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Study on the variations of structures of porta hepatis of liver in South Indian population

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Abstract

Introduction: The porta hepatis is bounded anteriorly by the quadrate lobe and posterosuperiorly by the caudate lobe. The hepatic artery with the autonomic plexus around it and the portal vein enter the liver through the porta hepatis, while the two hepatic ducts and some lymphatics emerge out from the liver through it. The porta hepatis of the liver is a very important area surgically. The knowledge of the variations in the structures passing through the porta hepatis might be of great help in reducing the risks of surgery in this area.

Materials and Methods: The study was conducted in the Department of Anatomy of our institution after obtaining the ethical clearance. 87 liver specimens in the Department were used for the study. The liver specimens will be removed during routine dissection for medical undergraduate teaching and would be preserved in 10% formalin.

Conclusion: The incidence of variations in the portal venous system can be of prime surgical and radiological importance for portocaval anastomosis and to study hemodynamic flow radiologically. This study highlights the various possible combinations of the structures at the porta hepatis and is thereby useful for the radiologists and surgeons dealing with this region.

Keywords: porta hepatis, bile duct, portal vein, hepatic artery

Introduction

The liver is the largest gland in the human body. It is situated in the upper right quadrant of the abdomen below the right dome of the diaphragm. The inferior surface of the liver contains a deep fissure called porta hepatis. The porta hepatis is about 2 inches long transversely and is devoid of peritoneum. However the margins of the porta hepatis give attachment to the lesser omentum^[1].

Porta hepatis transmits important neurovascular structures and hence it acquires great importance while carrying out clinical procedures like liver transplant, surgical interventions, and diagnostic radiological procedures which can be associated with complications^[2]. Knowledge and variations of hepatic system of is essential to minimize morbidity encountered during hepato-biliary surgeries^[3].

Variants of hepatic duct confluence are frequently involved and injured during major hepatic surgery and seriously complicate postoperatively all patients due to delay of diagnosis and on-going intra-abdominal sepsis. Hence, this study was conducted to observe the variations on the arrangement of structures of porta hepatis of liver.

Materials and Methods

The study was conducted in the Department of Anatomy of our institution after obtaining the ethical clearance. 87 liver specimens in the Department were used for the study. The liver specimens will be removed during routine dissection for medical undergraduate teaching and would be preserved in 10% formalin. The morphological variations of the number and arrangement of structures of porta hepatis of liver were noted. The hepatic artery, portal vein and the bile ducts were studied with a special interest to note their number and position in relation to each other at the porta hepatis. Photographs were taken to document the variations. The results obtained were then tabulated. Descriptive statistics was used to analyse the data and extract important information using SPSS.

Study design: Prospective descriptive study

Study period: January 2021 to February 2021

Results

The arrangement of the structures in the porta hepatis was constant. The ducts were anterior; the arteries in the middle and the veins were posterior in the porta hepatis in most of the livers studied. The number varied from one to three for the duct and vein but for the artery it was between one and four (Figure 1).

In 50% of livers, only one vein and in 52% of cases only one duct and in 20% of cases 1 artery passed through the porta hepatis. In 35% of cases two arteries passed through the porta hepatis. Combinations of veins, arteries and ducts were observed. (Table 1 & Table 2)



Fig 1: Liver showing structures of Porta Hepatis with two ducts, 1 artery and two veins and an enlarged view of porta hepatis structures

Table 1: shows the number of ducts, veins and arteries passing through the porta hepatis and the frequency of their occurrence

Number of structures	Number of livers	Percentage
1 duct	52	60
2 ducts	24	28
3 ducts	14	16
1 artery	20	23
2 artery	35	40
3 artery	22	25
4 artery	15	17
1 vein	50	57
2 vein	45	52
3 vein	10	11

Table 2: shows various combinations of veins, arteries and ducts passing through the porta hepatis

Variations in combinations	Number of livers
1 vein, 1 artery, 1 duct	15
1 vein, 2 arteries, 1 duct	30
1 vein, 3 arteries, 1 duct	4
2 veins, 1 artery, 1 duct	6
2 veins, 2 arteries, 1 duct	11
2 veins, 2 arteries, 2 ducts	10
2 veins, 3 arteries, 1 duct	2
2 veins, 3 arteries, 2 ducts	2
2 veins, 4 arteries, 1 duct	2
2 veins, 4 arteries, 2 ducts	2
2 veins, 4 arteries, 3 ducts	1
3 veins, 2 arteries, 2 ducts	1
3 veins, 4 arteries, 1 duct	1

Discussion

The number and arrangement of structures in the porta hepatis varies greatly and it is important for surgeons and radiologists to be knowledgeable about the variations. Though there are many studies on the variations of biliary system, hepatic artery and portal vein, the studies on the number and arrangement of the structures at the porta hepatis are still deficient [1].

The arrangement of the structures in the porta hepatis was constant. The ducts were anterior; the arteries in the middle and the veins were posterior in the porta hepatis of all the livers studied. The number varied from one to three for the duct and vein but for the artery it was between one and four. In 51% of livers, only one vein and in 80% of cases only one duct passed through the porta hepatis. In 56% of cases two arteries passed through the porta hepatis. Porta hepatis of only one liver had two ducts, 2 veins and 2 arteries passing through its porta hepatis [1]. In the present study, in 50% livers, only one vein and in 52% of cases only one duct and in 20% of cases 1 artery passed through the porta hepatis. In 35% of cases two arteries passed through the porta hepatis. Combinations of veins, arteries and ducts were observed in our study.

Variants are frequent and account for 20 to 35% of the population. The most frequent variants are portal trifurcation with division of the main portal vein into the left, right anterior, and posterior branches, and the early origin of the right posterior branch directly from the portal vein. The presence of portal vein variants increases the risk of bile duct hilar anatomical variation. These variants must be diagnosed before complex hepatectomy, split or living donor transplantation, and before complex interventional procedures such as portal vein embolization [1].

In a study by Koc *et al.* (2007) incidence of overall variations of portal vein was as high as 27.4%. The rate of main portal vein branching variation was 21.5%, right portal vein variation was 3.9%, and segmental portal vein origin traversing the interlobar boundary was 4% [1].

In the present study, branching pattern of portal vein was observed in 29% slightly more compared to the previous studies. The rate of main portal vein branching variation was 22% and right portal vein variation was 5%.

Kouadio *et al.* (2011) have reported a case of absence of portal vein bifurcation and in 51% of the livers the portal vein did not bifurcate before entering the liver substance [1].

In the current study, 45% of the livers, the portal vein did not bifurcate before entering the liver substance.

In a study by Chaib (2009) the portal vein trunk divided into right and left branches in 83.3% of cases and trifurcated in 15.2% cases [1].

Sapna M *et al* found bifurcation in 44% of cases and trifurcation in 5% of cases [1].

In the present study, bifurcation was seen in 50% of cases and trifurcation in 5% of cases.

Dhanalaxmi *et al* observed the most common combination to be two veins, two arteries, and one duct in 36% of specimens. Portal vein showed bifurcation in 72% of specimen which was highest followed by single vein in 26% and maximum number of veins as four which was seen in 2% of specimen. Trifurcation of vein was not observed in their study [2].

Mohammed Ali Belilo observed hepatic artery originating as common hepatic (by common stem) in 76.9% of cases and the left and right hepatic separately (by division) in 23.1% of cases. The right hepatic originated from celiac trunk in 76.9% of cases and from superior mesenteric in 17.9% of cases and from abdominal aorta 5.1% of cases. The left hepatic artery divided from common hepatic in 76.9% of cases or originated from celiac in 15.4% of cases and from left gastric in 7.7% of cases [3].

The PV had normal standard pattern in 30% cases and the rest 70% showed variations in one or the other form. The splenic vein was variant in 76.6% cases. The superior mesenteric vein showed variation in 73.3% cases. The mode of termination of the inferior mesenteric vein was variable in 60% of cases [4].

The variations in portal vein anatomy are few compared to those

in the anatomy of bile ducts and hepatic arteries. In addition, the sub segments of the liver are primarily determined on the basis of the branching of the portal vein and therefore are an important for planning and performing liver resection. In particular, portal vein anatomy is extremely important during systemic sub segmentectomy for treating hepatocellular cancer [5].

Among the Indian studies, Sharmila *et al* studied on the South Indian population, the incidence being 15% in 40 specimens. Bharath *et al* revealed 26.7% out of 30 specimens in North Indian population. Accessory hepatic duct arising from the right lobe of the liver is 9 times more common than that from left lobe of the liver [6].

Anatomical knowledge of variants of hepatic artery is required to reduce the iatrogenic complications in hepatobiliary surgeries, surgical management of liver trauma, and aneurysm of hepatic artery, hepatic arterial infusion chemotherapy, liver transplant surgery, pancreaticoduodenectomy, radical gastrectomy, and such other surgeries of this complex anatomical region. These variants are relevant in cholecystectomy because they affect the laparoscopic appearance of porta hepatis [7].

Extreme vasculobiliary injuries which involve major hepatic arteries and portal veins are rare, but have severe consequences, including liver infarction, which is not uncommon, often with rapid onset and frequently necessitating emergency right hepatectomy or urgent liver trans-plantation, in addition to various degrees of hepatic ischemia with subsequent liver necrosis, abscess formation, acute liver failure or secondary biliary cirrhosis. It is worth mentioning that among the structures involved in this type of injury, i.e., extrahepatic bile ducts, the hepatic arteries and portal vein, the latter is most likely to lead to a fatal outcome [8].

Portal vein, hepatic artery and bile duct anatomical variants were found in 11%, 25% and 25% of 407 donors respectively. These rates were consistent with the previously reported rates of 8.3–30% in living liver donors, 16.8–46% in patients undergoing liver resection, and 28–44% in radiological imaging studies [9].

During hepatic transplant, care should be taken while clearing the cystic and bile duct especially to preserve their blood supply. The replaced, aberrant and multiple hepatic arteries should be looked for and if present proper care should be taken to avoid post-operative ischemia and haemorrhage [10].

Conclusion

The incidence of variations in the portal venous system can be of prime surgical and radiological importance for portocaval anastomosis and to study hemodynamic flow radiologically. An accurate knowledge of the variations in the hepatic duct confluence is essential for successful living donor liver transplantation. This study highlights the various possible combinations of the structures at the porta hepatis and is thereby useful for the radiologists and surgeons dealing with this region.

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