

## ORIGINAL ARTICLE

**A Cadaveric Study of Portal Vein Termination and Its Surgical Relevance***Shilpa N. Gosavi<sup>1\*</sup>, Surekha D. Jadhav<sup>2</sup>, Rajendra S. Garud<sup>1</sup>*

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**Abstract:**

**Background:** The Portal Vein (PV) is formed from the convergence of the superior mesenteric and splenic vein posterior to the neck of the pancreas. At porta hepatis it divides into right and left main branches. **Aim and Objectives:** The study was conducted to note the level and types of termination of portal vein in Indian livers. **Material and Methods:** The level of termination of portal vein was classified as extrahepatic, capsular and intrahepatic in seventy seven normal adult human cadaveric livers. The type of termination of PV was noted and classified according to the classification suggested by Atasoy and Ozvurek. Length of extrahepatic part of right and left branch of portal vein was measured with the help of digital vernier caliper. **Results:** Termination of PV was observed as extrahepatic in 89.61%, Intrahepatic in 3.89% and capsular in 6.49%. Bifurcation was observed in 97.41% and trifurcation in 2.49%. Mean length of the extrahepatic part of right branch of portal vein was observed as  $1.38 \pm 0.38$  cm while length of left branch of portal vein was observed as  $1.91 \pm 0.73$ cm. **Conclusion:** Pre-surgical awareness of variant portal venous anatomy is important before graft procurement in liver transplantation, hepatic tumor resection, placement of Transjugular Intrahepatic Porto-systemic Shunts (TIPS) and PV embolization.

**Keywords:** Portal Vein, Transjugularintrahepaticporto-systemic shunts, Bifurcation

**Introduction:**

The Portal Vein (PV) begins at the level of second lumbar vertebra and is formed from the convergence of the superior mesenteric and splenic vein. It is approximately 8 cm long and lies anterior

to the Inferior vena cava and posterior to the neck of the pancreas. It lies obliquely to the right and passes behind the first part of the duodenum, the common bile duct and the gastroduodenal artery. At this point it is directly anterior to the inferior vena cava. It enters the right border of the lesser omentum, ascends anterior to the epiploic foramen to reach the right end of porta hepatis and then divides into right and left main branches which accompany the corresponding branches of the hepatic artery into the liver [1]. The PV usually terminates by bifurcating into the right and left PV branches. Other termination patterns include a bifurcation into a common left PV trunk and the right anterior PV trunk; trifurcation; and quadrifurcation [2, 3]. These terminations may be extracapsular, capsular, or intrahepatic [4]. Atasoy and Ozvurek [2] classified the branching pattern of the PV as follows: Type 1 - conventional bifurcation; Type 2 - variant bifurcation in which the PV gave the right anterior PV and a common trunk from which arose the left PV and right posterior PV; Type 3 - trifurcation into the right anterior, right posterior and the left portal veins. In addition, Munguti *et al.* [5] added the type 4, that is: quadrifurcation if it gave, besides the branches observed in Type 3, a branch to the caudate lobe whose diameter was at least a third of that of the PV [5].

Transjugular Intrahepatic Porto-systemic Shunt (TIPS) have been accepted in Asian countries as a definite and permanent treatment for portal

decompression [6]. The procedure is done by means of a percutaneous puncture of the right internal jugular vein. Structures are located by fluoroscopy and ultrasonography. Using a modification of the Seldinger technique, a guide wire is inserted into an intrahepatic branch of a hepatic vein. A needle is advanced over the guide wire through the substance of the liver into a nearby branch of the portal vein. The resulting tract is dilated with a balloon. An expandable stent of 8 to 10 mm in diameter is positioned to maintain patency of the communication between hepatic and portal veins. A patent portal vein is necessary for the performance of TIPS [7].

Pre-surgical awareness of variant portal venous anatomy is important before graft procurement in liver transplantation, hepatic tumor resection, and placement of TIPS and for accurate tumour localization [2].

#### Material and Methods:

The bifurcation of portal vein was studied in seventy seven normal adult human cadavers of unknown age and sex from two medical colleges. Livers with any anomaly or cirrhosis were not included in the study. Portahepatis was dissected to note the level and type of portal vein

termination. The level of termination was classified as extrahepatic, capsular and intrahepatic. The type of termination of PV was noted as per the classification suggested by Atasoy and Ozvurek [2]. Length of the extrahepatic part of the right and the left branch of portal vein was measured with the help of digital vernier caliper accurate up to 0.01 mm. Mean, standard deviation and percentage was calculated for the data.

#### Results:

In the present study of seventy seven adult normal cadaveric livers, termination of PV was observed as extrahepatic in 89.61% (n= 69) livers, Intrahepatic in 3.89% (n= 03) and at the capsule in 6.49% (n =05) livers.

In majority of cases (97.41%) termination of PV was by bifurcation (Type 1) into right and left PV branches. Trifurcation was present in 02 cases (2.59%) which were similar to Type 3 as per the classification by Atasoy and Ozvurek [2]. We did not observe any liver in this study, with Type 2 or Type 4, suggested by Munguti *et al.* [5].

Mean length of the extrahepatic part of Right Branch of Portal Vein (RPV) was observed as  $1.38 \pm 0.38$  cm while length of the Left Branch of Portal Vein (LPV) was observed as  $1.91 \pm 0.73$ cm.

**Table 1: Showing Incidence of Levels of Termination of Portal Vein**

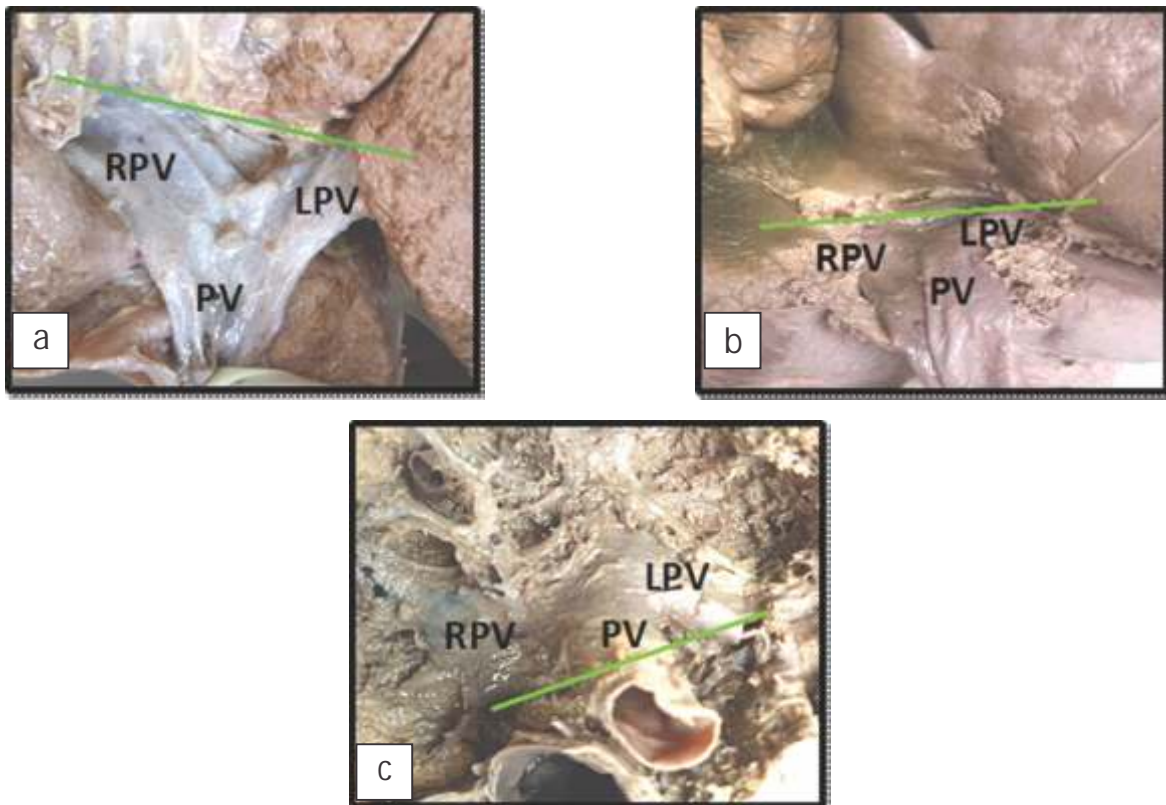
Termination of PV (%)			
	Intrahepatic	Extrahepatic	Capsular
<b>Present study</b>	3.89	89.61	6.49
<b>Munguti <i>et al.</i> [5]</b>	14	14	40
<b>Madoff <i>et al.</i> [8]</b>	26	48	26
<b>Kwok <i>et al.</i> [11]</b>	53	47	-
<b>Murphy <i>et al.</i> [12]</b>	-	47	-
<b>Schultz <i>et al.</i> [4]</b>	-	74.2	-

PV - Portal Vein

**Table 2: Table showing Comparison of Incidence (%) of Various Types of Branching Pattern of PV Depending on Classification Suggested by Atasoy and Ozvurek [2]**

	Type I	Type II	Type III	Type IV
Present study	97.41	0	2.59	0
Koc et al. [3]	72.9	9.7	11.1	0.2
Munguti et al. [5]	51	15	22	12
Covey et al. [9]	65	9	13	7
Gupta et al. [13]	88	0	12	0
Park et al. [14]	73.9	8.4	16.1	0.8
Carr et al. [15]	76	16	8	0

PV - Portal Vein



**Fig. 1: Figure showing the Different Types of Termination of Portal Vein (a) Extrahepatic Termination (b) Capsular Termination (c) Intrahepatic Termination. Green line showing the Level of Capsule PV–Portal Vein. RPV–Right Branch of Portal Vein, LPV–Left Branch of Portal Vein**

**Discussion:**

Anatomic variants of the portal vein are uncommon (10–15% of cases). However, when present, they are important to recognize because they may have profound implications for whether PVE (portal vein embolization) or subsequent resection can be performed successfully [8]. Variations in level and pattern of termination influence the risk of vascular injury during procedures such as hepatectomies, split or living donor transplantation, PV embolization and the placement of TIPS [8]. Knowledge of these variations decreases complication rates in these procedures and is also important in identifying the location of liver lesions [9, 10]. The incidence of these variations is variable in different populations [4, 11, 12].

In the present study of seventy seven cadaveric livers of unknown age and sex, termination of PV was extrahepatic in majority (89.61%) livers; this was similar to the observations by Madoff *et al.* [8] (48%) and Schultz *et al.* [4] (74.2%). Gupta *et al.* [13] in their study on Indian livers also observed that the division of the portal vein was always extra-hepatic. While Munguti *et al.* [5] observed only 14% cases having extrahepatic termination and majority (40%) were showing capsular and 14% intra-hepatic termination. While in the study conducted by Kwok *et al.* [11] majority (53%) livers showed intra-hepatic termination and extra-hepatic and capsular together was in 47%. These variations can be explained as the studies were conducted in different population groups (Table 1).

The branching pattern of the PV was classified after Atasoy and Ozvurek [2], as follows: Type 1 - conventional bifurcation; Type 2 - variant bifurcation in which the PV gave the right anterior PV and a common trunk from which arose the left PV and right posterior PV; Type 3 - trifurcation if it gave

three branches - the right anterior, right posterior and the left portal veins. In addition, Munguti *et al.* [5] included type 4, that is: quadrifurcation if it gave, besides the branches observed in Type 3, a branch to the caudate lobe whose diameter was at least a third of that of the PV.

Gupta *et al.* [13] observed 88% livers showing bifurcation, whereas in 12% trifurcation. In the present study, conventional bifurcation of PV (Type 1) was observed in 97.41% and trifurcation (type 3) in 2.59%. We did not observe any Type 2 or 4 in the present study which was similar to the observation by Gupta *et al.* [13], Koc *et al.* [3] observed presence of Type 1 in 72.9%, Type 2 in 9.7%, Type 3 in 11.1% and type 40.2%. Munguti *et al.* [5] and Park *et al.* [14] also observed presence of all four types in their study (Table 2). Munguti *et al.* [5] quoted that, Type 1 termination is associated with reduced risk during hepatic procedures.

We did not observe any major anatomic variation such as congenital absence or duplication of PV in the present study.

The branching pattern of the left and right portal veins from the main portal vein is important for surgical planning. In trifurcation, the left portal vein and the anterior and posterior branches of right portal vein branch at the same location, creating a surgical problem because there is no segment of the portal vein onto which a clamp can be placed [10].

The left PV has a longer extraparenchymal course (4-5 cm) and tend to lie slightly more horizontally than the right portal vein but is often of smaller caliber [1]. Gupta *et al.* [13] observed that the right branch of the portal vein was a stout short trunk, the length of which varied from 0.5 to 2.0 cm and that of left branch varied from 1 to 5 cm. In the present study mean length of extrahepatic part of



RPV was  $1.38 \pm 0.38$  cm ranging from 0.5 - 2.33cm (which was similar to Gupta *et al.* [13]) and that of left PV was  $1.91 \pm 0.73$  cm. Kwok *et al.*[11] observed the length of RPV as  $0.96 \pm 0.93$  cm and Schultz *et al.* [4] 1.18 cm and Murphy *et al.*[12] 1.81 cm. while length of LPV was observe as  $0.85 \pm 0.99$  cm by Kwok *et al.* [11], 2.02 cm by Schultz *et al.* [4] and 1.18 cm by Murphy *et al.* [12] Hepatic vascular anatomy is important to the surgeons who are evaluating donors and recipients in the living adult donor liver transplantation programs. The portal vein anatomy is also crucial, although its variants were noted less frequently [10].

### Conclusion:

Variation in the termination and branching pattern of portal vein is observed in different population. Extra-hepatic termination of PV was observed in majority livers (89.61%) in the present study of Indian cadaveric livers. Classical bifurcation of PV was present in majority (97.41%) livers and the variant termination in 2.59%. Detail preoperative radiological investigations can be helpful to surgeons to avoid injuries to portal vein during surgical procedures like hepatectomies, split or living donor transplantation, portal vein embolization and the placement of TIPS. The knowledge of variation is also important for anatomists.

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