

Obliterative Portal Venopathy: Findings at CT Imaging¹

Anne-Sophie Glatard, MD
Sophie Hillaire, MD
Gaspard d'Assignies, MD
Dominique Cazals-Hatem, MD
Aurélie Plessier, MD
Dominique C. Valla, MD
Valérie Vilgrain, MD

Purpose:

To retrospectively analyze the computed tomographic (CT) findings in a single-center series of adult patients with biopsy-proved obliterative portal venopathy (OPV) and to compare them with those observed in patients with cirrhosis.

Materials and Methods:

The requirement for informed consent was waived. This institutional review board–approved study included 42 consecutive patients with a histologically proved diagnosis of OPV who underwent CT at diagnosis. The clinical characteristics at diagnosis were recorded, and CT examination results were reviewed. Two radiologists evaluated portal vein patency and intrahepatic portal branches, the morphologic changes in the liver, the presence of hepatic nodules, and signs of portal hypertension in consensus. The control group consisted of 42 patients who had histologically proved cirrhosis. CT findings were compared between the OPV patient group and the cirrhotic group and also among the conditions associated with patients with OPV. The Fisher exact test was used. *P* values of .05 or less were considered to indicate significant differences.

Results:

The following CT findings were observed significantly more frequently in OPV than in cirrhosis: extrahepatic portal vein thrombosis (18 [43%] of 42 vs five [12%] of 42); intrahepatic portal abnormalities (18 [58%] of 31 vs one [2%] of 42) such as reduced caliber, occlusive thrombosis, and lack of visibility; focal nodular hyperplasia–like nodules (six [14%] of 42 vs 0 [0%] of 42); and perfusion disorders (15 [36%] of 42 vs six [14%] of 42). Conversely, the combination of hypertrophy of the caudate lobe and atrophy of segment IV (27 [64%] of 42 vs 10 [24%] of 42) and nodular surface (37 [88%] of 42 vs seven [17%] of 42) were seen significantly more often in cirrhosis.

Conclusion:

Characteristic CT findings in patients with OPV that differ from those in patients with cirrhosis were shown, the most common being the presence of intra- or extrahepatic portal abnormalities.

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Supplemental material: <http://radiology.rsna.org/lookup/suppl/doi:10.1148/radiol.12111785/-/DC1>

¹From the Departments of Radiology (A.S.G., G.d.A., V.V.), Pathology (D.C.), and Hepatology (A.P., D.C.V.), Assistance-Publique Hôpitaux de Paris, APHP, Hôpital Beaujon, 100 bd du Général Leclerc, 92110 Clichy, France; Department of Hepatology, Hôpital Foch, Suresnes, France (S.H.); and Université Paris Diderot, Sorbonne Paris Cité, INSERM Centre de Recherche Biomédicale Bichat Beaujon, Paris, France (G.d.A., D.C.V., V.V.). Received August 23, 2011; revision requested October 4; revision received November 17; accepted December 8; final version accepted December 29. Address correspondence to V.V. (e-mail: valerie.vilgrain@bjn.aphp.fr).

Obliterative portal venopathy (OPV), also known as idiopathic portal hypertension and hepatoportal sclerosis, is a major cause of noncirrhotic portal hypertension (1). Incomplete septal cirrhosis and nodular regenerative hyperplasia have recently been shown to be part of the spectrum of the disease. The primary lesions of OPV are in the portal tracts, which show varying degrees of thrombosis, fibrosis, and sclerosis of portal vein branches (2,3). OPV also includes a spectrum of lesions, such as nodular regenerative hyperplasia, perisinusoidal fibrosis, sinusoidal dilatation, aberrant vessels, and extensive portal fibrosis. The main clinical signs are marked splenomegaly and portal hypertension. OPV often goes unrecognized. Fiel et al (2) described eight patients who were diagnosed with OPV by using the pathologic specimen of liver explants. Before liver transplantation, these patients were all considered to have cirrhosis (2). Similarly, Krasinskas et al (4) described 16 patients whose results from pathologic examination of the liver explant revealed intrahepatic noncirrhotic portal hypertension related to OPV. The diagnosis before liver transplantation was cirrhosis in 13 of 16 patients, including 11 with radiologic evidence of cirrhosis (4). When typical histologic findings are present, liver biopsy is helpful to make the diagnosis of OPV. However, histologic changes may be subtle at liver needle biopsy, and the diagnosis may be missed unless there

is strong clinical suspicion of this entity (2). Thus, it is crucial to differentiate OPV from cirrhosis because patients with OPV usually have preserved liver function, and management of these cases differs (4). OPV is commonly associated with various diseases, the most common being prothrombotic diseases, immune-mediated disorders, and human immunodeficiency virus (HIV) infection. For instance, patients with OPV with prothrombotic conditions who receive early anticoagulation therapy appear to have a better outcome than patients who do not (5).

At present, the diagnosis of OPV is based on pathologic findings, while its imaging characteristics are not well known. One article has mentioned abnormalities such as intrahepatic portal vein radicle irregularities at ultrasonography and lack of visualization of the intrahepatic portal vein branches or sudden narrowing of second-degree portal vein branches in certain patients at splenoportovenography (6). The purpose of this study was to retrospectively analyze the computed tomographic (CT) findings in a single-center series of adult patients with biopsy-proved OPV and to compare them with those observed in patients with cirrhosis.

Materials and Methods

Patient Selection

This retrospective study received approval from our local institutional review committee, and the requirement for informed patient consent was waived.

Patients with OPV

From the database of the Department of Pathology, we selected all patients with a histologic diagnosis of OPV between 1993 and 2009 and who had undergone abdominal CT within 6 months

before or after the histologic diagnosis. Exclusion criteria were patients with insufficient specimen (needle biopsies where less than 1 cm of needle length contained specimen and with fewer than six complete portal tracts) or with uncertified diagnosis of OPV after pathologic review ($n = 23$) and no CT results available 6 months before or after histologic diagnosis ($n = 26$). A total of 42 patients were included in the study as indicated in the flowchart (Fig 1).

Liver specimens with a diagnosis of “highly suggestive of primary OPV” were reviewed by the same pathologist (D.C., with 18 years of experience in liver pathology) and had to fulfill two histologic criteria: (a) have an alternation of complete portal tract and centrilobular veins to exclude cirrhosis and (b) more than two-thirds (66%) of the complete portal tracts have abnormal portal venules. Abnormal venules were defined as venules that were absent or clearly reduced in caliber with sclerosis or thickening of the smooth muscle wall (1,7). According to Krasinskas et al (8), abnormal portal vessels corresponding to those described in noncirrhotic portal hypertension may be present in more than 25% of complete portal tracts in normal livers with normal portal pressure. Therefore, the diagnosis of OPV could be made with confidence

Advance in Knowledge

- The most common CT features suggestive of obliterative portal venopathy (OPV) are extrahepatic portal vein thrombosis (18 [43%] of 42) and/or intrahepatic portal abnormalities (18 [58%] of 31) such as reduced caliber (compared with other intrahepatic branches), occlusive thrombosis (clot in the vein or abrupt break in visualization), and lack of visibility (no contrast enhancement).

Implication for Patient Care

- CT imaging can help potentially diagnose OPV that is often mistaken for cirrhosis, which allows for modification in treatment.

Published online before print

10.1148/radiol.12111785 **Content code:** GI

Radiology 2012; 263:741–750

Abbreviations:

FNH = focal nodular hyperplasia
HIV = human immunodeficiency virus
OPV = obliterative portal venopathy

Author contributions:

Guarantors of integrity of entire study, A.S.G., A.P., V.V.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; manuscript final version approval, all authors; literature research, all authors; clinical studies, A.S.G., S.H., D.C., A.P., D.C.V., V.V.; statistical analysis, A.S.G., D.C., V.V.; and manuscript editing, A.S.G., S.H., G.d.A., D.C., D.C.V., V.V.

Potential conflicts of interest are listed at the end of this article.

on the basis of our latter criterion. In patients who underwent liver transplantation, the explanted liver tissue was examined in the same way as tissue for biopsies; all explanted livers were used to confirm the diagnosis of OPV. The clinical and biologic characteristics of patients at diagnosis were recorded: signs of portal hypertension such as hypersplenism, bleeding or nonbleeding varices, and blood liver test results. Conditions considered to cause OPV were identified from the patient's chart on the basis of conventional diagnostic criteria: professional exposure to copper sulfate or a vinyl chloride monomer; previous exposure to thorium sulfate, Spanish toxic oil, or arsenic salts; regular vitamin A supplement intake; autoimmune or collagen vascular diseases; primary biliary cirrhosis or primary sclerosing cholangitis; schistosomiasis; sarcoidosis; abdominal or systemic sepsis; and prothrombotic disorders. Tests for antithrombin, protein S, and protein C deficiencies and the detection of antiphospholipid antibodies, hyperhomocysteinemia, factor V Leiden (G1691A factor V gene mutation), G202100A factor II gene mutation, and Janus kinase 2 (or JAK2) mutation were performed according to previously reported methods (9). HIV serology was determined. The presence of a congenital and/or genetic syndrome was explored. Additional causes of chronic liver disease were identified on the basis of conventional diagnostic criteria (chronic viral hepatitis, alcoholic liver disease, nonalcoholic steatohepatitis, hemochromatosis, autoimmune hepatitis, Wilson disease, biliary diseases).

At diagnosis of OPV, the 42 selected patients had a mean age of 44 years (age range, 21–77 years). There were 12 women (29%; mean age, 44 years; age range, 23–70 years) and 30 men (71%; mean age, 44 years; age range, 21–77 years). The main indication for biopsy was portal hypertension in 33 (78%) patients. Twenty-two (52%) patients had hypersplenism or nonbleeding varices, five (12%) had bleeding varices, and six (14%) had

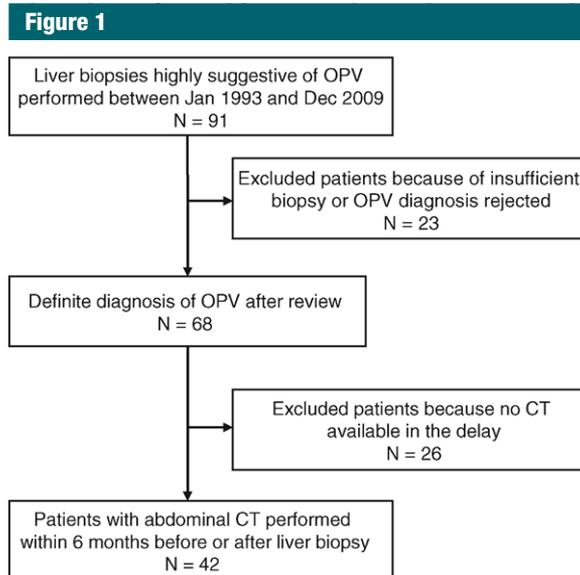


Figure 1: Flowchart of patient selection.

abnormal results for blood liver tests related to hepatocellular insufficiency. Nine patients (21%) underwent liver biopsy for unexplained and isolated chronic liver test result abnormalities (two had cholestasis during pregnancy). Ten (24%) patients underwent transplantation, and the liver explants were histologically extensively analyzed.

After a complete screening, associated disorders potentially involving vascular alterations were found in 23 (55%) patients; cases were divided into three groups according to the existence of prothrombotic diseases ($n = 12$, 29%) (seven myeloproliferative disorders and five other prothrombotic diseases), immune-mediated disorders ($n = 7$, 17%), or HIV-positive patients ($n = 4$, 9%, two also had a prothrombotic disorder). Finally, no associated diseases were identified in 19 (45%) patients.

Patients with Cirrhosis

The control group included patients with cirrhosis identified in the database of the Department of Pathology who underwent abdominal CT examination between 2008 and 2011 and who had histologic evidence of cirrhosis. Forty-two patients (mean age, 53 years; age range, 33–82 years)

were 26 men (mean age, 51 years; age range, 33–82 years) and 16 women (mean age, 56 years; age range, 40–76 years). The diagnosis of cirrhosis was made at liver biopsy in 37 (88%) patients and with explanted liver in five (12%) patients. At histologic examination, all patients had diffuse parenchymal damage characterized by septal fibrosis and hepatocellular nodular regeneration affecting the entire parenchyma and disturbing severely the normal architecture of the liver. The cause of cirrhosis was alcohol in 18 (43%) patients, alcohol associated with another cause in seven (17%) (hepatitis B in one, hepatitis C in three, nonalcoholic steatohepatitis in two, α_1 -antitrypsin deficiency in one), hepatitis B in three (7%), hepatitis C in five (12%), hepatitis B and C in one (2%), nonalcoholic steatohepatitis in two (5%), primary biliary cirrhosis in one (2%), and undetermined in five (12%). Slides were reviewed by the same pathologist (D.C.), and no patient had pathologic abnormalities suggestive of OPV. Eighteen (53%) patients had Child-Pugh grade A, eight (23.5%) had Child-Pugh grade B, and eight (23.5%) patients had Child-Pugh grade C. Twenty-eight (67%) patients had clinical signs of portal hypertension.

Table 1

CT Findings at the Diagnosis of OPV Distributed according to Known Associated Disorders

Parameter	All Patients (n = 42)	Immune-mediated Disease (n = 7)	Prothrombotic Disorder (n = 12)	HIV-Positive Patients (n = 4)	Other Patients (n = 19)
Intra- and/or extrahepatic abnormalities	30 (71)	3 (43)	12 (100)	4 (100)	11 (58)
Mural venous calcifications	7 (17)	1 (14)	3 (25)	0	3 (16)
Extrahepatic portal veins					
Patent	24 (57)	5 (71)	2 (17)	3 (75)	14 (74)
Thrombosis*	18 (43)	2 (29)	10 (83)	1 (25)	5 (26)
Cavernous transformation	11 (26)	2 (29)	7 (58)	1 (25)	1 (5)
Intrahepatic portal branches					
Normal	13/31 (42)	4/5 (80)	0	0	9/18 (50)
Abnormal†	18/31 (58)	1/5 (20)	5/5 (100)	3/3 (100)	9/18 (50)
Abnormal with normal extrahepatic portal veins	12/31 (39)	1/5 (20)	2/5 (40)	3/3 (100)	6/18 (33)
Not studied	11/42 (26)	2/7 (29)	7/12 (58)	1/4 (25)	1/19 (5)
Liver morphology					
Normal	7 (17)	1 (14)	2 (17)	0	4 (21)
Atrophy or hypertrophy of segments	35 (83)	6 (86)	10 (83)	4 (100)	15 (79)
Mimicking cirrhosis‡	10 (24)	1 (14)	1 (8)	0	8 (42)
Global atrophy	6 (14)	0	3 (25)	1 (25)	2 (11)
Liver surface					
Smooth	30 (71)	5 (71)	11 (92)	3 (75)	11 (58)
Nodular	7 (17)	1 (14)	1 (8)	1 (25)	4 (21)
Focal retraction	5 (12)	1 (14)	0	0	4 (21)
FNH-like nodules	6 (14)	0	3 (25)	0	3 (16)
Signs of portal hypertension	40 (95)	7 (100)	11 (92)	4 (100)	18 (95)
Hepatic artery enlargement	19 (45)	3 (43)	9 (75)	2 (50)	5 (26)

Note.—Data are numbers of patients, with percentages in parentheses. FNH = focal nodular hyperplasia.

* Either acute or chronic and occlusive or nonocclusive thrombosis of the portal vein or its tributaries.

† Reduction in caliber, occlusive or nonocclusive thrombosis, and/or lack of visibility of intrahepatic portal branches.

‡ Atrophy of segment IV and hypertrophy of caudate lobe.

Imaging Procedures

All patients underwent abdominal CT examinations.

OPV group.—The mean delay between CT and liver biopsy was 91 days (median, 48 days; range, 2–181 days). CT was performed before liver biopsy in 24 (57%) patients and after liver biopsy in 18 (43%) patients.

Because of the inclusion period, CT examinations were performed by using a variety of CT scanners: dual-helical scanner (CT Twin; Philips Medical System, Cleveland, Ohio) in nine patients and eight-detector (LightSpeed; GE Healthcare, Milwaukee, Wis) and 64-detector (LightSpeed VCT; GE Healthcare) CT scanner in 33 patients. Arterial phase and portal venous phase images were acquired after the administration of 2 mL per kilogram of body weight of nonionic contrast

material (350 mg/mL, Xenetix; Guerbet, Aulnay-sous-Bois, France) at a rate of 3 mL/sec with a pump through an 18-gauge catheter placed in a peripheral vein. The images for these phases were acquired at fixed delays (35 seconds and 70 seconds after contrast material administration, respectively). Delayed phase imaging was performed in 25 (60%) patients. Pre- and postcontrast section reconstructions ranged from 5 to 10 mm and from 2.5 to 5 mm, respectively.

Control group.—All CT scans were performed with a 64-detector CT scanner (LightSpeed VCT; GE Healthcare) with a similar protocol as for patients with OPV.

Image Analysis

Images were read by two radiologists (A.S.G. and V.V., with 5 and 24 years

of experience in liver imaging, respectively), and the vascular and liver characteristics were determined by consensus. Readers were blinded to all clinical information, as well as patient group. Case order was randomized to avoid bias. Results from 15 (36%) examinations in patients with OPV and results from all examinations in patients with cirrhosis were evaluated on a picture archiving and communication system. First, the readers semiquantitatively graded image quality in consensus by using a three-point scale: excellent, good, and unsatisfactory on the basis of enhancement of the portal vein during the portal venous phase.

Readers then evaluated images qualitatively by using the criteria shown in Table 1. Briefly, intrahepatic portal branches (main and second- and third-order branches) were analyzed during

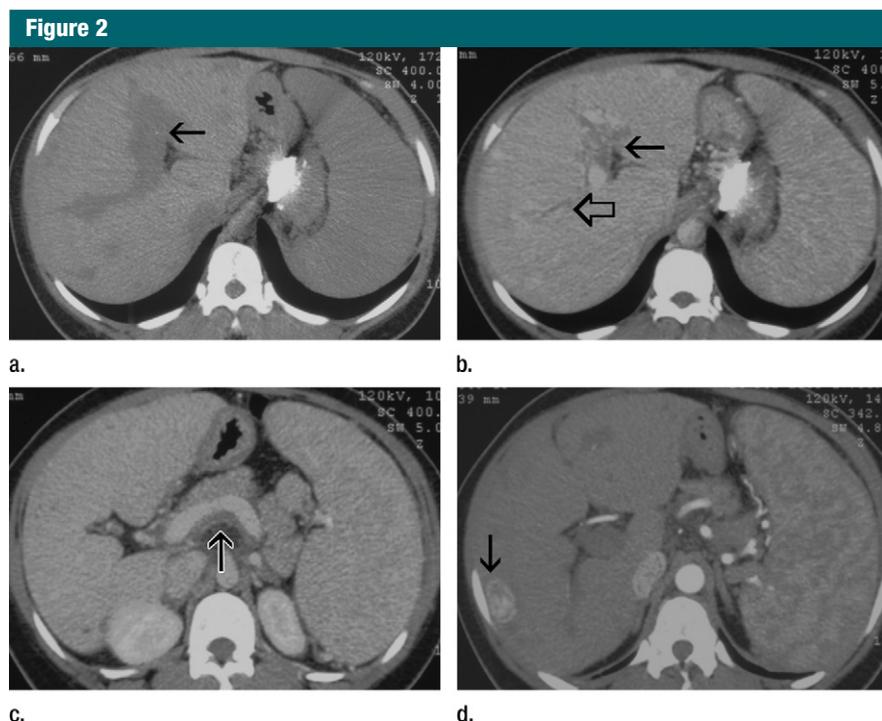


Figure 2: CT images in 39-year-old woman with OPV. (a) Axial unenhanced helical CT image shows calcifications within the left portal branch (arrow). (b, c) Axial contrast material-enhanced helical CT images during the portal venous phase show nonocclusive thrombosis of intrahepatic portal branches (arrows in b), the main portal vein, and the splenic vein (arrow in c). Signs of portal hypertension are present with splenorenal shunts and splenomegaly. (d) Axial contrast-enhanced helical CT image during the arterial phase shows a hypervascular nodule (arrow) in the right liver that was not seen during the other phases. Results of histologic examination of nodule biopsy specimen confirmed the diagnosis of FNH-like nodule. The liver shows morphologic changes that are atypical for cirrhosis with hypertrophy of segment IV.

the portal venous phase and classified into four groups: normal, thrombosed (clot in the vein or abrupt break in visualization), reduction in caliber (compared with other branches), or invisible (ie, no contrast enhancement). The other criteria are defined in Appendix E1 (online).

Statistical Analysis

Numeric variables were summarized, indicating the median, minimum, and maximum. Categorical variables were summarized with number and percentage. CT findings were compared between the OPV patient group and the cirrhotic group. CT findings were also compared among the conditions associated with patients with OPV. The Fisher exact test was used. *P* values of .05 or less were considered to indicate significant differences, and no adjustments for multiple testing were made in

these exploratory analyses. Statistical analyses were performed by using software (SAS; SAS Institute, Cary, NC).

Results

OPV Patient Group

Extrahepatic portal system.—Image quality was good to excellent in all patients with OPV, except for two patients who underwent CT imaging in 1993 and 1996.

The portal vein or its main tributaries were thrombosed in 18 (43%) patients and patent in 24 (57%) patients.

Thirteen (31%) patients had occlusive thrombosis. Eleven (26%) of these had chronic thrombosis with cavernous transformation of the portal vein. Thrombosis involved the portal vein, splenic vein, and superior mesenteric vein in five patients, the portal vein and superior mesenteric vein in two,

the portal vein in one, the superior mesenteric vein in one, and the right and left branches of the portal vein in one. One patient had acute thrombosis of the superior mesenteric vein and chronic thrombosis of the portal vein and splenic vein. Two others had acute occlusive thrombosis (superior mesenteric vein in one, portal vein and splenic vein in one).

Five (12%) patients had nonocclusive thrombosis of the main portal vein (extending to the main tributaries in two patients) (Figs 2–4).

Mural calcifications of the portal vein or its tributaries were found in seven (17%) patients; four had occlusive thrombosis and three had nonocclusive thrombosis (Fig 4).

Intrahepatic portal branches.—The intrahepatic portal branches could not be studied in patients with cavernous transformation of the portal vein ($n = 11$, 26%).

In the others ($n = 31$), the intrahepatic portal branches were normal in 13 (42%) patients and abnormal in 18 (58%) including seven who had combined abnormalities: thrombosis in nine, reduction in caliber in 10, and nonvisibility in six (Figs 2, 3, 5). Calcifications of the right and left portal branches were seen in one patient who also had nonocclusive calcified extrahepatic thrombosis (Fig 2).

Intrahepatic portal branch obstruction was associated with ipsilateral atrophy of the liver segment in nine (29%) patients.

Twelve (39%) of 31 patients had intrahepatic portal branch abnormalities, whereas the extrahepatic portal system was totally patent. Therefore, 30 (71%) patients had abnormalities of the intra- and/or extrahepatic portal system.

Liver size and morphologic findings.—Liver morphology was abnormal in 35 (83%) of 42 patients. The main abnormalities were hypertrophy of the caudate lobe in 22 (52%) patients, right liver atrophy in 14 (33%) patients, and atrophy or hypertrophy of segment IV in 12 (29%) and 10 (24%) patients (Fig 2), respectively. The left liver was found to be atrophic in six (14%) patients or hypertrophic in four

(9%) patients. Global atrophy of the liver was observed in six (14%) cases.

The liver surface was smooth in 30 (71%) patients and nodular in seven (17%) and presented with focal retraction in five (12%).

Ten (24%) patients had hypertrophy of the caudate lobe associated with atrophy of segment IV (mimicking cirrhosis). The liver was smooth in four of these patients and nodular in three and had focal retraction in three. Six (14%) patients had hypertrophy of segment IV and the caudate lobe associated with atrophy of the right liver and/or left lateral segment, including five patients with cavernous transformation of the portal vein and one patient with acute extrahepatic thrombosis.

Nodules were identified in 11 (26%) patients. Five (12%) patients had one or more nodules measuring between 10 and 20 mm, typical of FNH—homogeneous, hyperattenuating during the arterial phase, and with no washout (Fig 2). The nodule biopsy results confirmed the diagnosis of an FNH-like nodule in one of these patients. In another patient with one atypical 6-mm hyperattenuating nodule during the portal phase, the biopsy results showed an FNH-like nodule. Therefore, a total of six (14%) patients had FNH-like lesions. These six patients underwent serial CT examinations, results of which did not show any lesion change over time (range, 2–4.5 years). Hemangioma was observed in three patients, a regenerative macronodule in one (diagnosis made at histologic examination of explanted liver), and an undetermined nodule in one. No patient had nodules suggesting hepatocellular carcinoma.

The parenchyma was heterogeneous in 17 (40%) patients; perfusion disorders were observed in 15 (36%) patients, while enhancement during the late phase (fibrosis) was identified in two patients.

Portal hypertension.—Forty (95%) patients had signs of portal hypertension, including varices and portosystemic collateral vessels in 29 (69%),

Figure 3

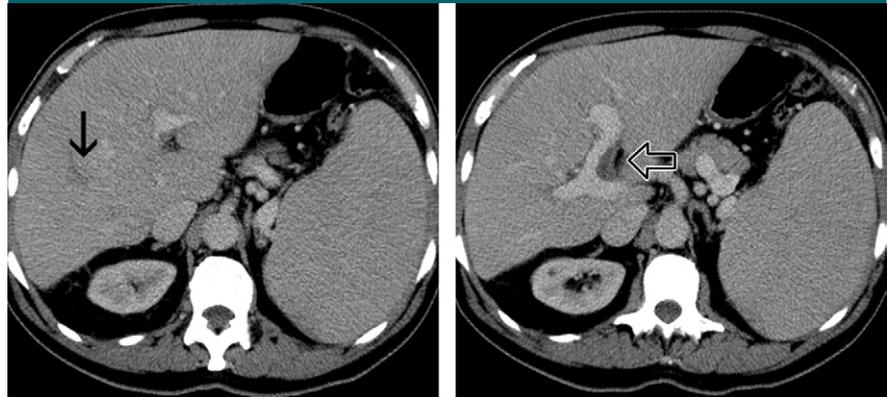
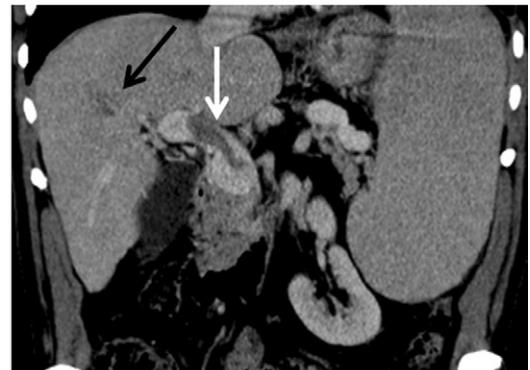


Figure 3: CT images in 77-year-old man with OPV and myeloproliferative disorder. (a, b) Axial contrast-enhanced helical CT images during the portal venous phase show occlusive thrombosis of the portal branch of segment VIII (arrow in a) and nonocclusive thrombosis of the left portal branch (arrow in b). (c) Coronal reconstruction of contrast-enhanced helical CT image during the portal venous phase shows nonocclusive thrombosis of the main portal vein (white arrow) and thrombosis of the portal branch of segment VIII (black arrow). Splenomegaly and portosystemic collateral vessels indicate portal hypertension. Note the right liver atrophy, which is probably related to complete obstruction of ipsilateral portal branches.



ascites in 12 (29%), and an enlarged spleen in 31 (73%) (Figs 2–4). Two others underwent splenectomy for portal hypertension. Two of the patients with isolated splenomegaly had a myeloproliferative disorder as well as varices at endoscopy. Five of the patients with ascites had extrahepatic portal thrombosis. Two patients had no signs of portal hypertension.

Hepatic arteries.—An enlarged hepatic artery or several arteries at the hilum were identified in 19 (45%) patients (Fig 4), including 13 who had thrombosis of the extrahepatic portal system and four with FNH-like lesions.

Clinical imaging correlation.—Table 1 summarizes the frequency of the main imaging findings in patients

with OPV distributed according to known associated pathologic conditions. Portal vein thrombosis occurred more frequently in patients with prothrombotic diseases (83%) than in other patients (27%) ($P = .001$). An enlargement of the hepatic artery was also more frequent in this group (75%) than in the others (33%) ($P = .02$). Liver morphology mimicking cirrhosis (hypertrophy of the caudate lobe and atrophy of segment IV) was more frequent in the group without OPV-associated diseases (42%) than in the other groups (9%) ($P = .03$). There were no other statistically significant differences between groups.

Cirrhotic Group

Image quality was good to excellent in all cirrhotic patients.

In the cirrhotic group, five (12%) patients had nonocclusive thrombosis of the extrahepatic portal system

Figure 4

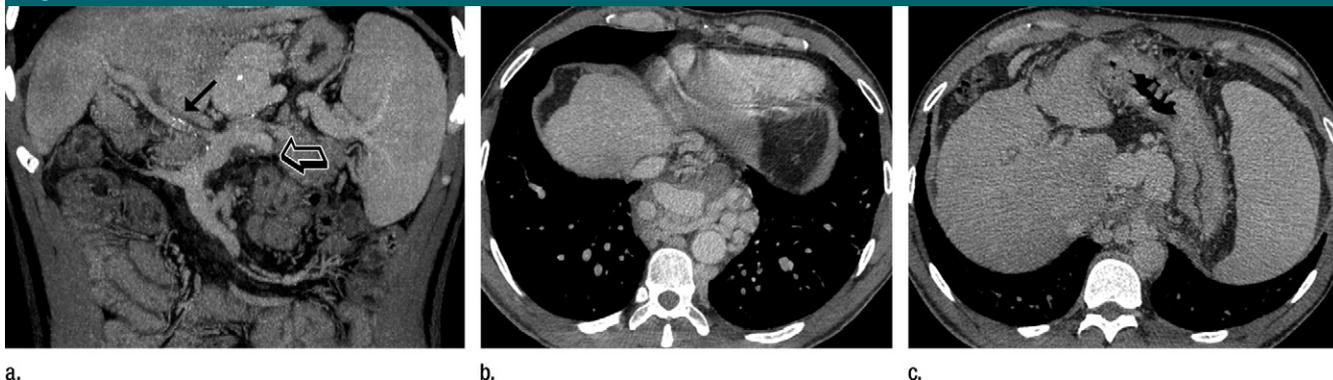


Figure 4: Images in 44-year-old man with OPV. **(a)** Coronal maximum intensity projection reconstruction of contrast-enhanced helical CT image during the portal venous phase shows mural calcifications of the portal vein (solid arrow) and nonocclusive thrombosis of splenic and superior mesenteric veins (open arrow). **(b, c)** Axial contrast-enhanced helical CT images during the portal venous phase show large gastroesophageal varices, morphologic changes of the liver with hypertrophy of the caudate lobe, and splenomegaly.

Figure 5

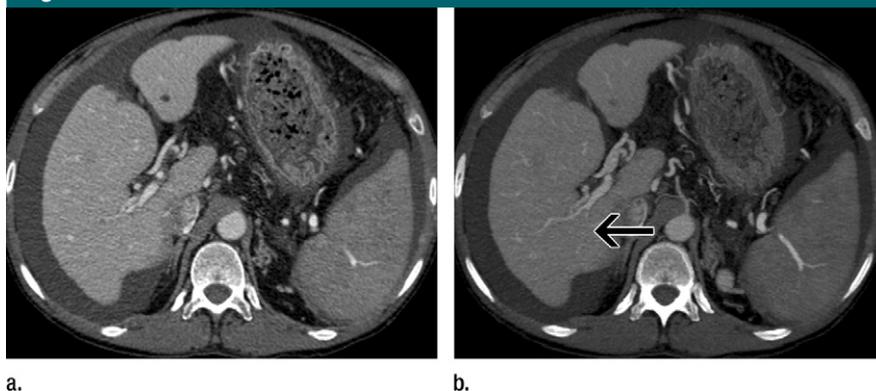


Figure 5: Images in 54-year-old woman with OPV and HIV infection. **(a)** Axial contrast-enhanced helical CT image during the portal venous phase shows few intrahepatic portal branches. **(b)** Axial maximum intensity projection reconstruction of contrast-enhanced helical CT image during the portal venous phase shows reduction in caliber of the portal branch of segment VII (arrow) compared with the branch of segment VIII. Note the enlarged intra- and extrahepatic arteries in **a** and **b**, presence of ascites, and signs of portal hypertension (splenorenal shunts and splenomegaly).

involving the portal vein in two patients (with mural calcifications of the portal vein in one), the portal vein and the superior mesenteric vein in one patient (with mural calcifications of the portal vein and the splenic vein), the portal vein and the left portal branch in one patient, and the splenic vein in one patient. In the 37 (88%) remaining patients, the extrahepatic portal system was patent without any mural calcification. No patient had cavernous transformation of the portal vein. Intrahepatic portal venous branches

were normal in 41 (98%) patients (Fig 6), and one patient had nonocclusive thrombosis of the right anterior portal branch (associated with nonocclusive thrombosis of the portal vein and superior mesenteric vein).

Liver morphology was abnormal in 41 (98%) patients with atrophy of segment IV in 36 (86%) patients, hypertrophy of the caudate lobe in 30 (71%), hypertrophy of left liver in 16 (38%), atrophy of right liver in 12 (29%), atrophy of left liver in two (5%), and hypertrophy of right liver in one (2%).

Atrophy of segment IV and hypertrophy of the caudate lobe occurred in 27 (64%) patients (Fig 6). Liver morphology was normal in one patient. The liver surface was nodular in 37 (88%) patients and smooth in five (12%).

One patient with cirrhosis had a 16-mm hypervascular nodule that was hypoattenuating during the delayed phase. Liver biopsy results confirmed hepatocellular carcinoma.

Perfusion disorders were observed in six (14%) patients, and confluent fibrosis was observed in five (12%) patients. Signs of portal hypertension were present in 39 (93%) patients: enlarged spleen in 38 (90%), varices and portosystemic collateral vessels in 33 (79%), and ascites in 15 (36%). Hepatic artery enlargement at the hilum was seen in 32 (76%) patients.

Table 2 shows the main CT findings in the OPV and cirrhotic groups. Both extra- and intrahepatic portal vein abnormalities occurred more frequently in patients with OPV than in patients with cirrhosis. Both groups showed morphologic changes of the liver in most cases. However, the combination of hypertrophy of the caudate lobe and atrophy of segment IV, as well as the presence of nodular liver surface, was statistically associated with cirrhosis. Conversely, FNH-like nodules were seen only in patients with OPV.

Discussion

Little is known of imaging features associated with OPV. In our study, we have shown characteristic CT findings including intra- and extrahepatic portal vein abnormalities and changes in liver morphology.

In our series, extra- and/or intrahepatic portal venous abnormalities were seen in most patients with OPV (71%). At diagnosis, we found acute or chronic and occlusive or nonocclusive extrahepatic thrombosis of the portal vein or its main tributaries in 43% of patients (10). We were also able to confirm that the incidence of extrahepatic portal vein thrombosis was more frequent in patients with OPV than in patients with cirrhosis (11). Interestingly, in 39% (seven of 18) of our patients with OPV who had extrahepatic portal vein thrombosis, these venous abnormalities could not be responsible for portal hypertension either because portal vein thrombosis was not occlusive or because diagnosis of portal vein thrombosis was made at an acute stage. Conversely, the diagnosis of OPV can be difficult in patients with cavernous transformation of the portal vein (often associated with signs of portal hypertension) in whom the intrahepatic portal branches cannot be analyzed.

In our study, intrahepatic portal vein abnormalities were identified at contrast-enhanced CT examinations in 58% of our patients with OPV and in one of the patients with cirrhosis, which suggests that these findings are highly specific of OPV. The different presentations we observed (from reduced caliber to vessel disappearance) reflect the severity of the phleboscrosis found at histologic examination of liver explants, ranging from mild with partial obstruction and the lumen open by more than 50% to severe involvement with more than 75% occlusion of the lumen (2). Interestingly, when the intrahepatic portal branches could be evaluated (31 patients), 12 patients had isolated intrahepatic abnormalities. Dhiman et al (6) have also described intrahepatic

portal branch abnormalities such as sudden narrowing of second-degree portal branches at splenoportovenography in some patients.

Morphologic changes were found in the liver of more than 80% of patients with OPV at diagnosis. Although the patterns of these changes varied, the two most common were hypertrophy of the caudate lobe and atrophy of the right liver. These changes could be because of intrahepatic portal venous obstruction inducing perfusion disorders and ipsilateral segmental liver atrophy. Morphologic changes of the liver may be found in other diseases such as cirrhosis, as well as vascular diseases such as Budd-Chiari syndrome, end-stage cholangitis, and congenital hepatic fibrosis. In our study, the morphologic changes in the liver mimicked cirrhosis (atrophy of segment IV and caudate hypertrophy) in nearly 25% of the patients with OPV, but most of these patients had a smooth liver surface. Nodular liver surface, which was rarely observed in OPV, could be because of distal portal venous obstruction, which is known to cause focal liver surface retraction. Conversely, as expected, most of our patients with cirrhosis had nodular liver surface and/or combined atrophy of segment IV and caudate hypertrophy. Global atrophy of the liver occurred rarely in our patients with OPV. In OPV, liver atrophy has been observed in more advanced cases and therefore could represent a later stage diagnosis (4,5,12).

Nodular regenerative hyperplasia is a common histologic finding in patients with OPV, while liver nodules are rarely described. In a pathologic study of explanted livers, Krasinskas et al (4) reported FNH-like lesions in two of 16 patients. In our series, hypervascular lesions sharing all the features of FNH-like lesions were seen in 14% of patients with OPV and not in patients with cirrhosis. These lesions are known to be a response to hemodynamic disturbances from decreased portal venous inflow and increased arterial inflow. FNH-like lesions are also seen

Figure 6

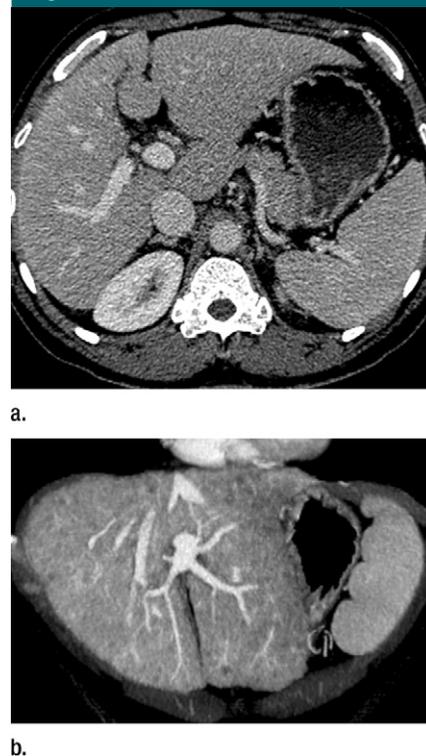


Figure 6: Images in 55-year-old man with cirrhosis. **(a)** Axial contrast-enhanced helical CT image during the portal venous phase shows morphologic changes of the liver with atrophy of segment IV and hypertrophy of the caudate lobe. Note the nodular liver surface. **(b)** Coronal maximum intensity projection reconstruction of contrast-enhanced helical CT image during the portal venous phase shows the normal appearance of the intrahepatic portal branches of the left liver.

in roughly one-third of patients with chronic Budd-Chiari syndrome (13). In patients with OPV with morphologic liver changes suggesting cirrhosis, the diagnosis of FNH-like lesions would be difficult because the lesions are hypervascular like hepatocellular carcinoma. However, only two cases of hepatocellular carcinoma in patients with OPV have been reported to date (14,15).

Signs of portal hypertension were seen at diagnosis at CT in nearly all patients with OPV, which is not surprising because the most common clinical presentation was complications related to portal hypertension. Because signs of portal hypertension

Table 2

Main CT Findings Observed in Patients with OPV and Patients with Cirrhosis

Parameter	OPV Group (n = 42)	Cirrhotic Group (n = 42)	P Value*
Intra- and/or extrahepatic portal vein abnormalities	30 (71)	7 (17)	<.001
Extrahepatic portal vein abnormalities	18 (43)	5 (12)	.003
Intrahepatic portal branches abnormalities	18/31 (58)	1 (2)	<.001
Mural calcifications of the portal veins	7 (17)	2 (5)	.16
Morphologic changes of the liver	35 (83)	41 (98)	.057
Hypertrophy of the caudate lobe and atrophy of segment IV	10 (24)	27 (64)	<.001
Nodular liver surface	7 (17)	37 (88)	<.001
FNH-like nodules	6 (14)	0	.03

Note.—Data are numbers of patients, with percentages in parentheses.

* P value represents the difference between observed findings in the two groups. The difference is statistically significant when P is less than .05.

were seen in most of our patients with cirrhosis, this feature is not helpful for differential diagnosis.

In our series, imaging features of increased arterial hepatic inflow were found in 45% of the patients with OPV, explaining the high prevalence of perfusion disorders. This feature has been previously described in liver specimens and called portal arteriopathy (4).

All the recognized risk factors for OPV were found in our patient population: The most common were prothrombotic disorders and immune-mediated diseases. There were also patients with HIV in our population. It has been shown that most cases of unexplained liver disease in patients with a long history of HIV infection and adequate immune restoration with antiretroviral therapy are due to nodular regenerative hyperplasia secondary to OPV (16–18). A statistically higher prevalence of portal vein thrombosis was observed in patients with prothrombotic diseases than in others.

There were certain limitations to our study. First, the study design was retrospective; however, both patients with OPV and patients with cirrhosis were consecutively enrolled, and CT analysis was performed blinded to clinical data and patient group. Second, the enrollment period differed between patients with OPV and patients with cirrhosis. Consequently, CT examinations were performed by using a variety

of equipment in patients with OPV. Yet, all patients were scanned with a helical technique and underwent both arterial and portal venous phase imaging. Using multidetector CT techniques, thinner section reconstruction, and adequate postprocessing could potentially increase the number of patients with OPV with suggestive intrahepatic abnormalities, especially those with alterations of intrahepatic third-order portal branches. Third, we did not assess interobserver variability of the CT findings because the goal of this first CT study was to describe imaging findings that have never been reported in OPV and to compare them with those in patients with cirrhosis. In conclusion, in patients with OPV, the presence of intra- or extrahepatic portal abnormalities and morphologic changes in the liver at CT are frequent and differ from those observed in patients with cirrhosis. On the basis of these findings, it is possible to diagnose OPV early, which could improve patient treatment, especially when the diagnosis is difficult at liver needle biopsy.

Disclosures of Potential Conflicts of Interest: **A.S.G.** No potential conflicts of interest to disclose. **S.H.** No potential conflicts of interest to disclose. **G.d.A.** Financial activities related to the present article: none to disclose. Financial activities not related to the present article: author is board member for Novartis (subject of the board is endocrine tumor). Other relationships: none to disclose. **D.C.** No potential conflicts of interest to disclose. **A.P.** No potential conflicts of interest to disclose. **D.C.V.** No potential conflicts of interest to disclose. **V.V.** Financial activities related to the present

article: none to disclose. Financial activities not related to the present article: institution receives grant from French health ministry. Other relationships: none to disclose.

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