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Original Research Article

Anatomical Variants of Portal Vein Branching in CECT Scan of Abdomen: A Descriptive Study

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ABSTRACT:

Introduction: Various anatomical variants are encountered in portal venous system which are quite important while undergoing hepatobiliary surgeries and percutaneous radiological interventions. Contrast enhanced computed tomography (CECT) of the abdomen is considered a better imaging modality to identify these variations. **Methods:** A descriptive prospective study was conducted in 1000 individuals undergoing CECT of abdomen. Triple phase CECT scan of the abdomen was done and the portal vein anatomy was reconstructed and analyzed. **Results:** Normal branching pattern of the portal vein was seen in 786 (78.6%) patients. Variations were seen in rest of the 214 (21.40%) patients. The most common variant was trifurcation of the portal vein seen in 113 (11.3%) patients. Right posterior portal vein as the first branch of main portal portal vein was found in 72 (7.2%) patients. Right anterior portal vein arising from left portal vein was seen in 29 (2.9%). Sixty nine of the 567 males had trifurcation accounting for 12.1% incidence of this variation amongst males. Trifurcation was seen in 44 of the 433 females resulting in an incidence of 10.1%. Forty-four (7.7%) males and 28 (6.4%) females had right posterior portal vein as the first branch of main portal vein. Right anterior portal vein was noted to arise from the left portal vein in 20 (3.5%) males and nine (2.07%) females. **Conclusion:** The most common variation in portal venous system was trifurcation of portal vein followed by right posterior as first branch and right anterior branch arising from left portal vein respectively.

Keywords: Anatomical Variants; Computed tomography; Portal vein

INTRODUCTION:

The portal vein (PV) is formed by the confluence of the splenic and superior mesenteric veins, and drains directly into the liver, contributing to approximately 75% of its blood flow.[1,2] Normally the main PV divides into right and left portal veins. [1] The left portal vein (LPV) is horizontal for a short distance before it turns cranially and branches, supplying Couinaud hepatic segments I, II, III, and IV. The right portal vein (RPV) subdivides into anterior and posterior branches; the anterior one supplying segments V and VIII, and the posterior branch supplying segments VI and VII.[1,3] The anatomy of PV and its branches can be assessed by different imaging modalities like Ultrasonography (USG), Contrast Enhanced Computed Tomography (CECT) and Magnetic Resonance Imaging (MRI) of abdomen. Delineation of anatomy from USG can be limited owing to patient and performer's factors and MRI, because of the cost and time, is seldom used for the same. Thus, CECT of the abdomen is considered better among these options in the evaluation of the portal venous anatomy.

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This study aimed to evaluate different anatomical variations of the portal vein and its branches. Since various hepatic interventional procedures have significantly progressed over the past years, the meticulous knowledge of anatomy of the portal venous system is a must prior to performing these procedures.

METHODS:

This was a descriptive prospective study conducted in 1000 individuals of all ages undergoing CECT of abdomen in the Department of Radio-diagnosis and Imaging at Dhulikhel Hospital, Kavre from January 2020 to January 2021. Individuals with history of major upper abdominal surgery involving liver, pancreas, biliary tree, stomach and duodenum were excluded. Similarly, those with known tumors in the upper abdomen involving liver, pancreas, biliary tree, stomach and duodenum were also not enrolled.

Ethical approval was granted by Institutional Review Committee (Approval no. 73/20). Convenience sampling technique was used. Informed consent was taken from each patient. The details about objectives and protocol of the study were explained to patients. A clinical data proforma was filled up. Siemens 128 slice CT scanner was used. Triple phase CECT scan of the abdomen was done. A non-contrast scan was then performed initially to cover the abdomen. Iohexol, an iodinated low osmolar contrast media containing 350mgI/100 ml of the solution was then administered via an intravenous cannula from the ante-cubital vein using a pressure injector. The rate of injection of the contrast media ranged between 3-5ml/sec and the amount to be administered was calculated based upon the weight of individuals (1-2 ml/kg body weight). CT scanning was then done in axial sections and images were acquired after contrast administration. The parameters used were hepatic arterial, portal venous and delayed phases with enhancement threshold set at 100 Hounsfield Unit (HU). Additional image reformation was done in sagittal and coronal sections. Maximum Intensity Projection (MIP) image demonstrating the portal vein anatomy was reconstructed in coronal section.

The portal venous anatomy and variants were recorded and analyzed. Type 1 categorization was done when the main portal vein divided into LPV and RPV and RPV then divided into right anterior portal vein (RAPV) and right posterior portal vein (RPPV). Main portal vein (MPV) trifurcating into LPV, RAPV, and RPPV was accepted as Type 2. Likewise, Type 3 variant was defined as RPV arising as first branch of MPV and Type 4 variant as RAPV arising from LPV.

All the data were compiled in the excel spreadsheet and statistical analysis was done using IBM Statistical Program for Social Science (SPSS) software version 20.

RESULTS:

Out of 1000 patients enrolled into the study, 567 were males (56.7%) and 433 were females (43.3%). The mean age ± SD was 33.4 ± 2.17 years (range: 1-85 years).

Anatomical variations in the branching of the portal vein were studied in these patients and incidence was calculated in relation to gender. Type I branching pattern of the portal vein was seen in 786 (78.6%) patients (Figure 1). Variations were seen in rest of the 214 (21.40%) patients. The most common variant was type II which was observed amongst 113 (11.3%) patients (Figure 2). Seventy-two (7.2%) patients had type III variation (Figure 3) and twenty-nine (2.9%) patients had type IV variation (Figure 4) (Table 1).

Fig 1. Axial CT scan showing normal branching pattern of portal vein.

Among 786 patients who had normal branching of the portal vein, 443 were males and 343 were females. Normal branching pattern of the

Fig 2. Axial CT scan showing trifurcation of portal vein.

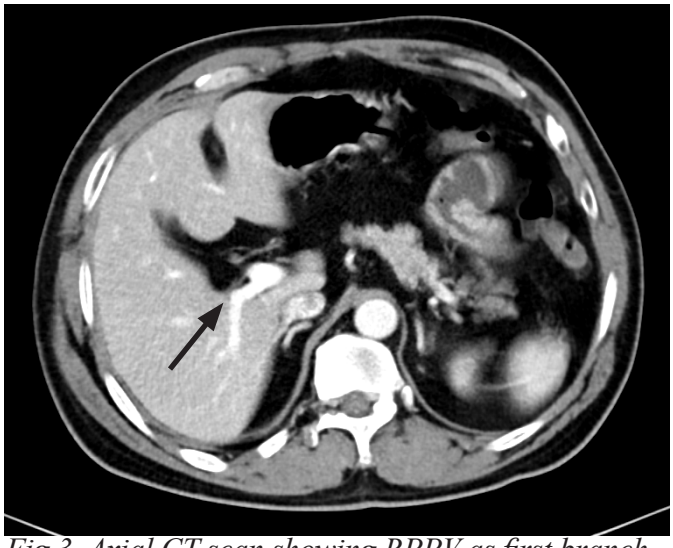

Fig 3. Axial CT scan showing RPPV as first branch of portal vein.

Table 1. Various branching patterns of the portal vein (N=1000).

Type	Branching pattern	Frequency (%)
I	Normal Branching Pattern	786 (78.60)
II	Trifurcation of portal vein	113 (11.30)
III	Right posterior portal vein as first branch of portal vein	72 (7.20)
IV	Right Anterior Portal Vein arising from Left Portal Vein	29 (2.90)

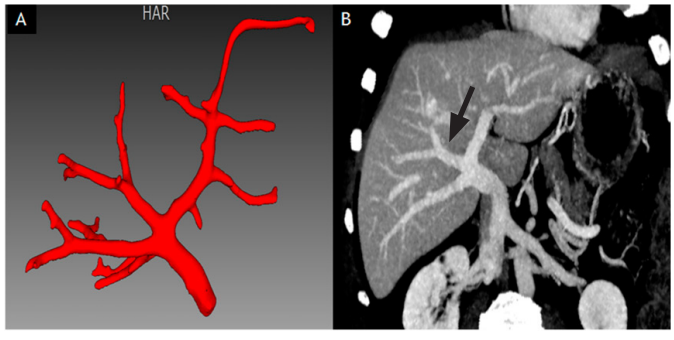

Fig 4. Coronal-oblique maximum intensity projection image showing corresponding right anterior portal vein arising from left portal vein.

portal vein was seen in 78.1% of the males and 79.2% females. Sixty nine of the 567 males had trifurcation accounting for 12.1% incidence of this variation amongst males. Trifurcation was seen in 44 of the 433 females resulting in an incidence of 10.1%. Forty-four (7.7%) males and 28 (6.4%) females had right posterior portal vein as the first branch of main portal vein. Right anterior portal vein was noted to arise from the left portal vein in 20 (3.5%) males and nine (2.07%) females (Table 2).

DISCUSSION:

The portal vein is a major vascular structure that needs to be evaluated in all the abdominal CT scans performed. A thorough knowledge about the normal anatomy and spectrum of congenital variations of the portal venous system is essential for hepatobiliary surgeons and interventional radiologists in order to avoid major catastrophic events during the planned procedures. Awareness of portal venous branching anatomy is important in planning liver surgery so as to ensure that portal perfusion to the future liver remnant is not compromised. It is also important in liver transplantation to enable appropriate graft selection so as to avoid complex anastomosis that might compromise the graft or the residual liver. It is also crucial while performing percutaneous interventional procedures.[1,4,5,6]

Table 2. Branching pattern of the portal vein in relation to sex (N=1000).

Type	Branching pattern	Males (n=567)	Females (n=433)
		Frequency (%)	Frequency (%)
I	Normal branching pattern	443 (78.1)	343 (79.2)
II	Trifurcation of portal vein	69 (12.1)	44 (10.1)
III	Right posterior portal vein as first branch of portal vein	44 (7.7)	28 (6.4)
IV	Right anterior portal vein arising from left portal vein	20 (3.5)	9 (2.07)

The incidence of typical branching pattern of the main PV has been reported to be 65 to 80% in previous studies.[1,3,5] In the current study also, the normal branching pattern of portal vein was seen in 78.6% patients which is similar to those studies.

The variations in portal vein morphology have been documented as 20–35% by many authors.[1,2,6,7] The most common patterns reported were trifurcation of the main portal vein (7.8–10.8%), right posterior segmental branch arising from the main portal vein (4.7–5.8%), and right anterior segmental branch arising from the left portal vein (2.9–4.3%).[4,9,10] We observed anatomical variations in 21.40%. However, we report a slightly higher incidence of trifurcation of the portal vein (11.3%), right posterior portal vein arising from the first branch of main portal vein (7.2%) and right anterior portal vein arising from the left portal vein (2.9%). Our observations were different from another author which showed a common RAPV–LPV trunk was almost 2.5 times more common than trifurcation.[11]

CONCLUSION:

The most common variation in portal venous branching pattern was trifurcation of portal vein followed by right posterior as first branch and right anterior branch arising from left portal vein respectively. Meticulous knowledge of the variations in portal venous anatomy is mandatory before graft procurement during liver transplantation, placement of transjugular intrahepatic portosystemic shunts, portal venous embolization, and localization and resection of hepatic tumors.

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Conflict of Interest: The authors declare that no competing interests exist.

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