying sizes that supply blood to the right, caudate and quadrate lobes. Of these, two small and one large branches ramify in the craniodorsal part of right lobe and 5 large branches supplied the caudate lobe. The 5th branch was termed the left diaphragmatic branch emerged at the junction of pars transversus and pars umbilicalis from the craniodorsal aspect of the umbilical portion and coursed near the diaphragmatic surface of caudate lobe. The last branch named the left ventral branch of pars umbilicalis was a stout branch and continuation of umbilical part that inclined towards ventral border of quadrate lobe. During its course gave off two branches from its caudal aspect to supply caudal part and two branches from its cranial aspect to supply cranial part of the quadrate lobe (Figs 4, 5 and 9).

The length of transverse portion was 9.5 cm and its course was craniodorsal. During its course, it gave off a small branch to visceral surface of cranial part of quadrate lobe, two relatively large branches towards diaphragmatic surface of portal lobe. Finally the transverse portion proximal to the groove between quadrate lobe and left lobe was found divided into three stout terminal branches those are termed the left dorsal branch, the left ventral branch of pars transversus and the left cranial branch (Figs 4, 6, 7 and 9).

The left dorsal branch ran dorsally and subsequently divided into two branches. The first of these two was the caudodorsal branch that supplied caudodorsal area of portal lobe by their tributaries. The second was the craniodorsal branch that was shorter, ran towards the dorsal border of left lobe and supplied craniodorsal area of left lobe by their tributaries (Figs 6 and 7). The left ventral branch of pars transversus extended towards ventral border of quadrate lobe and subsequently divided into two branches namely the caudoventral branch and the cranioventral branch. The caudoventral branch lied in the cranioventral area of quadrate lobe and supplied those area and their small process like lobes. The cranioventral branch was longer and reached the left lobe and their branches supplied area of left lobe next to groove between left lobe and quadrate lobe (Figs 6 and 7). The left cranial branch was larger than the other two branch ran towards the apex of the left lobe. During its course, it gave off 4 large and one slender secondary branches and then was divided into two terminal branches, the latter branches supplied apex of the left lobe and small process like lobes on this area. These 4 large branches were termed as the proximal branch, the distal branch, the intermediate branch and the lobar branch, respectively. The proximal branch ran towards dorsal border of the left lobe and supplied dorsal area of the left lobe, but the distal branch descended towards ventral border of the left lobe parallel to the left ventral branch. The intermediate branch distributed to middle area of craniodorsal part of the left lobe, whereas the lobar branch gave off branches to small process like lobes on the craniodorsal area of the left lobe (Figs 6 and 7).

The caudal branch of portal vein, below caudal process and caudate lobe ran towards renal fossa and ramified into 3 branches towards caudal border of the right lobe, 2 large branches to diaphragmatic surface of caudal process and caudate lobe and then divided into two terminal branches that supplied a part of the right lobe around the renal fossa (Figs 2, 3, 8 and 9).

The dorsal branch of portal vein ascended between caudal process and caudate lobe and papillary process and caudate lobe towards caudal vena cava groove and terminated in several branches. Two of those branches ran to caudal process and caudate lobe and supplied area of

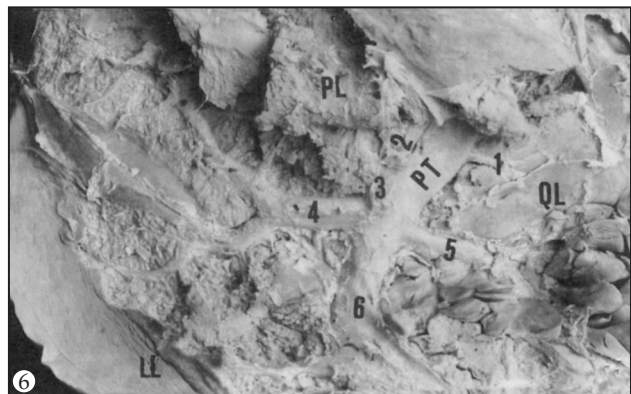
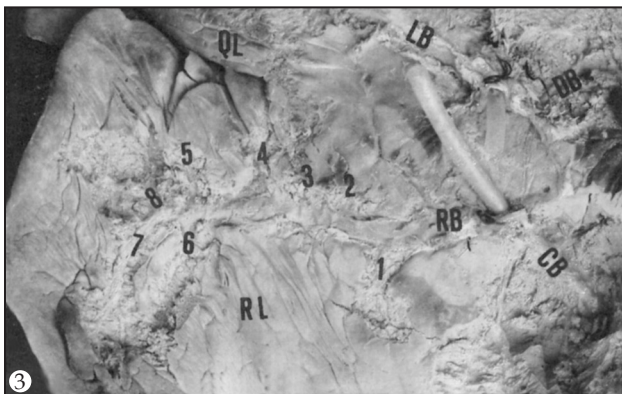
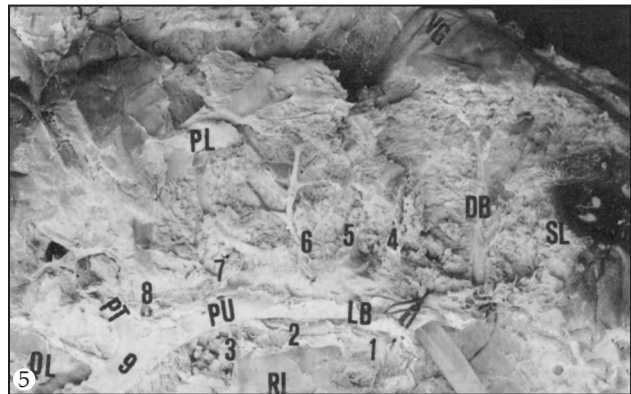
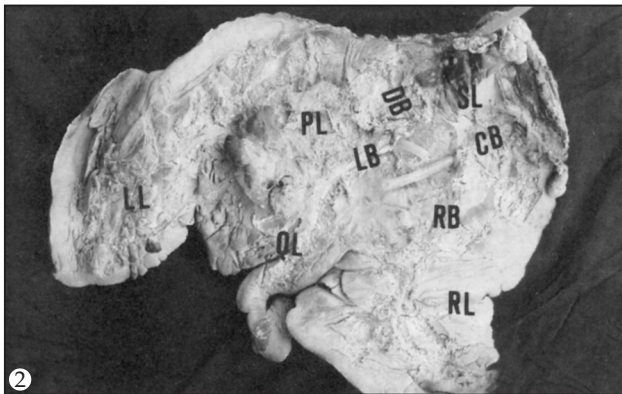
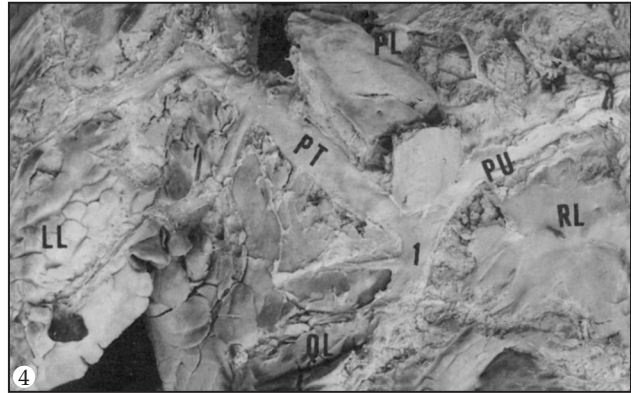
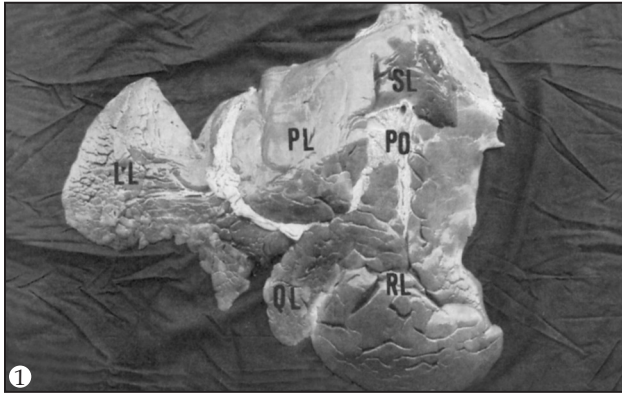


Fig 1. Showing visceral surface of liver in camel, indicated caudate process and caudate lobe (SL), right lobe (RL), quadrate lobe (QL), papillary process and caudate lobe (PL), left lobe (LL) and portal area (PO). **Fig 2.** Showing the major branches of portal vein in camel: right branch (RB), left branch (LB), dorsal branch (DB), caudal branch (CB), caudate process and caudate lobe (SL), right lobe (RL), quadrate lobe (QL), left lobe (LL) and papillary process and caudate lobe (PL) (Gross dissection). **Fig 3.** Gross appearance of the distribution of the right branch of portal vein (RB) in camel: right caudal branch (1), cranial branches (2,3), dorsal lobar branch (4), ventral lobar branch (5), right ventral branch (6), caudoventral branch (7) and cranioventral branch (8). Also showing right lobe (RL) quadrate lobe (QL), dorsal branch of portal vein (DB), left branch of portal vein (LB) and caudal branch of portal vein (CB) (Gross dissection). **Fig 4.** Gross dissection of the left branch showing pars umbilicalis (PU), pars transversus (PT), right lobe (RL), papillary process and caudate lobe (PL), left lobe (LL), left ventral branch of pars umbilicalis (1) and its distribution to quadrate lobe (QL). **Fig 5.** Gross dissection of the distribution of pars umbilicalis (PU) of the left branch of portal vein (LB) including 3 branches (1,2,3) to the right lobe (RL), 4 branches (4,5,6,7) and left diaphragmatic branch (8) to the papillary process and caudate lobe (PL), and left ventral branch (9) to the quadrate lobe (QL). Also showing pars transversus (PT), dorsal branch of portal vein (DB), caudate process and caudate lobe (SL) and caudal vena cava groove (VG). **Fig 6.** Gross dissection of the distribution of pars transversus (PT) of the left branch of portal vein showing one branch (1) to quadrate lobe (QL), two branches (2,3) to papillary process and caudate lobe (PL) and 3 large terminal branches: left dorsal branch (4), left ventral branch (5) and left cranial branch (6). Also showing left lobe (LL).

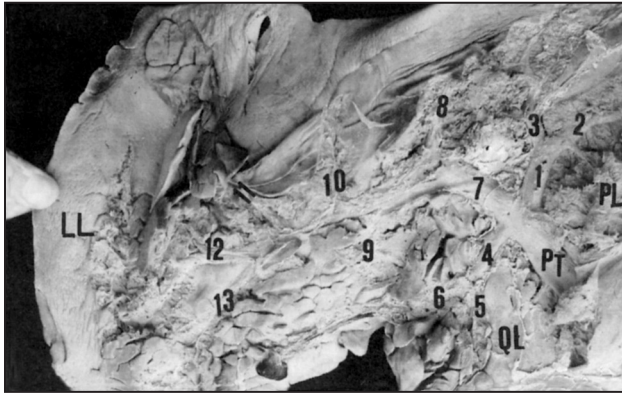


Fig 7. Gross dissection of the distribution of terminal branches of the pars transversus (PT) in the papillary process and caudate lobe (PL), quadrate lobe (QL) and left lobe (LL): the left dorsal branch (1) with its secondary branches including caudodorsal branch (2) and cranio dorsal branch (3). the left ventral branch (4) with its secondary branches including caudoventral branch (5) and cranioventral branch (6). the left cranial branch (7) with its secondary branches including proximal branch (8), distal branch (9), intermediate branch (10), lobar branch (11) and terminal branches (12,13).

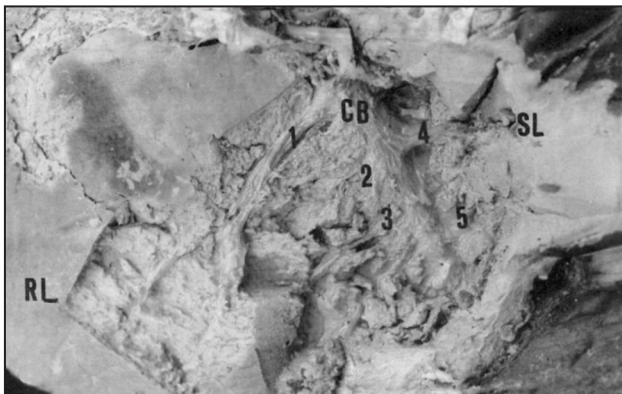


Fig 8. The distribution of the caudal branch of portal vein (CB): showing secondary branches (1,2,3) to right lobe (RL) and (4,5) to caudate process and caudate lobe (SL) (Gross dissection).

this lobe near the papillary process and caudate lobe and caudal vena cava groove. The others extended to papillary process and caudate lobe and supplied the caudal part of papillary process and caudate lobe and the area near caudal vena cava groove in the papillary process and caudate lobe (Figs 2, 3, 5 and 9).

Discussion

Since the hepatic portal circulation is an important exception to the usual arrangement of the systemic circulation, in which an artery breaks up into capillary beds which recombine to

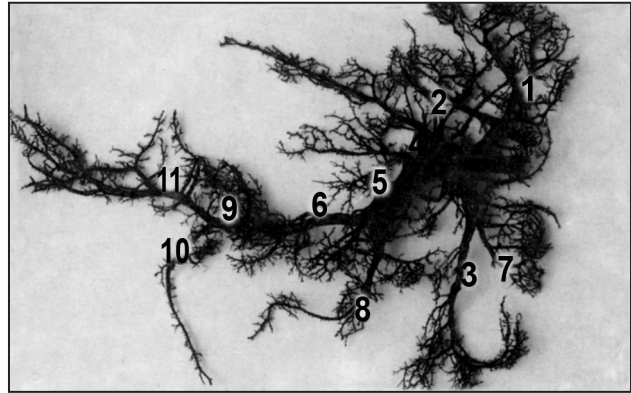


Fig 9. Showing major branches of portal vein and their tributaries in the liver of camel (corrosion - cast): caudal branch (1), dorsal branch (2), right branch (3), left branch (4), pars umbilicalis (5), pars transversus (6), right caudal branch (7), left ventral branch of pars umbilicalis (8), left dorsal branch (9), left ventral branch of pars transversus (10) and left cranial branch (11).

form veins which were direct tributaries to caudal vena cava. It is desirable that blood drained from the digestive tract be exposed to the liver cells before entering the general circulation. This contact permits nutrients to be modified and / or stored in the liver for future use and give the liver a chance to detoxify any harmful substances that may have been absorbed from the digestive tract. The major purpose of this investigation was to give a more precise description of the intrahepatic ramification of portal vein within the hepatic parenchyma in the camel as the normal basis for evaluation of portal venography. These observation revealed that the branches of portal vein in the camel were more complex than the other mammals, 4 main branches namely the left, right, dorsal and caudal branches can be identified. The right branch of portal vein distributed its branches only in the right lobe, whereas the left branch of portal vein supplied greater part of the liver including right, left, quadrate and papillary process and caudate lobes. The caudal branch of portal vein in the camel ramified in the around of renal fossa in the right lobe and also extend branches to the caudate process and caudate lobe, while the dorsal branch of portal vein not only supplied the caudate process and caudate lobe, but supplied the caudal area of the papillary process and caudate lobe and area near caudal vena cava groove. The portal vein in the cow (Williamson, 1967) and dog (Kalt and Stump, 1993) divides immediately upon

entering the liver into a very short right branch and a long left branch, of course in the sheep (Heath, 1968) the portal vein enters the liver porta, and immediately receives small vein from the gall bladder and cystic duct and then divides into the left and right branches. In the rabbit (Heath and House, 1970) the caudate branch emerges from portal vein that extends dorsally and to the right to supply the caudate lobe and then the portal vein continues in a cranioventral direction and divides into a right branch which passes ventrally and a left branch which curves ventrally and to the left. Also Heath and House (1970) reported that in the cat three main branches of the portal vein termed the caudate, right and left branches can be identified. The caudate branch emerges from the dorsal border of the portal vein and passes dorsally and to the right to supply the partly bifurcated caudate lobe. But in the human (Gupta *et al*, 1977) the division of portal vein was always extrahepatic and in 88% of cases it is divided into right and left branches and in 12% of cases it is divided into three branches, out of which two branches supplied the right lobe namely anterior and posterior segmental veins and one branch, corresponding to the left branch, supplied the left lobe.

The right branch of portal vein in the camel was short and ran towards ventral border of the right lobe. Its secondary branches lied for the most part close to the visceral surface and supplied the right lobe and small process like lobes on the right lobe. While in the cow (Williamson, 1967) the right branch divides immediately into four or five secondary branches that supplies the right and caudate lobes and in dog (Kalt and Stump, 1993) the right branch was a short wide trunk that ramifies in the caudate process of the caudate lobe and in the right lateral lobe of the liver. Heath and House (1970) reported that in the cat the right branch supplies that part of the right lobe to the right of the fossa for the gallbladder. Whereas in the sheep (Heath, 1968) right dorsal branches that supply blood to the caudate lobe and the dorsal part of the dorsal lobe emerge from the dorsal surface of either the portal vein at the point of bifurcation, or the proximal part of the right branch. The right branch proceeds ventrally and gives rise to 3 or 4 major branches and a variable number of minor branches which supply a wedge-shaped segment of liver tissue.

The apex of the wedge is at the depression for the gall bladder and the base along the line of the left branch of the portal vein. The right branch of the portal vein in the human was a stout short trunk. It divided into anterior and posterior segmental veins in 88% cases. In 12% cases there was no right branch of the portal vein and the anterior and posterior segmental veins arose directly from the portal vein. However, the right portion of the caudate lobe in 14% of cases and caudate process in 72% of cases received portal branches from the right branch of the portal vein (Gupta *et al*, 1977).

The left branch of portal vein in the camel was a stout and long major branch that supplied most part of liver including right, left, quadrate and papillary process and caudate lobes. This distribution is more or less similar to that of cow and dog. The left branch of portal vein in the camel similar to cow (Williamson, 1967) and human (Gupta *et al*, 1977) was divided for description into the umbilical part and the transverse part. In the camel a parts of quadrate, right and papillary process and caudate lobes received portal blood from secondary branches of umbilical part and secondary branches of transverse part supplied left lobe, quadrate lobe and a part of papillary process and caudate lobe. Whereas the pattern of distribution of these two parts of the left branch is different from the cow and human. In cows (Williamson, 1967) the transverse part gives off many branches to the caudate lobe and a few to the quadrate lobe and the umbilical part gives off branches to the left lobe and quadrate lobe. In human (Gupta *et al*, 1977) the right portion of the caudate lobe receives portal branches from the transverse portion of the left trunk in 68% cases and also the branches to the caudate process occasionally arose from the transverse portion in 12% cases. But the lateral inferior vein arose from left side and medial segmental vein originated from right side of umbilical part which ramified to the area of right lobe. In the sheep (Heath, 1968) the left branch curves ventrally and to the left within a deep depression on the liver surface. Number of small branches leave the cranial surface of the left branch, and supply the portion of the liver in the region of the caudal vena cava. At the level of the umbilical fissure, the left branch divides into dorsal, intermediate and ventral rami that supply left lobe and a part of quadrate lobe. Kalt

and Stump (1993) reported that the large left branch inclined briefly cranial and then abruptly curved to the left. The left branch terminated in 5-7 branches which supplied the right medial, quadrate, left medial and left lateral lobes and the papillary process of the caudate lobe. In its leftward course, it lay in a transverse plane. The left branch in rabbit and cat (Heath and House, 1970) curves ventrally and to the left and in the rabbit it bifurcates into the left medial and left lateral rami to supply the left medial lobe and the region of the right lobe to the left of the relatively deep fossa for the gall bladder. But in the cat it give off about five large rami to the left lateral and left medial lobes and two or three smaller branches to the right lobe to the left of the fossa for the gallbladder. Therefore the distribution pattern of portal vein in the liver of camel is altogether different from other animals and human.

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References

- Carlisle CH, WU JX and Heath TJ (1995). Anatomy of the portal and hepatic veins of the dog: a basis for systemic evaluation of the liver by ultrasonography. *Veterinary Radiology and Ultrasound* 36:227-233.
- Gupta SC, Gupta CD and Arora AK (1977). Intrahepatic branching patterns of portal vein. *Gastroenterology* 72: 621-624.
- Heath T (1968). Origin and distribution of portal blood in the sheep. *American Journal of Anatomy* 122:95-106.
- Heath T and Hous B (1970). Origin and distribution of portal blood in the cat and rabbit. *American Journal of Anatomy* 127:71-80.
- Kalt DJ and Stump JE (1993). Gross anatomy of the canine portal vein. *Anatomy Histology and Embryology* 22: 191-197.
- Yamane TA, Mori K, Sakamoto K, Ikei S and Akagi M (1988). Intrahepatic ramification of the portal vein in the right and caudate lobes of the liver. *Acta Anatomy* 133: 162-172.
- Williamson ME (1967). The venous and biliary system of the bovine liver. Thesis. Ithaca, N.Y, Cornell University.