

## Case Report

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## A Rare Variant of the Portal Vein Formation

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## ABSTRACT

The portal vein (PV) is a major vessel that supplies blood to the liver and is formed by the union of the superior mesenteric vein (SMV) and the splenic vein (SV) behind the neck of the pancreas. Generally, the inferior mesenteric vein (IMV) drains to the SV. Several variations to this anatomy have been reported, with the most frequent variant being the typical pattern (Type I) just described above, followed by IMV draining into SMV, then SMV joining SV to form PV (Type III), and trifurcation of SMV, IMV, and SV (Type II) respectively. The index case that we report here is unique as it is not described in published classifications such as Thomson or Krumm et al. Such unknown variants when found during surgical procedures may lead to unexpected adverse events during surgical and radiological procedures. Therefore, reporting such variants is important in minimizing iatrogenic injuries.

**Keywords:** portal vein origin, middle colic vein, mesenteric circulation, portal vein embryology

## INTRODUCTION

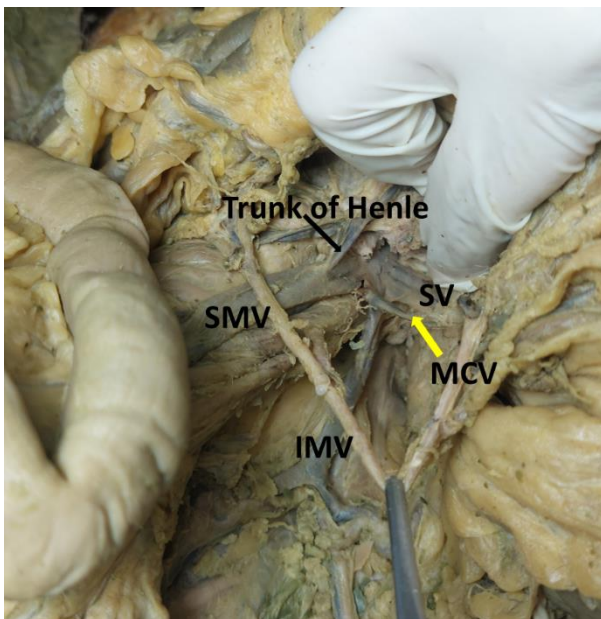
The portal vein (PV) is one of the main vessels that supply blood to the liver and contributes to approximately 75% of its blood flow (1,2). It is formed by the union of the splenic vein (SV), and superior mesenteric vein (SMV) behind the neck of the pancreas at the level of the second lumbar vertebra. The inferior mesenteric vein generally drains into the SMV. In the abdomen, the portal vein lies anterior to the inferior vena cava and posterior to the pancreas and first part of the duodenum. Here, the PV runs between the two layers of lesser omentum at its free edge and can be compressed manually during surgeries. It enters the liver at the porta hepatis (2,3).

Knowledge regarding its variants is important in interpreting radiological images and surgical procedures to prevent adverse events. Various classification systems are described in the literature such as Thomson classification and classification by Krumm et al (4,5). This case outlines a rare variant of PV formation not included in the above classifications.



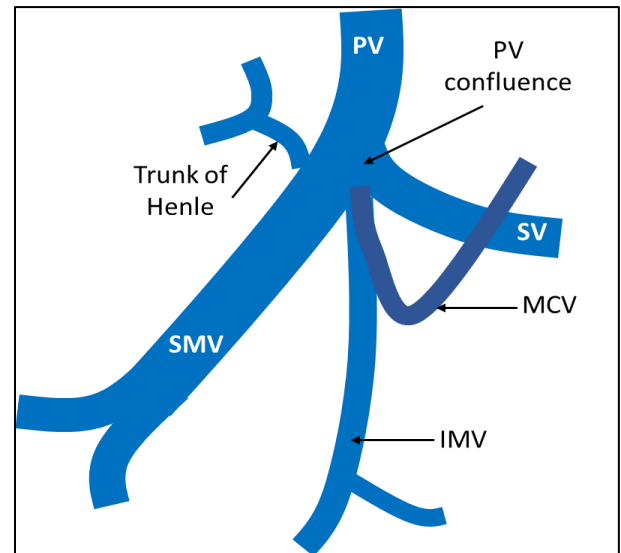
## CASE REPORT

During dissections at the Department of Anatomy, Faculty of Medicine, University of Peradeniya, a variant origin of PV was observed in a cadaver of a 90-year-old Sri Lankan female. There were no surgical scars on the abdomen and no evidence of intra-abdominal surgery or pathology were seen. The liver and intestines were normal in their gross appearance.



**Figure 1: Confluence of SV, SMV, IMV, and MCV to form the portal vein. (SV – Splenic vein, SMV – Superior mesenteric vein, IMV – Inferior mesenteric vein, MCV – Middle colic vein)**

The PV was formed behind the neck of the pancreas by the confluence of four veins (figure 1): the SV, SMV, IMV, and middle colic vein (MCV). This is an unusual draining pattern of the MCV, which was seen to drain directly into the confluence of PV rather than into the SMV. No other abnormalities or variants were detected among the abdominal vessels. Figure 2 shows a diagram of the described variation.



**Figure 2: Diagram of the portal vein confluence. (PV – Portal vein, SV – Splenic vein, SMV – Superior mesenteric vein, IMV – Inferior mesenteric vein, MCV – Middle colic vein)**

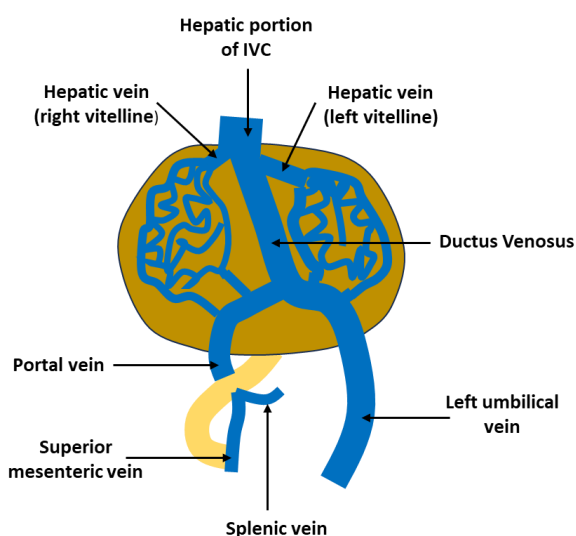
## DISCUSSION

The portal vein is the main vessel draining the gut and is therefore clinically important. It is approximately 6–8 cm long and 0.8 cm wide [2][3]. Although the SV, SMV, and IMV are the three main tributaries of the PV, there may be other contributing veins. Namely, these are the left gastric vein (LGV), pancreaticoduodenal vein, and right gastric vein. Further tributaries include cystic veins (when they don't drain directly into the liver), pancreatic veins, and paraumbilical veins (2,3,6,7).

The SV receives splenic tributaries, the left gastroepiploic vein, short gastric veins, posterior gastric veins, pancreaticoduodenal veins, and IMV (2,3,6). SMV receives tributaries from the small intestine (jejunal and ileal), colon (ileocolic, right colic, and middle colic (MCV)), pancreas, and stomach through the right gastroepiploic veins (3,6). The MCV typically joins the SMV on its anterior surface when the SMV crosses the uncinate process of the pancreas (8).

Embryologically, the venous system starts to develop during the 4th week of intrauterine life (IUL), and by the 5th week three pairs of major veins can be identified (9): vitelline veins and umbilical veins that make the extraembryonic

component and cardinal veins that make the intraembryonic component of the venous system. Vitelline veins are derived from the splanchnopleural mesoderm of the yolk sac, and they grow around the primitive foregut, proceed, and pass through the septum transversum as a venous plexus. During the 4th week of IUL, liver cords grow into the septum transversum and make the hepatic sinusoids by interrupting the vitelline venous plexus. The left and right vitelline veins have communications between them. Initially, these can be mainly seen on both sides ventrally (cranial and caudal ends) and dorsally (in the middle). Later the distal and proximal parts of the left vitelline vein disappear and the dorsal anastomosis with the right vitelline vein located in the middle part remains. The proximal part of the right vitelline vein enlarges and forms the hepatocardiac part of the inferior vena cava. When the duodenum and the stomach move to the final adult position in the abdomen, venous blood from the left vitelline vein goes straight through the liver by its dorsal anastomotic connection with the right vitelline vein which later becomes the PV (around 8th week) (figure 3), and the duodenum spirals around it. The dorsal part of the right vitelline vein becomes SMV and some of the remaining left to right vitelline anastomoses differentiate into the SV and the IMV. Most of the commonly reported anomalies of these veins can be related to incomplete regression (or persistence) of the early vitelline vessels (7,9,10).



**Figure 3: Embryological development of Porto-mesenteric venous system**

The Thomson classification (1890) of PV variants is the most well-known in surgical and radiological practice (3,4). Prado Neto and Petroianu in their systematic review describe 12 variants of PV formation out of which the first three variants are the most frequent and found in around 93% of the patients and were first described by Thomson (3). The first ten types mentioned in this systematic review are in the classification described by Krumm et al (5).

In type I, IMV drains into SV, while type II is the trifurcation of SMV, IMV, and SV. In type III, IMV drains into the SMV. In type IV, there is an accessory mesenteric vein (AccMV) draining into triple confluence. In type V, IMV drains into SV and an AccMV drains into the confluence. In type VI, IMV drains into AccMV. In type VII, AccMV and IMV both drain into SV at the same point. There is no IMV in type VIII. In type IX, AccMV drains into SV separately. There are two SMVs in type X. In type XI, LGV and IMV drain into SMV. In XII, there are 2 IMVs, each draining into SMV and SV (3,5).

Khamanarong et al. describe a new variant where the LGV enters the PV when there is a triple confluence [11], while Stagno et al. report a rare case of a PV located on the outer surface of the liver (12). Further, Gorantla et al. report a case of LGV emptying into the SMV (13), while Yang et al. describe a case of PV duplication with a preduodenal PV (14).

The MCV typically drains the proximal 2/3 of the transverse colon, accompanying the middle colic artery, and drains into the SMV in around 80% of cases (6,15,16). Other variable sites reported in the literature are the gastrocolic trunk of Henle, IMV, SV, and jejunal vein (15,17). There can be one or more MCVs (16).

Our case differs from the above-mentioned reported literature as it not only reports a case of a rare variant of PV origin by the contribution of four veins at the confluence but also describes an anomalous insertion of MCV into the PV confluence.

## CONCLUSION

The pre-operative workup of a liver, pancreatic, or bowel surgery or a radiological intervention or evaluation requires proper planning and a thorough understanding of the normal embryological development and the anatomical variations in this region. Such knowledge will help to interpret the imaging and surgical findings associated with variations, minimizing iatrogenic injuries, unexpected changes in surgical procedures, and better handling of catheter-based interventions.

### Author declaration

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#### Authors' contributions:

Study concept and design: M.J.S.J.; Acquisition of data: M.J.S.J., S.C.H., E.W.K.; Drafting of the manuscript: M.J.S.J., E.W.K., H.A.A.; Study supervision: J.U., H.A.A.

#### Conflicts of interest:

The authors declare that there is no financial or non-financial conflict of interest.

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#### Statement on data availability:

All data generated during this study are included in this published article.

## REFERENCES

1. Karki S, Paudel RC, Bhandari A, Phuyal A, Dahal MR. Anatomical Variants of Portal Vein Branching in CECT Scan of Abdomen: A Descriptive Study. *Journal of Lumbini Medical College*. 2021 Oct 4;9(2).
2. Sinnatamby CS. *Last's Anatomy: Regional and Applied*. 12th ed. Edinburgh: Churchill Livingstone; 2011.
3. Prado Neto EV, Petroianu A. ANATOMICAL VARIATIONS OF PORTAL VENOUS SYSTEM: IMPORTANCE IN SURGICAL CLINIC. *Arquivos brasileiros de cirurgia digestiva: ABCD = Brazilian archives of digestive surgery* [Internet]. 2022 [cited 2023 May 2];35:e1666. Available from: <https://pubmed.ncbi.nlm.nih.gov/35766611/>
4. Thomson A. Report of The Committee of Collective Investigation of The Anatomical Society of Great Britain and Ireland for The Year 1889-90. *Journal of Anatomy and Physiology* [Internet]. 1890 Oct [cited 2024 Feb 16];25(Pt 1):89–101. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1328111/>.
5. Krumm P, Schraml C, Bretschneider C, Seeger A, Klumpp B, Kramer U, et al. Depiction of Variants of the Portal Confluence Venous System Using Multidetector Row CT: Analysis of 916 Cases. *RöFo - Fortschritte auf dem Gebiet der Röntgenstrahlen und der bildgebenden Verfahren*. 2011 Oct 10;183(12):1123–9.
6. Wineski LE. *Snell's Clinical Anatomy by Regions*. 10th ed. Philadelphia: Wolters Kluwer; 2019.
7. MARKS C. Developmental Basis of the Portal Venous System. *The American Journal of Surgery*. 1969 May;117:671–81.
8. Sharma M, Babu CSR, Garg S, Rai P. Portal Venous System and Its Tributaries: A Radial Endosonographic Assessment. *Endoscopic Ultrasound*. 2012;1(2):96.
9. Sadler TW. *Langman's medical embryology*. 12th ed. Philadelphia: Wolters Kluwer; 2012.
10. Zimmerman P, Huseynova K, Pillai L. Anatomy and Physiology of the Mesenteric Circulation. In: Yeo CJ, editor. *Shackelford's Surgery of the Alimentary Tract*, 2 Volume Set (Eighth Edition) [Internet]. Elsevier; 2019 [cited 2024 Feb 20]. p. 1014–26. Available from: <https://www.sciencedirect.com/science/article/pii/B9780323402323000868>
11. Khamanarong K, Woraputtaporn W, Amarttayakong P, Ahooja A, Khuntikeo N. Classification of portal vein tributaries in Thai cadavers including a new type V. *Surgical and Radiologic Anatomy*. 2015 Nov 30;38(6):735–9.
12. Stagno A, Saitta C, Silipigni S, Catanzariti F, Caloggero S, Bottari A. Anatomic variations: a rare variant of formation of the portal vein. *Surgical and Radiologic Anatomy*. 2019 May 23;41(9):1093–5.
13. Gorantla VR, Potu BK, Pulakunta T, Vollala VR, Addala PK, Nayak SR. Anomalous formation of the portal vein: a case report. *Jornal Vascular Brasileiro*. 2007 Dec;6(4):399–401.
14. Yang Q, Li J, Wang H, Wang S. A rare variation of duplicated portal vein: left branch derived from splenic vein mimicking cavernous transformation. *BMC Gastroenterology*. 2021 Oct 26;21(1).
15. Maki Y, Mizutani M, Morimoto M, Kawai T, Nakagawa M, Ozawa Y, et al. The variations of the middle colic vein tributaries: depiction by three-dimensional CT angiography. *British Journal of Radiology*. 2016 Jul 1;89(1063):20150841–1.
16. Alsabilah J, Kim WR, Kim NK. Vascular Structures of the Right Colon: Incidence and Variations with Their Clinical Implications. *Scandinavian Journal of Surgery*. 2016 May 23;106(2):107–15.

17. Chrysikos D, Sgantzios M, Tsiaoussis J, Piperos T, Varlatzidou A, Bonatsos V, et al. Middle colic vein draining to splenic vein: a rare anatomic variation encountered during a right hemicolectomy. *Journal of Surgical Case Reports*. 2018 Aug 1;2018(8).