J Surg Med. 2020;4(11):978-981.
DOI: 10.28982/josam.717046

Research article
Araştırma makalesi

Journal of Surgery and Medicine
e-ISSN=2602-2079

Evaluation of portal vein variations in multidetector CT

Vena porta varyasyonlarının multidetector CT'de değerlendirilmesi

Mahinur Ulusoy [1], Güneş Bolatlı [2], Mustafa Koplay [3], Musa Acar [4], İsmail Zararsız [5]

[1] Beykent University, School of Medicine, Department of Anatomy, İstanbul, Turkey
[2] Siirt University, School of Medicine, Department of Anatomy, Siirt, Turkey
[3] Selcuk University, School of Medicine, Department of Radyology, Konya, Turkey
[4] Necmettin Erbakan University, Faculty of Health Sciences, Department of Physical Therapy and Rehabilitation, Konya, Turkey
[5] Girne American University, Faculty of Health Sciences, Girne, Kıbrıs

ORCID ID of the author(s)

MU: 0000-0002-0647-8828
GB: 0000-0002-7648-0237
MK: 0000-0001-7513-4968
MA: 0000-0002-5646-693X
İZ: 0000-0002-0551-337X

Corresponding author / Sorumlu yazar:
Mahinur Ulusoy
Address / Adres: Beykent Üniversitesi, Beylikdüzü Kampüsü, Anatomi Anabilim Dalı, Tıp Fakültesi, 34520, Büyükçekmece, İstanbul, Türkiye
E-mail: mahinur.ulusoy@hotmail.com

Ethics Committee Approval: This study was approved by Mevlana University Faculty of Medicine Clinical Trials Ethical Committee (Date and number: 12.03.2014 3/12/2014 and 26857650/015). All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.
Etik Kurul Onayı: Bu çalışma Mevlana Üniversitesi Tıp Fakültesi Klinik Araştırmalar Etik Kurulu tarafından onaylanmıştır (Tarih ve sayı: 12.03.2014 ve 26857650/015). İnsan katılımcıların katıldığı çalışmalardaki tüm prosedürler, 1964 Helsinki Deklarasyonu ve daha sonra yapılan değişiklikler uyarınca gerçekleştirilmiştir.

Conflict of Interest: No conflict of interest was declared by the authors.
Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Financial Disclosure: The authors declared that this study has received no financial support.
Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

Published: 11/29/2020
Yayın Tarihi: 29.11.2020

Abstract

Aim: It is important for surgeons to have a comprehensive knowledge of vascular anatomy when performing liver interventions. For example, liver transplantation requires a vast understanding of vascular anatomy and variations. This study aimed to evaluate the intrahepatic branching pattern of the portal vein to find out unknown variations.

Methods: Multidetector computed tomography images of the abdomen region were used from the PACS archives of Selcuk University Medical Faculty Hospital. Images of 838 patients (464 females and 374 males) who had no hepatic pathologies were examined. Images were evaluated in terms of the presence of variations, and the cases were divided into groups, all of which were compared in terms of gender.

Results: A previously unknown variation of the portal vein was detected in 4.9% of the patients: The left portal vein curved reversely after its origination from the main portal vein, supplying liver segments II and IV, after which it branched to supply segment III. In addition, four types of previously known variations of the portal vein were detected. Normal anatomic branching of portal vein was detected in 82.6% of the patients.

Conclusion: A previously unknown variation was detected. Awareness of this variation and other known variations is significant in hepatic transplantation, surgery, and interventions.

Keywords: Portal vein, Multidetector CT, Variation of the Portal Vein, Couinaud segmentation, Liver

Öz

Amaç: Cerrahların, karaciğer müdahalelerini gerçekleştirirken kapsamlı bir vasküler anatomi ye sahip olmaları gereklidir. Karaciğer transplantasyonu operasyonu vasküler anatomi ve varyasyonlar hakkında iyi bir bilgi gerektirir. Bu çalışma amacı, bilinmeyen varyasyonları bulmak için portal venin intrahepatik dallanma paterninin değerlendirilmesidir.

Yöntemler: Bu kesitsel çalışma, çok yönlü BT (MDCT) kullanan bir araştırma makalesidir. Karaciğer patolojisi olmayan 838 hastanın (464 kadın ve 374 erkek) çok dedektörlü BT görüntüleri incelendi. Görüntüler varyasyon varlığı açısından değerlendirildi. Sonuç olarak, vakalar gruplara ayrıldı. Tüm gruplar cinsiyete göre analiz edildi.

Bulgular: Hastaların %4,9'unda daha önce bilinmeyen bir portal ven varyasyonu tespit edildi: sol portal ven, ana portal venden çıktıktan sonra ters yönde eğrilir. Karaciğerin II ve IV segmentlerini besler ve segment III'ü besler. Ayrıca, portal damarın önceden bilinen dört çeşidi de tespit edildi. Hastaların %82,6'sında portal vende normal anatomik dallanma bulundu.

Sonuç: Önceden bilinmeyen bir varyasyon tespit edildi. Bu varyasyonun ve diğer bilinen varyasyonların farkında olunması, karaciğer transplantasyonu, cerrahi ve girişimlerde çok önemlidir.

Anahtar kelimeler: Portal ven, Multidetector BT, Portal ven varyasyonu, Couinaud segmentasyonu, Karaciğer

How to cite/Atıf için: Ulusoy M, Bolatlı G, Koplay M, Acar M, Zararsız İ. Evaluation of portal vein variations in multidetector CT. J Surg Med. 2020;4(11):978-981.

Introduction

The portal vein is an important blood vessel that conducts blood from the gastrointestinal tract and spleen to the liver. It is formed by the combination of the superior mesenteric vein and the splenic vein and divides into the right and left branches to enter the liver. Branches of the portal vein are distributed according to Couinaud segmentation and involved in the liver's blood supply. Couinaud segmentation divides the liver into eight functionally independent segments, each with its own vascular inflow, outflow, and biliary drainage [1-5].

Around 20,000 liver transplants are performed annually all over the world [1]. Complex hepatobiliary surgical and vascular intervention procedures have also increased immensely. Lack of awareness of anatomical variations can result in serious complications when dealing with such procedures [2-5]. There are some portal vein variations detected so far. This study was performed to evaluate the variations of portal vein and describe undefined variations if found.

Materials and methods

Tomographic images of 838 patients without any liver pathologies (374 males and 464 females) who underwent abdominal MDCT imaging for any reason at the Hospital of Selcuk University, Medical Faculty were examined. The examination was conducted with 256-section double-tube CT (Siemens, Somatom, Definition Flash, Germany) device at a routine section thickness of 3 mm, and 1 mm section intervals and 1 mm section thickness after reconstruction. The incidence and type of portal vein variations were defined with multiplanar reconstruction (MPR), maximum intensity projection (MIP), and 3D volume rendering images [4,6-9]. This study was approved by the Clinical Trials Ethical Committee of Mevlana University, Faculty of Medicine (Date and number 3/12/2014 and 26857650/015).

Statistical analysis

Statistical analyses were performed by the Statistical Package for Social Sciences, version 15.0 (SPSS. Inc, Chicago, Illinois, USA). Descriptive statistical methods (mean, standard deviation, frequency, correlation) were used. The incidences of portal vein variations were compared between males and females. $P<0.05$ was considered statistically significant.

Results

Normal branching pattern of the portal vein was detected in 345 male and 347 female patients (82.6%; Figures 1 and 2). Portal veins which branched out of the ordinary were considered variations, which occurred in 246 (29.4%, 129 males, 117 females) patients (Figure 1).

A previously unknown variation was detected in 4.9% of the patients (22 males and 19 females). The left portal vein curved reversely after its origination from the main portal vein, supplying the liver segments II and IV, then branching to supply segment III (Figure 3).

Four other types of variations previously reported by other studies were detected. They are as follows:

Trifurcation of the main portal vein into the left portal vein, right anterior portal vein, and right posterior portal vein was detected in 8.6% of patients (35 males and 37 females, Figure 4).

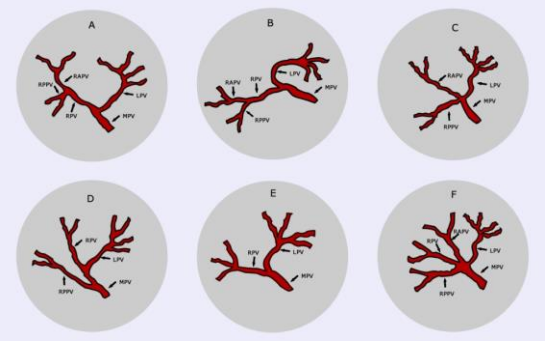

Figure 1: Drawing of (PV) portal vein variations. A: Normal (classic) main PV branching pattern, B: Main PV output and segmentation branching variation of left PV. C: Trifurcation. D: Right posterior PV as the first branch of the main PV. E: Segmental branching variance of right PV divided into three branches. F: Quartifurcation. (MPV: Main portal vein; LPV: Left portal vein; RPV: Right portal vein; RPPV: Right posterior portal vein; RAPV: Right anterior portal vein).

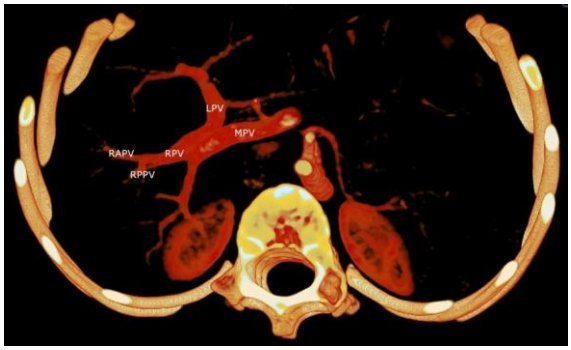

Figure 2: MDCT axial image showing, normal anatomy of intrahepatic segmentation branching PV. (MPV: Main portal vein; LPV: Left portal vein; RPV: Right portal vein; RPPV: Right posterior portal vein; RAPV: Right anterior portal vein). (Figure 1-A)

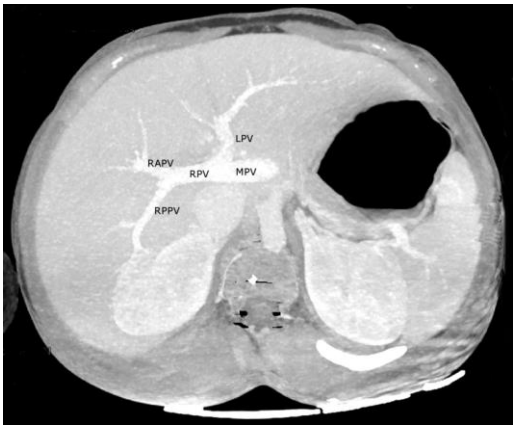

Figure 3: MDCT axial image showing segmental branching variation of left PV. (MPV: Main portal vein; LPV: Left portal vein; RPV: Right portal vein; RPPV: Right posterior portal vein; RAPV: Right anterior portal vein). (Figure 1-B)

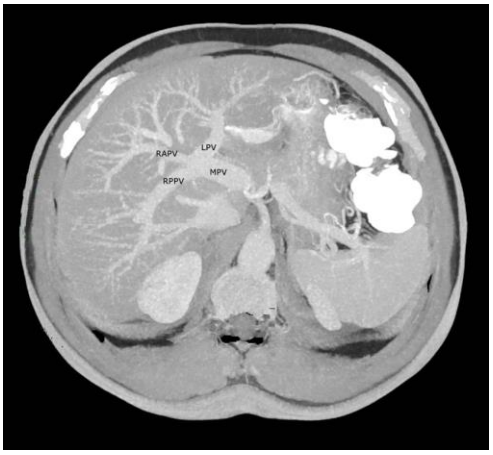

Figure 4: MDCT axial image showing, trifurcation variation of PV. (MPV: Main portal vein; LPV: Left portal vein; RPPV: Right posterior portal vein; RAPV: Right anterior portal vein). (Figure 1-C)

The right posterior portal vein as a first branch of main portal vein: The first branch of main portal vein is right posterior portal vein, it continues to the right for a short distance, and divides into right anterior portal vein and left posterior vein. This variation was detected in 8.9% of the patients (42 males and 33 females, Figure 5).

Segmentary branching of the right portal vein into 3 parts was detected in 5.7% of the patients (25 males and 23 females, Figure 6).

Quartifurcation of the main portal vein into right portal vein, left portal vein, right anterior portal vein, and right posterior portal vein (all these branches originate from the same root of the portal vein) was detected in 1.2% of the patients (5 males and 5 females, Figure 7).

There was no significant difference between males and females for incidences of all variation types (P=0.08).

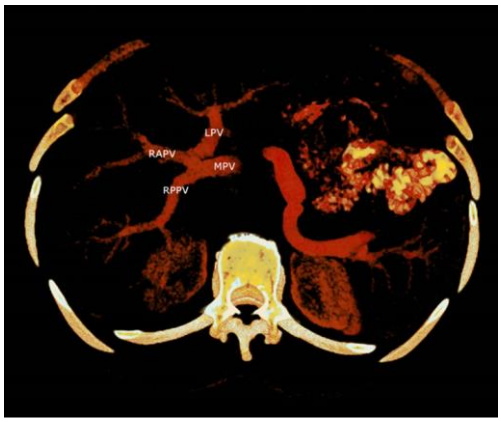

Figure 5: MDCT axial image showing, right posterior portal vein arising from MPV. (MPV: Main portal vein; LPV: Left portal vein; RPPV: Right posterior portal vein; RAPV: Right anterior portal vein). (Figure 1-D)

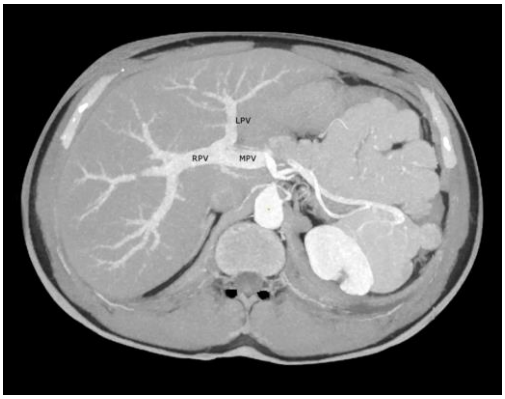

Figure 6: MDCT axial image showing, segmental branching variation of right PV. (MPV: Main portal vein; LPV: Left portal vein; RPV: Right portal vein). (Figure 1-E)

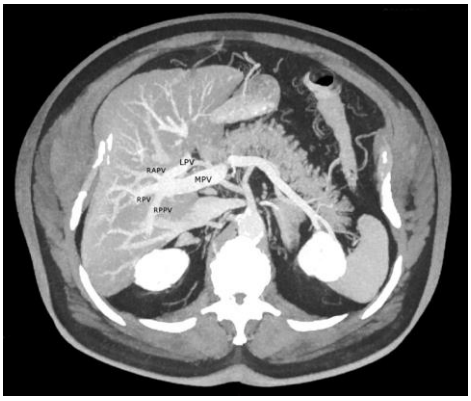

Figure 7: MDCT axial image showing Quartifurcation variation of PV. (MPV: Main portal vein; LPV: Left portal vein; RPV: Right portal vein; RPPV: Right posterior portal vein; RAPV: Right anterior portal vein). (Figure 1-F)

Discussion

Complications during liver transplantation may result from portal vein variations, most of which include branching variations according to segmentation in the liver. In the literature, there are a lot of studies conducted on this subject. According to these studies and this present study, approximately 20 % of people have portal vein variations [10-14], some of which are accompanied by an anomaly. We found portal vein branching variation in cases with normal abdominal MDCT findings and determined that the results of the studies reporting variations were similar to ours. Understanding these variations facilitates determination of the portal vein segment that will be ligated.

A previously unknown portal vein variation was detected in the present study. In this variation, the left portal vein curved reversely after its origination from the main portal vein, supplying liver segments II and IV, then branching to supply segment III. Awareness of this variation is important, especially in left hepatic lobe interventions. The fact that we have not found another study reporting this variation may be because of ethnicity. For example, Munguti et al. [4] reported low (51%) incidence of normal portal vein branching anatomy in a black Kenyan population.

In 2002, Gallego reported that the variants in the normal branching pattern of the intrahepatic portal vein have been reported since 1957, and they were seen in about 20% of the population. The most common variations include origination of the right posterior portal vein from the main portal vein (4.7 - 5.8%), right anterior portal vein originating from the left portal vein (2.9 - 4.3%) and main portal vein trifurcation (7.8%-10.8%). The incidence of trifurcation variation in our study was 8.6%. Akgul et al. [10], Baba et al. [11], Covey et al. [15], Koc et al. [12], Takaishi et al. [14], and Sureka et al. [13] reported the incidences of this variation as 12.3%, 5.2%, 9%, 11.1%, 6.1% and 6.8%, respectively.

In 2002, Akgul et al. [10] found the prevalence of intrahepatic portal venous branching variations on helical CT images. They did not specify a typing in their study and reported the incidence of right posterior portal vein variation as a first branch of main portal vein as 0.3%, while it was 8.9% in our study. Baba et al. [11], Covey et al. [15], Koc et al. [12], Takaishi et al. [14], and Sureka et al. [13] reported incidence of this variation as 2.6%, 13%, 9.7%, 4.7% and 5% respectively. However, that reported by Akgul et al. [10] was exceptionally low.

In a study by Covey et al. [15] examining portal vein variations in 200 CT portographies, the authors reported that knowing the presence of portal vein variations is important also in transhepatic portal vein embolization and percutaneous interventions such as transhepatic intraparenchymal portosystemic shunting. The incidence of segmentary branching of the right portal vein in our study is 5.7%. Covey et al. [15], Koc et al. [12], and Sureka et al. [13] reported the incidence of this variation as 7%, 3% and 4%, respectively.

Iqball et al. [7] studied liver segmentation and portal vein variations in their review. They grouped the variables under 5 types in accordance with the definition by Cheng Y et al: Type 1, which occurred in 65% to 80% of general population, was

defined as the one in which the right portal vein branched into the right anterior portal vein (RAPV) and right posterior PV (RPPV) from the main portal vein. Type 2 indicated portal trifurcation and had an incidence of 10.9 - 15% among the general population. They defined portal trifurcation as branching of the right anterior, right posterior, and left portal vein from the main portal vein. Type 3 or "Z" anomaly was branching of the right posterior PV directly from the main portal vein. This was the second most common type with an incidence between 0.3 - 7%. The authors stated that right portal vein trifurcation was seen in 0.6 - 2.69%. Type 5 was defined as the right vein trifurcation in which the branch of segment VI is the first branch of right portal vein, with an incidence of 1.34 - 2.4%. The incidence of quartifurcation variation in our study is low, as in the other studies [7,12,16-18].

Incidences of previously known variations detected in the present study are similar with the incidences reported in other studies.

Limitations

Our study was studied on a single race in a single hospital, therefore, the differences of variations based on race could not be determined. Individuals whose variation is screened retrospectively were healthy, thus, the connection between the detected variations and diseases was not determined.

Conclusion

A previously unknown variation was detected with an important incidence in the present study. Awareness of this variation and other known variations is imperative in hepatic transplantation, surgery, and interventions. Well understanding of intrahepatic portal vein variations with the increasing use of abdominal MDCT will reduce the possible risk in practice.

References

1. Matesanz R, Rosa G. Liver transplantation: The Spanish experience. Digestive and Liver Disease Supplements. 2009;3:75-81.
2. Hu GH, Shen LG, Yang J, Mei JH, Zhu YF. Insight into congenital absence of the portal vein: is it rare? WJG. 2008;14(39):5969-79.
3. Kim TS, Noh YN, Lee S, Song SH, Shin M, Kim JM, et al. Anatomic similarity of the hepatic artery and portal vein according to the donor-recipient relationship. Transplant Proc. 2012;44(2):463-65. doi: 10.1016/j.transproceed.2012.01.062
4. Munguti J, Awori K, Odula P, Ogeng'o J. Conventional and variant termination of the portal vein in a black Kenyan population. Folia Morphol (Warsz). 2013;72(1):57-62.
5. Vauthey JN, Yamashita S. Perfecting a challenging procedure: The Nagoya portal vein guide to left trisectionectomy. Surgery. 2017;161(2):355-6. doi: 10.1016/j.surg.2016.07.030
6. Fishman EK. From the RSNA refresher courses: CT angiography: clinical applications in the abdomen. Radiographics. 2001;21:3-16. doi: 10.1148/radiographics.21.suppl_1.g01oc23s3
7. Iqbal S, Iqbal R, Iqbal F. Surgical Implications of Portal Vein Variations and Liver Segmentations: A Recent Update. J Clin Diagn Res. 2017;11(2):AE01-AE05. doi: 10.7860/JCDR/2017/25028.9453
8. Madoff DC, Hicks ME, Vauthey JN, Charnsangavej C, Morello FA, Ahrar K, et all. Transhepatic portal vein embolization: anatomy, indications, and technical considerations. Radiographics. 2002;22(5):1063-76. doi: 10.1148/radiographics.22.5.g02se161063
9. Pang G, Shao G, Zhao F, Liu C, Zhong H, Guo W. CT virtual endoscopy for analyzing variations in the hepatic portal vein. Surg Radiol Anat. 2015;37(5):457-62. doi: 10.1007/s00276-015-1463-2
10. Akgul E, Inal M, Soyupak S, Binokay F, Aksungur E, Oguz M. Portal Venoz Variation. Prevalance with contrast-enhanced helical CT. Acta Radiolagica. 2002;43:315-9.
11. Baba Y, Hokotate H, Nishi H, Inoue H, Nakajo M. Intrahepatic portal venous variations: demonstration by helical CT during arterial portography. J Comput Assist Tomogr. 2000;24(5):802-8.
12. Koc Z, Oguzkurt L, Ulusan S. Portal vein variations: clinical implications and frequencies in routine abdominal multidetector CT. Diagn Interv Radiol. 2007;13(2):75-80.
13. Sureka B, Patidar Y, Bansal K, Rajesh S, Agrawal N, Arora A. Portal vein variations in 1000 patients: surgical and radiological importance. Br J Radiol. 2015;8820150326. doi: 10.1259/bjr.20150326
14. Takeishi K, Shirabe K, Yoshida Y, Tsutsui Y, Kurihara T, Kimura K, et all. Correlation Between Portal Vein Anatomy and Bile Duct Variation in 407 Living Liver Donors. Am J Transplant. 2015;15(1):155-60.
15. Covey AM, Brody LA, Getrajdman GI, Sofocleous CT, Brown KT. Incidence, patterns, and clinical relevance of variant portal vein anatomy. AJR Am J Roentgenol. 2004;183(4):1055-64. doi: 10.2214/ajr.183.4.1831055
16. Schmidt S, Demartines N, Soler L, Schnyder P, Denys A. Portal vein normal anatomy and variants: implication for liver surgery and portal vein embolization. Semin Intervent Radiol. 2008;25(2):86-91. doi: 10.1055/s-2008-1076688
17. Gallego C, Velasco M, Marcuello P, Tejedor D, Campo LD, Friera A. Congenital and Acquired Anomalies of the Portal Venous System. Radiographics. 2002;22:141-59.
18. Cheng YF, Huang TL, Chen CL, Sheen-Chen SM, Lui CC, Chen TY, et al. Anatomic Dissociation between the Intrahepatic Bile Duct and Portal Vein: Risk Factors for Left Hepatectomy. World J Surg. 1997;21:297-300.

This paper has been checked for language accuracy by JOSAM editors.
The National Library of Medicine (NLM) citation style guide has been used in this paper.