Extrahepatic portosystemic shunt via the superior mesenteric vein: a review of imaging and clinical features

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Learning objectives

- To describe the anatomy of spontaneous portosystemic shunts (SPSS), focusing on extrahepatic systemic anastomoses from the superior mesenteric vein (SMV).

- To recognize their characteristics imaging findings, and review the different shunt pathways, as well as the most frequent drainage veins to the systemic circulation.

- To analyze the relationship between SPSS and liver cirrhosis, portal hypertension, and hepatic encephalopathy (HE).
Background

The development of portal hypertension is the most common complication of cirrhosis that includes a wide range of manifestations and the main cause of mortality in patients suffering the disease.

Portal hypertension can be described as a portal pressure of greater than 10 mmHg. Patients with increased portal venous pressure have a reversal of flow in the portal system changing from hepatopetal to hepatofugal. Once the liver disease progresses, increasing resistance of the hepatic sinusoidal level elevates portal venous pressure and causes development and enlargement of portosystemic collateral vessels. The prognosis of these collateral circulation depends on the risk of gastrointestinal bleeding, and development on hepatic encephalopathy.

Portosystemic shunts develop mainly in patients with cirrhosis and portal hypertension as a way to decompress the splachnic flow. Portosystemic shunts divert portal blood from the abdominal viscera to systemic venous system bypassing the hepatic sinusoids and carrying intestinal absorption products like ammonia, directly to the brain producing hepatic encephalopathy when the intrahepatic circulation is effectively bypassed. This encompasses a wide range of neuropsychiatric derangements that are associated with a liver failure. Clinical manifestations of portosystemic shunts depend on the magnitude of the shunt and the liver function, and are precipitated by events such as infections or gastrointestinal bleeding.

Portosystemic shunts can also occur even in children or patients without this clinical situation considering them as congenital, therefore abdominal imaging should be considered in patients with signs of HE.

In both situations (spontaneous and congenital) they can be divided as intra or extrahepatic. We focus on the extrahepatic ones that have an important role on hepatic disease development. Among them, the most common collaterals vessels include gastroesophageal varices, paraesophageal varices, gastro and splenorenal and paraumbilical shunts.

The present review will focus specifically on extrahepatic anastomoses between the portal venous system and the systemic veins, via the superior mesenteric vein. These mesenteric collateral vessels may ultimately drain into the systemic venous system through the gonadal vein, the renal vein, the iliac vein or via retroperitoneal varices known as the veins of Retzius. The shunts can be defined according to the receiving vein
as mesenteric-gonadal, mesenteric-renal, mesenteric-iliac, or mesenteric-caval shunts. These uncommon SPSS often have a large diameter and increase the risk of hepatic encephalopathy.

Although it is difficult to trace their course due to the complex and tortuous drainage, multidetector CT is the best method to display the vascular system and an excellent tool to demonstrate the drainage pathways as well as the number and size of these shunts. The volume rendering reconstructions can enhance the perception of the pathway by precisely demonstrating the courses of varices and the anatomic relationship of the shunts to plan a treatment (medical, surgical closure, embolization...).
Findings and procedure details

MATERIAL AND METHODS:

The present retrospective study focuses on portosystemic shunts (SPSS) via the superior mesenteric vein (SMV). We retrospectively reviewed 32 cases of SPSS via the SMV identified in our tertiary referral hospital between 2001 and 2013 by means of multidetector-row computed tomography (MDCT), including 24 men and 8 women aged between 40-78 years (mean age 57.9 years), all of them performed for evaluating liver disease.

All our 32 patients had liver disease, and five of them presented also hepatic encephalopathy. Three patients with liver cirrhosis were bearing hepatocellular carcinoma and one cholangiocellular carcinoma.

Initial studies were performed with a 4-row (n=4), 16-row (n=26), or 64-row (n=2) MDCT scanner. All patients have a portal venous phase CT from the diaphragm to the pelvis with a slice-thickness of 2 to 2.5 mm, and a reconstruction interval of 1.5 mm. In all cases the venous enhancement was considered satisfactory. We revised imaging findings by scrolling CT images in axial plane and also using multiplanar evaluation for the assessment of the vascular anatomy. Maximum intensity projection (MIP) and volume rendering (VR) were also systematically performed on a workstation to analyze portosystemic collateral vessels.

Studies were analyzed assessing the pathway, the drainage level, the number and the size of the shunts, and their configuration, as well as the presence of other portosystemic shunts. The diameters of the portal vein and SMV vein were also obtained, as well as the presence of a "jet" flow into the drainage vein.

FINDINGS:

We retrospectively reviewed 32 cases of SPSS via the SMV. All our patients had liver disease and five of them presented hepatic encephalopathy (cases number 2, 8, 11, 16 and 27). We identified 53 shunts in 32 patients (average of 1.7 draining veins per patient). Although most patients showed a single drainage vein (18/32), eight patients had two draining veins, five patients presented three draining veins and in one patient four draining veins were identified. [The results of our study are shown in Table 1].
Fig. 38: Table 1. Table depicts results observed in our 32 patients with mesocaval shunts. PV: portal vein; SMV: superior mesenteric vein; IVC: inferior vena cava; HE: hepatic encephalopathy; OLT: orthotopic liver transplantation.

References: Hospital Vall d'Hebron - Barcelona/ES

In patients with a single draining vein, the most frequent shunt observed was through the right gonadal vein in most than 50% of cases (10/18, Fig. 1 on page 18, Fig. 2 on page 18, Fig. 7 on page 23, Fig. 8 on page 24, Fig. 9 on page 25, Fig. 17 on page 33, Fig. 19 on page 35, Fig. 25 on page 41, Fig. 27 on page 43), although a single shunt through retroperitoneal varix (Reitzus veins, 4/18, Fig. 5 on page 21, Fig. 11 on page 27, Fig. 15 on page 31, Fig. 21 on page 37), through the left renal vein (3/18, Fig. 30 on page 46, Fig. 33 on page 49, Fig. 35 on page 51), or through the right renal vein (1/18, Fig. 4 on page 20) were also observed.
Fig. 1: Case 1. SPSS from SMV to the IVC via the right gonadal vein (RGV). Fig. a: coronal CT image depicts a patent portal vein (arrow). Fig. b axial CT image shows a dilated (14 mm) SMV (arrow). Fig. c: coronal CT reconstruction shows a dilated right gonadal vein (arrow) draining into the dilated IVC (asterisk). Fig. d: volume rendering reconstruction nicely demonstrates the course of the shunt from the dilated SMV, through mesenteric varices (arrows) and RGV into the IVC (asterisk).

References: Hospital Vall d’Hebron - Barcelona/ES
Fig. 30: Case 26. Mesocaval shunt through the left renal vein. Fig. a: axial CT image shows a dilated (20 mm) SMV (arrow). Fig. b: axial CT image depicts a wide shunt (arrow) into the dilated left renal vein. Fig. c: volume rendering image demonstrates dilated jejunal veins (arrow) and left renal vein (LRV). Fig. d: lateral view of volume rendering reconstruction shows the precise location of the portosystemic shunt (arrow).

References: Hospital Vall d'Hebron - Barcelona/ES
Fig. 20: Case 18. Portosystemic shunt from SMV through retroperitoneal varices to the IVC and right internal iliac vein. Fig. a: axial CT image shows a retroperitoneal varix entering into the IVC (arrow). Fig. b: coronal CT image shows a larger communication with the right internal iliac vein (arrow). Figs. c & d: volume rendering images depict the pathway of mesenteric varices and the shunt with the right internal iliac vein (arrow).

References: Hospital Vall d'Hebron - Barcelona/ES

When considering the individual draining veins, the most frequent portosystemic shunt found in the present study was through the right gonadal vein (16/53, mean diameter was 7 mm, range 4-11 mm) (Fig. 1 on page 18, Fig. 2 on page 18, Fig. 6 on page 22, Fig. 7 on page 23, Fig. 8 on page 24, Fig. 9 on page 25, Fig. 17 on page 33, Fig. 18 on page 34, Fig. 19 on page 35, Fig. 22 on page 38, Fig. 25 on page 41, Fig. 27 on page 43, Fig. 28 on page 44, Fig. 29 on page 45, Fig. 34 on page 50), retroperitoneal varices were the second most frequent pathway (Retzius veins, 14/53, mean diameter was 5.6 mm, range 4-10 mm) (Fig. 5 on page 21, Fig. 11 on page 27, Fig. 12 on page 28, Fig. 14 on page 30, Fig. 15 on page 31, Fig. 16 on page 32, Fig. 18 on page 34, Fig. 20 on page 36, Fig. 24 on page 40, Fig. 28 on page 44), followed by the right renal vein (12/53, mean diameter was 6 mm, range 2-11 mm) (Fig. 4 on page 20, Fig. 10 on page 26, Fig. 12 on page 28, Fig.
the left renal vein (6/52, mean diameter was 8.3 mm, range 5-14 mm) (Fig. 22 on page 38, Fig. 30 on page 46, Fig. 31 on page 47, Fig. 33 on page 49, Fig. 33 on page 49, Fig. 35 on page 51), and the right internal iliac vein (3/52, mean diameter was 8.6 mm, range 5-14 mm) (Fig. 6 on page 22, Fig. 20 on page 36, Fig. 31 on page 47). Others communications observed in the sample were through the right common iliac vein (1/52, 6 mm) (Fig. 32 on page 48), and the left gonadal vein (1/52, 7 mm) (Fig. 29 on page 45). The mean diameter per shunt was 6.7 mm (range 2-14 mm). Noteworthy that in most cases, the largest sizes were observed in those who had multiple draining veins.

Fig. 10: Case 9. Mesocaval shunt through the right renal vein (RRV). Figs. a & b: coronal and volume rendering images respectively demonstrate retroperitoneal varices draining into the RRV (arrows). Fig. c: volume rendering image clearly shows the course of the mesocaval shunt and the pathway of the two draining veins (white arrows).

References: Hospital Vall d'Hebron - Barcelona/ES
**Fig. 11:** Case 10. Mesocaval shunt. Figs. a & b: axial and coronal CT images respectively depict a draining retroperitoneal vein into the medial aspect of IVC (arrows). Fig. c: volume rendering image shows the pathway of the superior mesenteric vein shunt through mesenteric and retroperitoneal varices (white arrows). See also left gastric vein varices (orange arrow). Fig. d: Volume rendering image shows the IVC drainage (arrow).

**References:** Hospital Vall d’Hebron - Barcelona/ES

The mean diameter of SPSS from SMV to IVC per patient was 11 mm (range 4-28 mm). When considering patients with a single shunt, the mean diameter was 6.9 mm (range 4-14 mm), whereas patients with several shunts presented a mean diameter of 16.36 mm (range 11-28 mm). In eight cases, additional nine IVC shunts were identified. Four gastrorenal shunts (Fig. 29 on page 45, Fig. 35 on page 51), three splenorenal shunts (Fig. 4 on page 20), and two shunts through umbilical vein (Fig. 7 on page 23). The diameter of these shunts were added to the SMV-IVC shunt in those cases. The mean diameter of SPSS per patient was thereafter 13 mm (range 4-34 mm).
Fig. 7: Case 6. SPSS through right gonadal vein. Fig. a: axial CT image shows the right gonadal vein entering the IVC (arrow). Fig. b: coronal CT image depicts a patent portal vein and presence of mesenteric varices in small bowel (yellow arrow). Fig. c: volume rendering image depicts a portosystemic shunt through the umbilical vein to the right external iliac vein (white arrows), as well as mesenteric varices (yellow arrow) draining into the right gonadal vein. Fig. d: volume rendering reconstruction demonstrates the mesenteric varices depending from ileal mesenteric branches communicating with the right gonadal vein (arrows) and draining into the IVC. The patient presented gastrointestinal bleeding from these mesenteric varices.

References: Hospital Vall d’Hebron - Barcelona/ES

Although our CT are not dynamic studies for evaluating vascular flows, we observed in 6 cases (Fig. 2 on page 18, Fig. 8 on page 24, Fig. 9 on page 25, Fig. 15 on page 31, and Fig. 22 on page 38) a jet flow from the draining vein into the IVC, representing inflow from an opacified drainage pathway toward an unenhanced IVC, and a “flow artifact” in left renal vein at the shunt level during the arterial phase was was clearly identified in one case (Fig. 35 on page 51), representing inflow from unenhanced collateral vessel toward a high opacified left renal vein during arterial late phase.
Fig. 15: Case 13. Mesocaval shunt through retroperitoneal varices. Fig. a: axial CT image depicts a dilated (19 mm) superior mesenteric vein (arrow). Fig. b: axial CT image at a caudal level demonstrates communication between a large retroperitoneal varix and the IVC, with a jet flow entering the vena cava (arrow). Fig. c: sagittal CT image shows the shunt communication and also a jet flow into the IVC (arrow). Fig. d: volume rendering image depicts the dilated superior mesenteric vein as well as mesenteric and retroperitoneal varices (arrows).

References: Hospital Vall d'Hebron - Barcelona/ES

We also measure the PV and SMV diameters in all cases. Four patients presented partial or almost complete thrombosis of the PV (Fig. 6 on page 22, Fig. 17 on page 33). From the other 18 patients the mean diameter of the PV was 11.4 mm (range 5-16 mm). Two patients presented thrombosis of the distal SMV; the mean SMV diameter of the other 30 cases was 14.5 mm (range 9-27 mm), superior to mean PV diameter.

In our study only five of 32 patients (15.6%) exhibit symptoms suggestive of EH. The total average diameter of the portosystemic shunt in these patients was 13.4 mm (range 9-22 mm), similar to the patients without symptoms (12.9 mm, range 4-34). Two of these patients with EH show a single draining vein from SMV to the IVC (although one had an
additional splenorenal shunt), and the other three patients had three draining veins and no additional shunt. Moreover no significant differences were found in the PV or SMV diameter among patients with or without EH.

Five patients received an orthotopic hepatic transplantation. In all cases the SPSS remained patent although the diameter decreased in all cases (see Fig. 17 on page 33, Fig. 22 on page 38, and Fig. 23 on page 39).

**Fig. 17**: Case 15. Mesocaval shunt through the right gonadal vein. Fig. a: axial CT image depicts a dilated right gonadal vein entering the IVC (arrow). Fig. b: coronal CT image shows a partially thrombosed portal vein (arrow). Fig. c: volume rendering image shows the shunt pathway through mesenteric varices (white arrow) to the dilated right gonadal vein (yellow arrow). Fig. d: volume rendering image of the same patient after an orthotopic liver transplantation, demonstrates patency of the portal vein, and reduction in size of the mesenteric varices (white arrow) and gonadal vein (yellow arrow), probably secondary to decreased pressure in the mesenteric vein, although the mesocaval shunt remains patent.

**References**: Hospital Vall d’Hebron - Barcelona/ES
Only in three cases the shunt were embolized (all of them with EH), by means of retrograde obliteration using an Amplatzer Vascular Plug (Fig. 3 on page 19, Fig. 9 on page 25, and Fig. 13 on page 29). The other 29 patients were treated conservatively due to lack of EH, important comorbidity, severe portal hypertension or with medical therapy to correct the precipitating cause of the EH.

Fig. 13: Case 11. Same case as fig. 12. Fig. a: posterior view of volume rendering reconstruction shows the dilated right gonadal vein and two small retroperitoneal collateral veins (arrows) that drain into the right renal vein (see axial images in Fig.12b). Fig. b: same projection of volume rendering image after embolization with an Amplatzer Vascular Plug (blue arrow), demonstrates occlusion of the right gonadal vein (the larger shunt), although the two small shunts to the right renal vein increased in size (white arrows).

References: Hospital Vall d'Hebron - Barcelona/ES

Finally, it is important to highlight that two of our patients developed gastrointestinal bleeding from submucosal ectopic varices in the small bowel (Fig. 7 on page 23, Fig. 25 on page 41 and Fig. 26 on page 42) that communicate with the IVC through the right gonadal vein.
**Fig. 25:** Case 22. Mesocaval shunt through right gonadal vein. Fig. a: axial CT image depicts the right gonadal vein entering the IVC (arrow). Fig. b & c: axial CT images at a caudal level demonstrated mesenteric varices within small bowel loops (arrows). Figs. d & e: Coronal MIP images nicely shows the mesenteric varices (arrows in Fig. d) and the dilated right gonadal vein (yellow arrows in Fig. e). Note also dilated left gastric veins (white arrow in Fig. e) and periuterine venous plexus in Fig. d. The patient presented acute lower gastrointestinal bleeding.

**References:** Hospital Vall d'Hebron - Barcelona/ES

**DISCUSSION:**

Portosystemic shunts develop mainly in patients with cirrhosis and portal hypertension as a way to decompress the splachnic flow and play an important role in the etiology of chronic recurrent hepatic encephalopathy in liver cirrhosis which remains a major cause of morbidity in these patients.
Although portosystemic shunts arising from the SMV are rare, they can be a major cause of sustained HE as a result of the retrograde direction of flow from mesenteric veins to the systemic circulation, bypassing the liver. The retroperitoneal pathways between the tributaries of the SMV and IVC are considered a remnant of fetal communication, known as veins of Retzius, with passive opening of vascular channels in response to increased portal pressure.

It is often difficult to completely trace the drainage course of these collateral veins due to the complex and often extensive nature of these vessels that appear as small, rounded or tubular areas of increased attenuation that enhance to the same degree as the mesenteric veins. These collateral varices, developed in response to increased portal pressure, frequently drain through IVC tributaries such as the right gonadal vein, right or left renal veins, or directly into the IVC or the iliac veins, as in our serie. The drainage is often through a single vein, although quite frequently the draining veins can be multiple.

Relationship between the caliber of the shunt and the incidence of encephalopathy have been demonstrated, although the development of HE is multifactorial and depends not only on the magnitude of the shunt, but also on the liver function, and precipitating events such as infection or gastrointestinal bleeding. Our serie didn't demonstrate a clear relationship between the number or size of the portosystemic shunts and HE, supporting the idea that it depends largely on the function of residual hepatocytes.

The existence of portosystemic shunts should be investigated in patients with clinical symptoms of HE, since their presence not only provides an explanation for the refractoriness of encephalopathy, and can be useful in the management of these patients and it might also represent a therapeutic target. Moreover, unrecognized large systemic shunts may reduce the liver perfusion and further compromise the liver function.

MDCT is the best method to display the vascular system and an excellent tool to explore the drainage pathways, as well as the number and size of these shunts, and in addition MIP and volume rendering reconstructions can enhance the perception of the pathway and the anatomic relationship of the shunt to plan the treatment. Although sometimes it is difficult to trace the entire shunt pathway due to its tortuous course, precise recognition of the path of confluence is essential for successful endovascular treatment. MDCT is also important to confirm portal vein patency before shunt closure.
**Fig. 1:** Case 1. SPSS from SMV to the IVC via the right gonadal vein (RGV). Fig. a: coronal CT image depicts a patent portal vein (arrow). Fig. b axial CT image shows a dilated (14 mm) SMV (arrow). Fig. c: coronal CT reconstruction shows a dilated right gonadal vein (arrow) draining into the dilated IVC (asterisk). Fig. d: volume rendering reconstruction nicely demonstrates the course of the shunt from the dilated SMV, through mesenteric varices (arrows) and RGV into the IVC (asterisk).

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Fig. 2: Case 2. SPSS from SMV to the IVC. Fig a: axial CT image shows a dilated (9 mm) right gonadal vein draining into the IVC (arrow). Fig b: volume rendering reconstruction depicts tortuous mesenteric varices draining through the right gonadal vein (arrow). Fig c: coronal MDCT reconstruction shows the dilated RGV as a single drainage vein of the mesocaval shunt, and a clearly visible "jet flow" (arrow) within the IVC. The patient presented hepatic encephalopathy and the portosystemic shunt was embolized.

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**Fig. 3:** Case 2. Same case as Fig. 2. Figs. a, b &c: coronal MDCT reconstructed images depict partial extensive thrombosis of the shunt (white arrows) after embolization with an Amplatzer Vascular Plug (yellow arrow).

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Fig. 4: Case 3. SPSS from SMV through a single drainage vein to the right renal vein. Fig. a: axial CT image demonstrates a 7 mm shunt to the right renal vein (arrow). Fig. b: coronal CT image depicts a 9 mm splenorenal shunt (arrow). Fig. c: anterior view of volume rendering reconstruction shows tortuous mesenteric varices (arrows). Fig. d: posterior view of volume rendering reconstructions depicts a single draining vein (white arrow) connecting with the posterior aspect of the right renal vein (yellow arrow).

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**Fig. 5:** Case 4. Mesocaval shunt through retroperitoneal varices. Fig. a: axial CT image shows a direct shunt from a single retroperitoneal draining vein to the anterior aspect of the IVC (arrow). Fig. b: coronal CT image depicts the inflow jet within the IVC (arrow). Figs. c & d: volume rendering images demonstrates the course of the mesocaval shunt through tortuous and dilated mesenteric varices (arrows) to the IVC.

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Fig. 6: Case 5. SPSS through right gonadal vein and right internal iliac vein. Fig. a: coronal CT image shows a partially thrombosed portal vein (white arrow) and a dilated right gonadal vein (yellow arrow). Fig. b: sagital CT image shows dilated mesenteric varices (blue arrow) and the dilated right gonadal vein (yellow arrow) that drains into the IVC. Figs. c &d: volume rendering images demonstrates the course of the shunt through mesenteric varices (blue arrow) to the RGV (yellow arrow), as well as a small shunt to the right internal iliac vein (yellow arrowhead).

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Fig. 7: Case 6. SPSS through right gonadal vein. Fig. a: axial CT image shows the right gonadal vein entering the IVC (arrow). Fig. b: coronal CT image depicts a patent portal vein and presence of mesenteric varices in small bowel (yellow arrow). Fig. c: volume rendering image depicts a portosystemic shunt through the umbilical vein to the right external iliac vein (white arrows), as well as mesenteric varices (yellow arrow) draining into the right gonadal vein. Fig. d: volume rendering reconstruction demonstrates the mesenteric varices depending from ileal mesenteric branches communicating with the right gonadal vein (arrows) and draining into the IVC. The patient presented gastrointestinal bleeding from these mesenteric varices.

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**Fig. 8:** Case 7. Mesocaval shunt through the right gonadal vein. Figs. a & b: axial and coronal CT images respectively demonstrate a dilated right gonadal vein draining into the IVC (arrows). Note the inflow jet into the IVC in Fig. b. Figs. c & d: volume rendering images shows the course of the mesocaval shunt through the dilated RGV (arrows).

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**Fig. 9:** Case 8. SPSS through the RGV in a patient with hepatic encephalopathy. Fig a & b: axial and coronal CT images respectively demonstrate the inflow jet of the dilated right gonadal vein into the IVC (arrows). Fig. c: volume rendering image shows the shunt through mesenteric varices (arrows). Fig. d: volume rendering image after shunt embolization shows the artifact of the embolization material (arrow), disappearance of mesenteric varices, and secondary dilatation of paraumbilical veins, draining into the internal thoracic vein through superior epigastric vein (arrows).

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**Fig. 10:** Case 9. Mesocaval shunt through the right renal vein (RRV). Figs. a & b: coronal and volume rendering images respectively demonstrate retroperitoneal varices draining into the RRV (arrows). Fig. c: volume rendering image clearly shows the course of the mesocaval shunt and the pathway of the two draining veins (white arrows).

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Fig. 11: Case 10. Mesocaval shunt. Figs. a & b: axial and coronal CT images respectively depicts a draining retroperitoneal vein into the medial aspect of IVC (arrows). Fig. c: volume rendering image shows the pathway of the superior mesenteric vein shunt through mesenteric and retroperitoneal varices (white arrows). See also left gastric vein varices (orange arrow). Fig. d: Volume rendering image shows the IVC drainage (arrow).

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Fig. 12: Case 11. Portosystemic shunt through right gonadal vein and right renal vein.
Fig. a: axial CT image depicts a dilated right gonadal vein entering the IVC (arrow). Fig. b: coronal and axial CT images show two different collateral retroperitoneal veins draining into the right renal vein (arrows). Figs. c & d: anterior and posterior view of volume rendering reconstruction respectively, demonstrate the shunt pathway and the larger draining vein into the IVC (right gonadal vein, arrows). The patient presented hepatic encephalopathy and the gonadal shunt was embolized.

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Fig. 13: Case 11. Same case as fig. 12. Fig. a: posterior view of volume rendering reconstruction shows the dilated right gonadal vein and two small retroperitoneal collateral veins (arrows) that drain into the right renal vein (see axial images in Fig.12b). Fig. b: same projection of volume rendering image after embolization with an Amplatzer Vascular Plug (blue arrow), demonstrates occlusion of the right gonadal vein (the larger shunt), although the two small shunts to the right renal vein increased in size (white arrows).

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Fig. 14: Case 12. Mesocaval shunt trough retroperitoneal veins to IVC and right renal vein. Fig. a: axial CT image depicts a small shunt to IVC (arrow) near the right renal vein entrance. Fig. b: axial CT image at a caudal level shows a second small shunt (arrow) to the IVC. Fig. c: coronal CT image depicts a shunt to the superior aspect of the right renal vein (arrow). Fig. d: coronal CT image shows the same shunt that Fig. b into the IVC. Fig. e: volume rendering image shows mesenteric-retroperitoneal varices (arrows). The patient presented also a gastrorenal shunt and a patent and dilated umbilical vein connecting to both external iliac veins (not shown).

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Fig. 15: Case 13. Mesocaval shunt through retroperitoneal varices. Fig. a: axial CT image depicts a dilated (19 mm) superior mesenteric vein (arrow). Fig. b: axial CT image at a caudal level demonstrates communication between a large retroperitoneal varix and the IVC, with a jet flow entering the vena cava (arrow). Fig. c: sagital CT image shows the shunt communication and also a jet flow into the IVC (arrow). Fig. d: volume rendering image depicts the dilated superior mesenteric vein as well as mesenteric and retroperitoneal varices (arrows).

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Fig. 16: Case 14. Portosystemic shunt through right gonadal and retroperitoneal veins. Fig. a: coronal CT image shows a dilated right gonadal vein entering the IVC (arrow). Fig. b, c & d: axial, coronal and axial CT images respectively, depict three different small retroperitoneal veins draining into the IVC (arrows). Fig. e: volume rendering image clearly depicts the larger shunt through the right gonadal vein (arrow).

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**Fig. 17:** Case 15. Mesocaval shunt through the right gonadal vein. Fig. a: axial CT image depicts a dilated right gonadal vein entering the IVC (arrow). Fig. b: coronal CT image shows a partially thrombosed portal vein (arrow). Fig. c: volume rendering image shows the shunt pathway through mesenteric varices (white arrow) to the dilated right gonadal vein (yellow arrow). Fig. d: volume rendering image of the same patient after an orthotopic liver transplantation, demonstrates patency of the portal vein, and reduction in size of the mesenteric varices (white arrow) and gonadal vein (yellow arrow), probably secondary to decreased pressure in the mesenteric vein, although the mesocaval shunt remains patent.

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**Fig. 18:** Case 16. Portosystemic shunt from the SMV through right renal vein, right gonadal vein and retroperitoneal veins to IVC. Fig. a: axial CT image depicts a slightly dilated right gonadal vein entering the IVC (arrow). Fig. b: axial CT image shows retroperitoneal varices draining into the IVC (arrow). Fig. c: coronal MIP reconstruction shows the shunts described in Fig. a and b (middle and lower arrows respectively), and a third shunt though the right renal vein (upper arrow). Fig. d: volume rendering image depicts the mesenteric varices connecting to retroperitoneal veins (arrows).

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Fig. 19: Case 17. Mesocaval shunt. Figs. a, b & c: anterior, right oblique and posterior view volume rendering images demonstrates a mesocaval shunt through a dilated right gonadal vein (arrows).

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Fig. 20: Case 18. Portosystemic shunt from SMV through retroperitoneal varices to the IVC and right internal iliac vein. Fig. a: axial CT image shows a retroperitoneal varix entering into the IVC (arrow). Fig. b: coronal CT image shows a larger communication with the right internal iliac vein (arrow). Figs. c & d: volume rendering images depict the pathway of mesenteric varices and the shunt with the right internal iliac vein (arrow).

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Fig. 21: Case 19. Mesocaval caval shunt through retroperitoneal veins. Figs. a & b: axial and coronal CT images demonstrate communication between a dilated retroperitoneal varix and the IVC (arrows). Figs. c & d: volume rendering images nicely depict the mesenteric varices from ileal branches of the SMV (arrows).

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Fig. 22: Case 20. Portosystemic shunt from SMV through right gonadal vein and both renal veins. Figs. a & b: axial and coronal CT images show a dilated right gonadal vein draining into the IVC (arrows). Note the jet flow into the IVC. Fig. c: axial CT image depicts a retroperitoneal varix draining into the right renal vein (arrow). Fig. d: coronal CT image demonstrates a large retroperitoneal shunt with distal left renal vein (arrow). Fig. e: volume rendering images shows the dilated mesenteric veins.

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**Fig. 23:** Case 20. Same case as Fig. 22, after orthotopic liver transplantation. CT images show persistence of the shunts previously described, through right gonadal vein (Fig. a, arrow), right renal vein (Fig. b, arrow), and left renal vein (Fig. c, arrow), as well as mesenteric varices (Fig. d), although all of them were reduced in size, probably due to decrease of the portal vein system pressure secondary to the liver transplantation.

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**Fig. 24:** Case 21. Mesocaval caval shunt through retroperitoneal veins draining into the IVC and right renal vein. Fig. a: coronal CT image depicts a large retroperitoneal vein draining into the right renal vein (arrow). Figs. b & c: axial and coronal CT images show a second shunt entering the IVC at a caudal level (arrows). Fig. d: volume rendering image demonstrates the entire pathway of the shunt and the draining locations (arrows).

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Fig. 25: Case 22. Mesocaval shunt through right gonadal vein. Fig. a: axial CT image depicts the right gonadal vein entering the IVC (arrow). Fig. b & c: axial CT images at a caudal level demonstrated mesenteric varices within small bowel loops (arrows). Figs. d & e: Coronal MIP images nicely shows the mesenteric varices (arrows in Fig. d) and the dilated right gonadal vein (yellow arrows in Fig. e). Note also dilated left gastric veins (white arrow in Fig. e) and periuterine venous plexus in Fig. d. The patient presented acute lower gastrointestinal bleeding.

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**Fig. 26:** Case 22. Same case that Fig.25. Figs a, b & c: volume rendering images clearly demonstrates the entire pathway of the shunt between mesenteric varices (yellow arrows) and right gonadal vein (white arrows).

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**Fig. 27:** Case 23. SPSS through right gonadal vein. Fig. a: coronal CT reconstruction shows retroperitoneal varices and a dilated right gonadal vein (arrow) entering into the IVC. Fig. b: anterior view of volume rendering image shows connexion between SMV and retroperitoneal varices through a mesenteric branch (arrow). Fig. c: posterior view of volume rendering image depicts a dilated right gonadal vein (arrow).

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Fig. 28: Case 24. Mesocaval shunt through right gonadal vein and retroperitoneal varices. Figs. a & b: axial and coronal CT images respectively show a dilated right gonadal vein draining into the IVC (arrows). Figs. c & d: axial and coronal CT images respectively at a caudal level demonstrate a second caval shunt (arrows) through retroperitoneal varices. Fig. e: volume rendering image depicts the distal mesenteric varices (arrows).
Fig. 29: Case 25. Mesocaval shunt through right and left gonadal veins. Fig. a: axial CT image shows dilated right retroperitoneal varices draining into IVC through the right gonadal vein (arrow). Fig. b: coronal CT image demonstrates a dilated left gonadal vein (arrow) entering the homolateral renal vein. Fig. c: coronal CT image shows an additional gastrorenal shunt (arrow). Fig. d: volume rendering image depicts right mesenteric varices (arrow) communicating with the right gonadal vein. Communication between both gonadal veins occur through periuterine venous plexus (not shown).

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Fig. 30: Case 26. Mesocaval shunt through the left renal vein. Fig. a: axial CT image shows a dilated (20 mm) SMV (arrow). Fig. b: axial CT image depicts a wide shunt (arrow) into the dilated left renal vein. Fig. c: volume rendering image demonstrates dilated jejunal veins (arrow) and left renal vein (LRV). Fig. d: lateral view of volume rendering reconstruction shows the precise location of the portosystemic shunt (arrow).

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**Fig. 31:** Case 27. SPSS from the SMV through the left renal vein and right internal iliac vein. Fig. a: coronal CT image displays a shunt (arrow) between retroperitoneal varices and left renal vein. Fig. b: axial CT image shows communication of mesenteric varices with the right internal iliac vein (arrow). Fig. c: volume rendering image demonstrates varices from the superior mesenteric distal branches (arrows). Fig. d: volume rendering image shows two draining veins to the left renal vein (upper arrow) and to the right internal iliac vein (lower arrow).

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**Fig. 32:** Case 28. Mesocaval shunt through right renal vein and right common iliac vein. Fig. a: axial CT image shows a small shunt with the right common iliac vein (arrow). Fig. b: axial CT image displays a larger shunt with the right renal vein (arrow). Figs. c & d: volume rendering images show the shunt pathway and draining veins into the right renal vein (arrow in Fig. c) and right common iliac vein (arrow in Fig. d).

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**Fig. 33:** Case 29. Mesenteric-renal shunt. Fig. a: coronal CT image depicts the shunt between the mesenteric circulation and the left renal vein. Figs. b & c: volume rendering images shows the shunt pathway (arrows) between jejunal branches of the SMV and the left renal vein (LRV).

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**Fig. 34**: Case 30. Mesocaval shunt through the right gonadal vein draining in the IVC and right renal vein. Fig. a: axial CT image depicts a small vessel draining into the distal right renal vein (arrow). Fig. b: coronal CT reconstruction shows a dilated right gonadal vein entering the IVC (arrow). Fig. c: volume rendering reconstruction image shows the shunt pathway through mesenteric varices and right gonadal vein (arrows). Fig. d: posterior view of volume rendering reconstruction demonstrates a small collateral vessel (arrows) draining into the right renal vein (RRV).

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**Fig. 35:** Case 32. Mesocaval shunt through the left renal vein. Fig. a: coronal CT image in the arterial phase demonstrates a laminar flow artifact (arrow) in the enhanced left renal vein due to unenhanced blood from the mesenteric shunt. Fig. b: coronal CT image in the venous phase shows the shunt (arrow) and disappearance of the "pseudothrombosis" because blood from the SMV becomes opacified. Fig. c & d: anterior and posterior view of volume rendering reconstruction depict the mesenteric to left renal vein shunt (yellow arrows) and also an additional gastrorenal shunt (white arrows).

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Conclusion

Extrahepatic portosystemic shunts developed between the SMV vein and systemic veins are rare. The retroperitoneal pathways between the tributaries of the SMV and IVC are considered a remnant of fetal communication, with passive opening of vascular channels in response to increased portal pressure. It is often difficult to completely trace the drainage course of these collateral veins due to the complex and often extensive nature of these vessels that appear as small, rounded or tubular areas of increased attenuation that enhance to the same degree as the mesenteric veins. Since Retzius reported on several anastomoses between the portal venous system and the IVC in the retroperitoneum, anastomoses between branches of the SMV or IMV and the IVC are known as the veins of Retzius. They usually have a tortuous or cirrhotic appearance and sometimes can drain through IVC tributaries such as the renal, the gonadal or the iliac veins.

The clinical manifestations of these shunts are the result of the retrograde direction of flow from the SMV, and they depend largely on the function of residual hepatocytes. Relationship between the caliber of the anastomosis and the incidence of encephalopathy have been demonstrated in this study. Although hepatic encephalopathy usually occurs in patients with end-stage liver disease with established portal hypertension, a small percentage of cases the disease can be present in patients with no apparent liver disorder.

MDCT is the best method to display the vascular system and an excellent tool to demonstrate the drainage pathways, as well as the number and size of these shunts, and MIP and volume rendering reconstructions allows creation of vascular maps, being the optimal imaging technique to guide the treatment when surgical or endovascular procedures are considered. MDCT is also important to confirm portal vein patency before shunt closure.

Radiologists should be familiar with the various imaging findings of these portosystemic shunts for establishing the correct diagnosis of affected patients, make the correct diagnosis and accurately describe the drainage pathways, since they are critical to select and guide the treatment's strategy for symptomatic shunts.
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