

Intrahepatic ramifications of the portal vein in the horse

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Summary

The ramifications of the portal vein in the liver of horses were studied by using corrosion casting and gross dissection. The portal vein in the horse supplies the hepatic lobes by six major branches. The right lobe is supplied by three main branches, namely the dorsal diaphragmatic, the right caudodorsal and the right intermediate branches. The left branch supplies the left lateral and medial lobes and parts of the quadrate lobe adjacent to the left medial lobe. The caudate branch supplies caudate process of the caudate lobe. The right common trunk supplies also a part of right lobe and quadrate lobe. Therefore, the pattern of blood distribution in portal vein of horse differs from that of other species.

Key words: Portal vein, Liver, Corrosion-cast, Gross dissection, Horse

Introduction

There is some literature on the intrahepatic ramifications of the portal vein in man (Gupta *et al.*, 1977; Yamane *et al.*, 1988) and some domestic animals such as cow (Williamson, 1967), sheep (Heath, 1968), cat, rabbit (Heath and House, 1970), dog (Kalt and Stump, 1993; Carlisle *et al.*, 1995) and camel (Tadjalli and Akhavan, 2003). Since there was no information on the intrahepatic ramification of hepatic portal vein in horse, this report was conducted to determine the ramification pattern of portal vein in the liver of horse.

Materials and Methods

Six horses were euthanized due to incurable severe traumatic injuries by mixture of acethyl-promazine, thiopental sodium and magnesium sulfide. They were in good physical conditions and were free from liver disorders. Their livers (Fig. 1) were obtained. The portal vein of each liver was then perfused with normal saline. Two different methods of anatomical techniques were employed:

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

2- *Gross dissection:* Into the portal vein of the remaining three livers a preserving fluid was injected. After a suitable interval, colored gelatin was injected in the portal vein and kept submerged in fixative for 72 hrs. Then, the branches of portal vein were dissected.

Results

In horse, the portal vein enters into the porta hepatis on the visceral surface of the liver and close to the visceral surface runs obliquely towards the ventral border of the left lateral lobe. At its course, it gives off five major branches, namely, the caudate branch, the dorsal diaphragmatic branch, the right caudodorsal branch, the right intermediate branch and the right common trunk; it then continues as the left branch.

The caudate branch is the first branch that separates from the right ventral aspect of the portal vein. This branch extends to the conical apex of the caudate process of the caudate lobe and supplies it by several secondary branches (Figs. 2 and 5). The dorsal diaphragmatic branch is short and stout emerges from the right dorsal aspect of the portal vein. This branch passes deeply towards the diaphragmatic surface of the liver and its collateral branches supply the dorsal part of the right lobe near to the dorsal border of the liver (Fig. 6). The right caudodorsal and right intermediate branches separate from the portal vein in a short distance from each other. They are stout and give off a number of small branches along their course towards the right border of the right lobe. Each of them finally bifurcate into two terminal branches which supply the right lobe (Figs. 2, 5 and 6). The right common trunk is a short but wide trunk that immediately divides into two stout branches, namely, the right caudoventral branch and the quadrate branch. The right caudoventral branch runs towards the right border of the right lobe and at its course gives off one short and a number of slender secondary branches that supply the ventral part of the right lobe. The quadrate branch descends towards the quadrate lobe of the liver and it ramifies into two segments of the quadrate lobe (Figs. 2 and 6).

The left branch of the portal vein is very prominent and the main continuation of portal vein. This branch supplied most part of the liver in horse including the left lateral lobe, left medial lobe and the distal segment of the quadrate lobe. The left branch of the portal vein runs towards the ventral border of liver which at its course gives off seven large and a numerous small slender branches and finally bifurcates into two terminal branches. The terminal branches passes next to the ventral border of the left lateral lobe and supplied that area (Figs. 3, 4, 5 and 6). The first branch is the left craniodorsal branch that emerges from left aspect of the left branch of the portal vein. It is a long and stout branch and inclines towards the left border of the left lateral lobe. During its course, it gives off four large and four small slender branches to supply the visceral surface of the dorsal part of the left lateral

lobe, and two relatively small branches that passes deeply towards the diaphragmatic surface to supply parts of the left lateral lobe next to the left border (Fig. 4). The second branch of the left branch of the portal vein is the left medial branch which is long and descends towards the ventral border of the left medial lobe. During its course, it gives off three branches to supply the left medial lobe and one deep branch and then divided into two branches. The deep branch passed towards the diaphragmatic surface to supply the left medial lobe adjacent to the quadrate lobe (Figs. 3, 5 and 6). The third and fourth branches of the left branch of the portal vein proceed to the extremity of the distal segment of the quadrate lobe that supplied it by their tributaries (Fig. 3). The fifth branch, the so-called "left intermediate branch," emerges from the left aspect of the left branch of the portal vein approximately at the middle of left lateral lobe. This is a short branch and its tributaries supply the middle part of the left lateral lobe (Fig. 4). The sixth and seventh branches—the left caudoventral branch and left cranioventral branch—emerge opposite to each other from the left branch of the portal vein at the distal third of the left lateral lobe. They supply the area of the distal third of the left lateral lobe next to the ventrolateral border (Figs. 4, 5 and 6).

Discussion

The main purpose of this study was to convey a more precise explanation of the intrahepatic ramifications of the portal vein within liver of horse as the normal basis for evaluation of portal venography. This investigation revealed that the branching pattern of portal vein in liver of horse is different from other mammals. In horse, six main branches, namely the caudate, dorsal diaphragmatic, right caudodorsal, right intermediate, right common and left branches can be identified. The portal vein in 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. In sheep (Heath, 1968), the portal vein enters the liver porta and immediately receives a small vein from the gallbladder and the cystic duct and then divides into the left and right branches.

Fig. 1: Visceral surface of liver in horse indicating caudate process of caudate lobe (CA), right lobe (RL), quadrate lobe (QL), left medial lobe (LM), left lateral lobe (LL) and portal vein (PV)

Fig. 2: Gross dissection of the branches of portal vein: the caudate branch (1), right caudodorsal branch (2), right intermediate branch (3), right common trunk (4), right caudoventral branch (5), quadrate branch (6) and left branch (7)

In rabbit (Heath and House, 1970), the caudate branch emerges from the portal vein that extends dorsally to the right to supply the caudate lobe. The portal vein, then 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. Heath and House (1970) reported that in cat, three main branches of the portal vein, the so-called

Fig. 3: Gross dissection of the distribution of the left branch (1) of portal vein in the quadrate lobe (QL) and left medial lobe (LM): branch to the distal segment of quadrate lobe (2), left medial branch (3), quadrate branch (4) and left lateral lobe (LL)

Fig. 4: Gross dissection of the distribution of left branch (1) of portal vein in the left lateral lobe (LL): left craniodorsal branch (2), left intermediate branch (3), left cranioventral branch (4), left caudoventral branch (5) and terminal branches (6 and 7)

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. In human

(Gupta *et al.*, 1977), the division of the portal vein was always extrahepatic and in 88% of cases it is divided into the right and left branches; in 12% of cases, it is divided into three branches out of which two

Fig. 5: Branches of the portal vein and their tributaries in liver of horse (corrosion-cast): portal vein (PV), caudate branch (1), right caudodorsal branch (2), right intermediate branch (3), right caudoventral branch (4), left branch (5), left medial branch (6), left cranioventral branch (7) and terminal branches of the left branch (8 and 9)

Fig. 6: Branches of the portal vein and their tributaries in liver of horse (corrosion-cast): portal vein (PV), left branch (LB), dorsal diaphragmatic branch (1), right intermediate branch (2), right common trunk (3), left medial branch (4), left caudoventral branch (5) and left cranioventral branch (6)

branches—the anterior and posterior segmental veins—supply the right lobe and one branch, corresponding to the left branch, supplied the left lobe. Tadjalli and Akhavan

(2003) reported that in camel four main branches of the portal vein namely the left, right, dorsal and caudal branches, can be identified; the caudal branch ramifies around

the renal fossa in the right lobe and to the eschpigne lobe, while the dorsal branch supplies the eschpigne lobe, caudal area of the portal lobe and area near caudal vena caval groove.

In camel (Tadjalli and Akhavan, 2003) the right branch of portal vein is short and runs towards the ventral border of the right lobe. Its secondary branches lie for the most part close to the visceral surface and supply the right lobe and small process like lobe on the right lobe. In cow (Williamson, 1967), the right branch divides immediately into four or five secondary branches that supply the right and caudate lobes. 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 cat the right branch supplies that part of the right lobe to the right of the fossa for the gallbladder. In sheep (Heath, 1968), the 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 from the proximal part of the right branch. The right branch proceeds ventrally and gives rise to three or four 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 gallbladder and the base along the line of the left branch of the portal vein. The right branch of the portal vein in the human is a stout short trunk. It divides into the anterior and posterior segmental veins in 88% of cases. In 12% of cases, there are no right branch of the portal vein and the anterior and posterior segmental veins arise directly from the portal vein. However, the right portion of the caudate lobe in 14% of cases and caudate process in 72% of cases receive portal branches from the right branch of the portal vein (Gupta *et al.*, 1977).

This distribution is different from that of camel (Tadjalli and Akhavan, 2003), cow (Williamson, 1967) and dog (Kalt and Stump, 1993); in these animals, the left branch supplies the right, left and quadrate lobes, and also the caudate lobe in cow and dog and portal lobe in camel. On the other

hand, the left branch of the portal vein in camel (Tadjalli and Akhavan, 2003), cow (Williamson, 1967) and human (Gupta *et al.*, 1977) is divided into the umbilical part and the transverse part. In camel, the quadrate lobe, right lobe and portal lobe receive portal blood from secondary branches of the umbilical part and the secondary branches of transverse part supply the left lobe, quadrate lobe and a part of portal lobe. In cow (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% of cases. The branches to the caudate process occasionally arise from the transverse portion in 12% of cases. However, the lateral inferior vein arises from the left side and medial segmental vein originated from the right side of the umbilical part that ramifies to area of the right lobe. In sheep (Heath, 1968), the left branch curves ventrally and to the left within a deep depression on the liver surface with a number of small branches leave the cranial surface of the left branch that 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 the left lobe and a part of the quadrate lobe. Kalt and Stump (1993) reported that in dog, the large left branch inclines briefly cranially and then abruptly curves to the left and terminates in 5-7 branches which supply the right medial, quadrate, left medial and left lateral lobes and the papillary process of the caudate lobe; in its leftward course, it lays in a transverse plane. In rabbit and cat (Heath and House, 1970), the left branch curves ventrally and to the left. In 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 gallbladder. In cat, it gives 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 intrahepatic ramification

patterns of portal vein in liver of horse are different from other animals and human.

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