Imaging Appearance and Nonsurgical Management of Pelvic Venous Congestion Syndrome

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Abbreviations: IVC = inferior vena cava, PVCS = pelvic venous congestion syndrome, PVI = pelvic vein insufficiency

RadioGraphics 2019; 39:596–608

https://doi.org/10.1148/rg.2019180159

Content Codes: CT GU IR MR OB VA

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SA-CME LEARNING OBJECTIVES

After completing this journal-based SA-CME activity, participants will be able to:

- Describe features of PVCS with multiple modalities including US, CT, MRI, and angiography.
- Identify various structural and secondary causes of PVCS.
- Discuss nonsurgical treatment options for PVCS caused by PVI.

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Pelvic venous congestion syndrome (PVCS) is a challenging and complex cause of chronic pelvic pain in female patients. PVCS due to incompetent vein valves is the combination of gonadal vein reflux and pelvic venous engorgement in patients with chronic pelvic pain without other causes. However, pelvic venous engorgement and gonadal vein reflux can be seen in patients without pelvic pain, which makes obtaining a detailed history and physical examination important for workup and diagnosis. The underlying cause of PVCS may be incompetent gonadal vein valves or structural causes such as left renal vein compression with an incompetent gonadal vein valve (nutcracker syndrome) or iliac vein compression (May-Thurner configuration) with reflux into the ipsilateral internal iliac vein. Venography is considered the criterion standard for imaging diagnosis; however, more recently, US and MRI have been shown to provide adequate accuracy for diagnosis. Noninvasive imaging studies aid in the diagnosis of PVCS and also aid in pretreatment planning. When PVCS is caused by incompetent gonadal vein valves, treatment typically is performed by means of embolization via a minimally invasive catheter with excellent technical and clinical success rates. When PVCS is caused by venous obstruction, the obstruction must be treated first before gonadal vein embolization and sclerotherapy are considered.

Online supplemental material is available for this article.

Introduction

Chronic pelvic pain is a common presenting symptom in female patients and has been reported to account for approximately 10% of outpatient gynecologic visits (1). *Chronic pelvic pain* is defined as noncyclic pelvic pain of at least 6 months duration (2). One of many causes of noncyclic pelvic pain is pelvic venous congestion syndrome (PVCS), which is often considered an underdiagnosed and underrecognized cause of chronic pelvic pain. PVCS is defined as chronic pelvic pain attributed to gonadal vein reflux and venous engorgement caused by either incompetent vein valves or a structural abnormality due to obstruction. PVCS was first described by Louis Alfred Richet in 1857 and is characterized by chronic dull pelvic pain, pressure, and heaviness that persist for more than 6 months with no other identified cause (3). PVCS caused by incompetent gonadal vein valves is termed *pelvic venous insufficiency* (PVI) (4).

Typical patients with PVI are premenopausal and multiparous. Pain often worsens with prolonged standing or sitting and with pregnancy. Some patients report unilateral pain, typically more often on the left side than on the right side. The pain may be relieved when the patient assumes the supine position. Risk factors for PVI may include hormonal influence, prior pelvic surgery, a retroverted uterus,

TEACHING POINTS

- Polycystic ovaries, an unexplained associated condition that may be related to hormonal factors, is found in more than 40% of patients with PVI.
- Not all patients with gonadal vein dilatation and parauterine varices have PVCS or PVI.
- Normal gonadal vein diameter at venography is considered less than 5 mm, and a diameter of greater than 8 mm is considered abnormal. However, ovarian vein diameter has been shown to be a poor predictor of gonadal vein reflux. Therefore, the consensus statement from the Society of Interventional Radiology states that the absolute diameter of the veins should not preclude treatment of PVI in the presence of other findings.
- Three-plane high-temporal-resolution small–field-of-view T2-weighted MRI and multiplanar nonenhanced and contrast material–enhanced multiplanar T1-weighted MRI are essential for evaluation of other causes of chronic pelvic pain and the morphologic changes of PVCS. However, in our opinion, high-temporal-resolution dynamic time-resolved MR angiography is essential for evaluation of gonadal vein reflux and pelvic venous connection.
- Treatment of vulvar varices alone in patients with PVI is thought to be insufficient and therefore should be used as adjunct therapy.

a history of varicose veins, and multiple pregnancies. Polycystic ovaries, an unexplained associated condition that may be related to hormonal factors, is found in more than 40% of patients with PVI (5,6).

The prevalence of pelvic varices has been reported as up to 10% of the general population, and of these, up to 40% may develop PVI (7,8). Therefore, not all patients with gonadal vein dilatation and parauterine varices have PVCS or PVI. Given the broad range of considerations in the differential diagnosis for chronic pelvic pain, exclusion of other causes of pelvic pain including endometriosis, adenomyosis, inflammatory bowel disease, urinary tract causes, and orthopedic conditions by obtaining a complete history, physical examination, and appropriate imaging studies is important. The broad range of conditions to consider in the differential diagnosis of chronic pelvic pain and the disparity between imaging findings and clinical symptoms likely contribute to this often overlooked (9) cause of pelvic pain. In patients for whom no cause of pelvic pain is found after routine diagnostic workup, approximately 30% subsequently have been shown with pelvic imaging to have PVI and therefore, by definition, PVCS (10). This fact demonstrates the need for focused and dedicated noninvasive diagnostic imaging techniques. The purpose of this article is to describe the typical imaging findings, essential imaging techniques, and effective minimally invasive catheter-based treatment of PVCS.

Pathogenesis

Normal Female Pelvic Venous Anatomy

The venous drainage of the female pelvis is complex and interconnected. Both parietal and visceral tributaries of the pelvis drain to the internal iliac vein. Parietal tributaries include the superior and inferior gluteal veins, the internal pudendal vein, and the obturator vein. The visceral tributaries drain the venous plexus of the uterus and vagina. The ovarian venous plexus drains to the ipsilateral gonadal vein, which, on the left, drains to the left renal vein and, on the right, typically drains directly to the inferior vena cava (IVC). Rarely, the right gonadal vein drains to the right renal vein. There is also a complex connection between the venous plexus of the uterus and ovaries. In addition, the vulvoperineal veins drain into either the internal pudendal vein or into the circumflex femoral vein (5).

Normal variants in venous anatomy, including internal iliac veins that drain into the contralateral common iliac vein, duplicated IVCs, and reverse-angle renal veins with alternative left gonadal vein drainage, may alter the approach to and success of treatment (11).

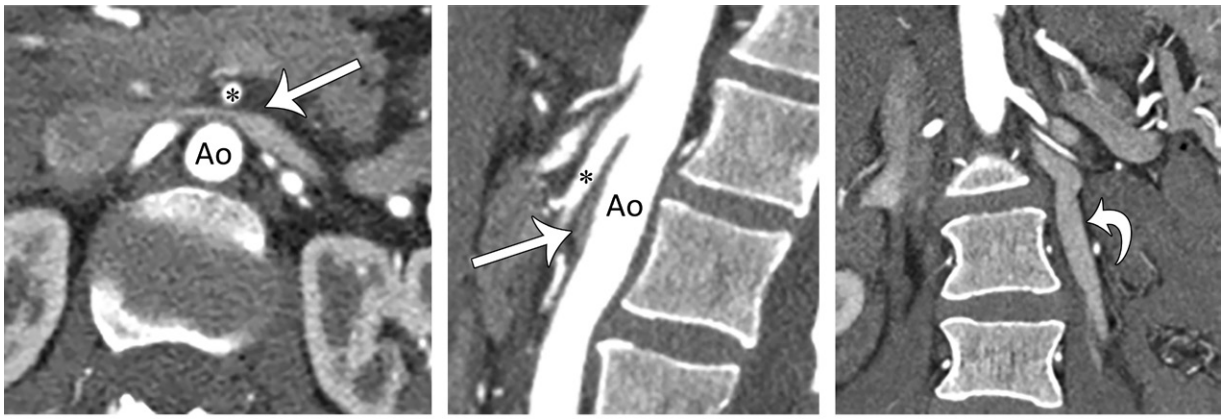
Abnormal Pelvic Venous Dilatation

In the presence of impeded or insufficient venous drainage of the pelvis, the gonadal veins and pelvic visceral venous plexus engorge and dilate. This venous dilation may be exacerbated further by the vasodilatory effects of estrogen. A study in mice showed selective enlargement of the ovarian and uterine veins with administration of exogenous estradiol, with no change in the caliber of the femoral or iliac veins. This selective dilation suggests that the ovarian and uterine veins may be particularly sensitive to the vasodilatory effects of hormones produced in the ovaries. This theory of hormonal influence is supported further by worsened symptoms during menses and pregnancy and improved symptoms after menopause in patients with PVCS. Similar to varicose veins in other parts of the body and varicoceles, this engorgement is thought to contribute to a syndrome of pelvic pain and pressure in some patients.

Both anatomic structures and incompetent vein valves cause impeded or insufficient pelvic venous drainage and will be described in this article. Structural (ie, obstructive) causes include left renal vein compression syndrome (nutcracker syndrome), iliac vein compression (May-Thurner configuration), congenital or acquired absence of the IVC, and extrinsic venous compression by an abdominal or pelvic mass and/or lymphadenopathy (12). Structural causes of PVCS are

Table 1: Clinical Symptoms and Imaging Findings Suggestive of a Diagnosis Other than PVCS

Diagnosis	Imaging Findings
Nutcracker syndrome	Angle less than 39° between the superior mesenteric artery and the aorta on sagittal CT angiograms Hematuria Proteinuria Left flank pain
May-Thurner configuration	Compression of the left common iliac vein by the right common iliac artery Often manifests as thrombotic disease
IVC thrombus or atresia	Small-caliber or occluded IVC Extensive collateral venous circulation via pathways including the inferior mesenteric vein to the portal system and the inferior epigastric veins in the superficial abdominal wall to the lumbar veins or internal mammary veins
Arteriovenous malformation	Early filling of parauterine vessels and early draining veins (antegrade flow)



a. **b.** **c.**

Figure 1. Nutcracker syndrome in a 43-year-old woman with abdominal pain. **(a, b)** Axial **(a)** and sagittal **(b)** CT angiograms show marked narrowing of the left renal vein (arrow) between the aorta (*Ao*) and the superior mesenteric artery (*). An angle of less than 39° is considered diagnostic of nutcracker anatomy. **(c)** Coronal CT angiogram shows a dilated left gonadal vein (arrow).

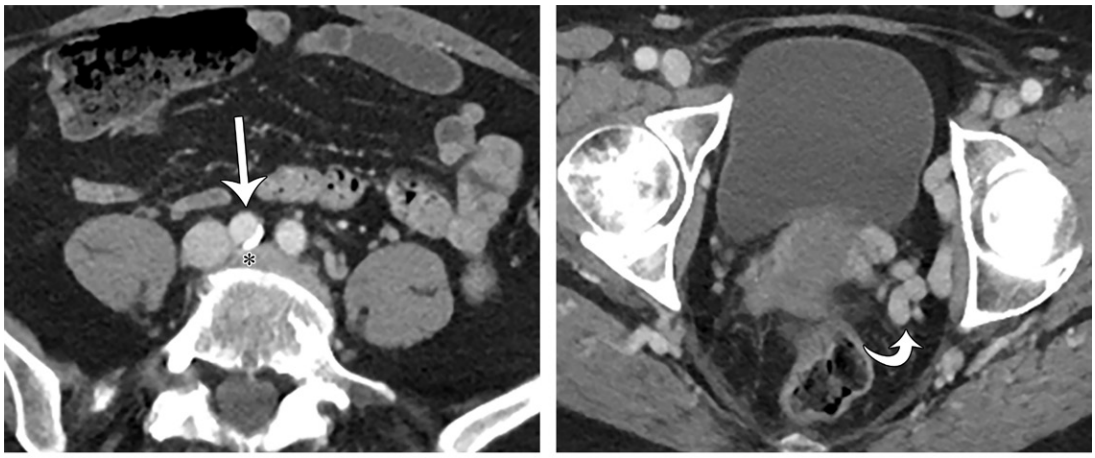
considered to be rare; however, recognizing them is important because they involve differences in treatment approach. Imaging and clinical features associated with these structural causes are summarized in Table 1.

Incompetent Gonadal Vein Valves

The most common cause of PVCS is incompetent gonadal vein valves, whether acquired or congenital. Prior anatomic studies including Ahlberg et al (13) have shown that female subjects lack valves in the cephalad portion of the right and left gonadal vein up to 6% and 15% of the time, respectively, and have incompetent valves 46% and 41% of the time, respectively. The high prevalence of PVCS in multiparous patients supports the theory of acquired incompetent vein valves due to chronic venous distention during pregnancy. The vascular capacity of the ovarian veins has been reported to expand as much as 60-fold during pregnancy (14). Pelvic venous congestion due to incompetent or absent vein valves is considered PVI according to the consensus of the Society of Interventional Radiology (4). PVI, whether due to congenitally absent or acquired incompetent vein valves, typically is treated with minimally invasive catheter-based embolization and sclerotherapy.

Nutcracker Syndrome

Nutcracker syndrome describes the compression of the left renal vein between the aorta and the superior mesenteric artery (Fig 1), which causes clinical symptoms such as hematuria, proteinuria, and flank pain. The prevalence of nutcracker syndrome is unknown, and the diagnostic criteria vary (15–17). An angle of less than 39° between the superior mesenteric artery and the aorta



a. b.

Figure 2. May-Thurner configuration in a 74-year-old woman. Axial CT images show marked compression of the left common iliac vein (* in **a**) by the right common iliac artery (arrow in **a**) and dilated parauterine vessels (arrow in **b**).

when measured on sagittal CT angiograms has been reported, with sensitivity of 92% and specificity of 89% for symptomatic patients (15). Detection of nutcracker anatomy is often incidental at CT in asymptomatic patients (18) but also has been described in up to 17.9% of patients with PVCS in a small study by Scultetus et al (19) of 51 patients. In another study (20) with a large patient cohort, nutcracker syndrome was observed in less than 2% of patients undergoing evaluation for PVCS. In a symptomatic patient, treatment is typically surgical. Placement of a stent in the left renal vein also has been described (21).

A retroaortic left renal vein is a normal anatomic variant seen in 3% of the population (22). This configuration is typically asymptomatic and only an incidental finding; however, the presence of collateral vessels may indicate a hemodynamically significant stenosis. When hemodynamically significant compression of the left renal vein occurs between the aorta and adjacent vertebral body, it is termed *posterior nutcracker syndrome* (21).

May-Thurner Configuration

May-Thurner configuration occurs when there is compression of the left common iliac vein by the right common iliac artery (Fig 2). The prevalence of hemodynamically significant compression may be as high as one-third of the population (23,24). There are no standardized criteria for diagnosis; however, in a patient who is dehydrated, there is a known tendency to overdiagnose compression at CT venography (25). Similar to nutcracker syndrome, May-Thurner configuration is thought to be a rare cause of pelvic congestion (ie, nonthrombotic pelvic hypertension); however, it can cause dilated parauterine vessels (because of retrograde flow into the ipsilateral internal iliac vein). Symptomatic May-Thurner configuration more commonly manifests as thromboembolism and worsening stenosis, which may be treated by means of placing an endovascular stent (26–28). In comparison, thromboembolism is not a typical feature of PVCS due to incompetent vein valves.

Congenital Absence of the IVC or Acquired IVC Syndrome

At imaging, congenital absence of the IVC (Fig 3) and chronic thrombosis of the IVC (Fig 4) may appear similar, with multiple dilated collateral pathways draining the pelvis and lower extremities. These pathways may include the gonadal veins, with subsequent dilation and a similar appearance compared with PVI, although they typically involve other collateral veins as well.

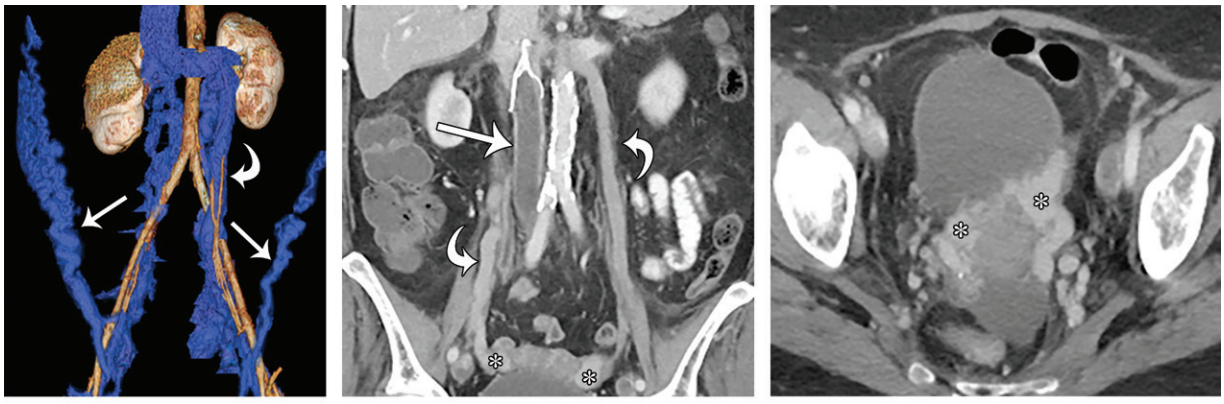
Other Similar Abnormalities

Other causes of dilated gonadal veins and pelvic varices include pelvic arteriovenous malformations and other vascular malformations. Recognizing the different structural abnormalities and flow dynamics at noninvasive imaging eliminates the need for venography for diagnosis (Fig 5).

Noninvasive Imaging Workup for PVCS due to PVI

Conventional Venography for PVCS Workup

Invasive catheter–based venography is considered the criterion standard for the evaluation of PVI in the search for spontaneous retrograde reflux through incompetent gonadal veins into distal dilated varices (Fig 6). Consensus diagnostic guidelines from the Society of Interventional Radiology at conventional venography for PVI include a



3. 4a. 4b.

Figures 3, 4. **(3)** IVC atresia in an 18-year-old woman. Coronal three-dimensional maximum intensity projection reconstruction CT venogram of the infrarenal IVC shows extensive abdominal wall (straight arrows) and pelvic collateral veins, including a dilated left gonadal vein (curved arrow). **(4)** Chronic occlusion of the IVC in an 80-year-old woman. Coronal **(a)** and axial **(b)** CT venograms show chronic IVC thrombus (straight arrow in **a**) and dilated bilateral gonadal veins (curved arrows in **a**) and bilateral pelvic varices (∗ in **b**).

diameter of at least 5 mm in the gonadal, uterine, and utero-ovarian arcade veins, free reflux in the gonadal vein, reflux of contrast material across the midline to the contralateral side through the utero-ovarian arcade, opacification of thigh or vulvar varices, and stagnation of contrast material in pelvic veins (4). Normal gonadal vein diameter at venography is considered less than 5 mm, and a diameter of greater than 8 mm is considered abnormal (29). However, ovarian vein diameter has been shown to be a poor predictor of gonadal vein reflux (30). Therefore, the consensus statement from the Society of Interventional Radiology states that the absolute diameter of the veins should not preclude treatment of PVI in the presence of other findings.

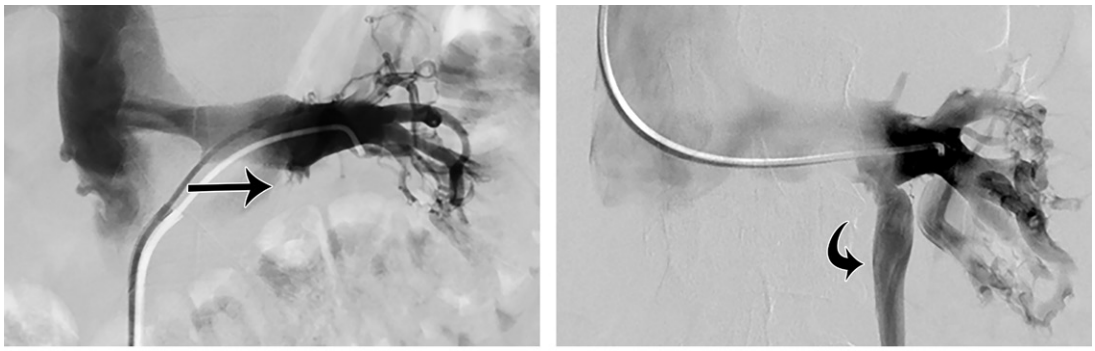
Multiple noninvasive imaging modalities are useful for evaluating the morphologic and dynamic imaging features of PVI, such as gonadal vein size, flow direction, and the anatomic configuration between the ovarian vein and the surrounding structures.

US for PVCS Workup

Real-time dynamic imaging and broad availability makes US ideal for PVCS evaluation. Transvaginal gray-scale and Doppler US criteria for PVCS include a dilated tortuous parauterine vein with a diameter larger than 4 mm (ie, pelvic varicocities), slow blood flow (≤3 cm/sec), and a dilated arcuate vein in the myometrium that communicates with pelvic varicosities (6,31) (Fig 7). Positive predictive values for ovarian vein diameter greater than 5 mm and greater than 6 mm have been reported as 71.2% and 83.3%, respectively, when measured on transabdominal US images. Transabdominal US also can be used to evaluate for direction of flow in the gonadal veins, with reported sensitivity of 100% and specificity of 75%. The sensitivity and specificity of a dilated arcuate vein were reported to be 25% and 91%, respectively, in a 2004 article (6). More recently, authors (20,32–34) suggested that transvaginal duplex US could replace venography as the criterion standard screening imaging method. Unlike CT and MRI, US may be performed in a semiupright position and with provocative maneuvers (ie, Valsalva maneuver) to best simulate anatomic conditions and accentuate venous reflux for visualization. Authors of one study (32) showed that reflux may be detected

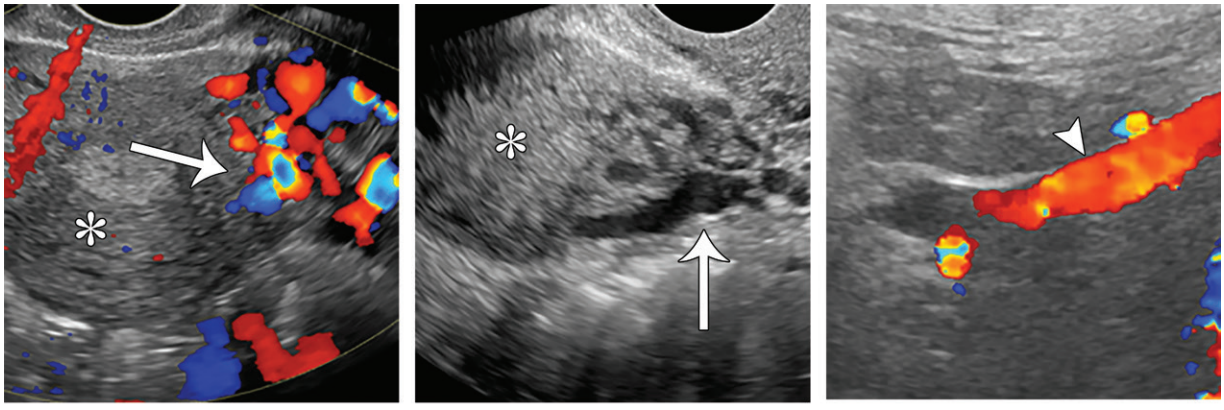
a. b.

Figure 5. Pelvic arteriovenous malformation mimicking PVCS in a 38-year-old woman with chronic pelvic pain. Time-resolved MR angiograms were obtained 13 seconds **(a)** and 18 seconds **(b)** after contrast material injection. Both images show a tangle of arterial parauterine vessels (∗), with a prominent draining vein (straight arrow), which is consistent with an arteriovenous malformation. Note the early visualization of the IVC (curved arrow), even 13 seconds after contrast material injection, and the absence of a dilated gonadal vein.



a. b.

Figure 6. Normal and abnormal renal veins in two women. **(a)** Digital subtraction venogram in a 31-year-old woman shows a normal left renal vein without reflux of contrast material into the left gonadal vein (arrow). **(b)** Venogram in a 36-year-old woman shows an abnormal renal vein with reflux of contrast material into the left gonadal vein (arrow).



a. b. c.

Figure 7. US findings of PVCS in a 37-year-old woman with chronic left pelvic pain. **(a, b)** Transverse transvaginal duplex **(a)** and gray-scale **(b)** US images of the uterus (*) show dilated left parauterine vessels (arrow) measuring more than 4 mm in diameter. **(c)** Oblique transabdominal duplex image shows reversed flow in the left gonadal vein (arrowhead) at the level of the left renal vein.

with the patient in a supine and/or semierect position and suggested that both may be necessary for complete evaluation. The flexibility of positioning, the relatively noninvasive nature, and the lack of ionizing radiation are all advantages of US. Limited sensitivity for other conditions that cause pelvic pain (eg, endometriosis) is one disadvantage of US for evaluation of PVCS.

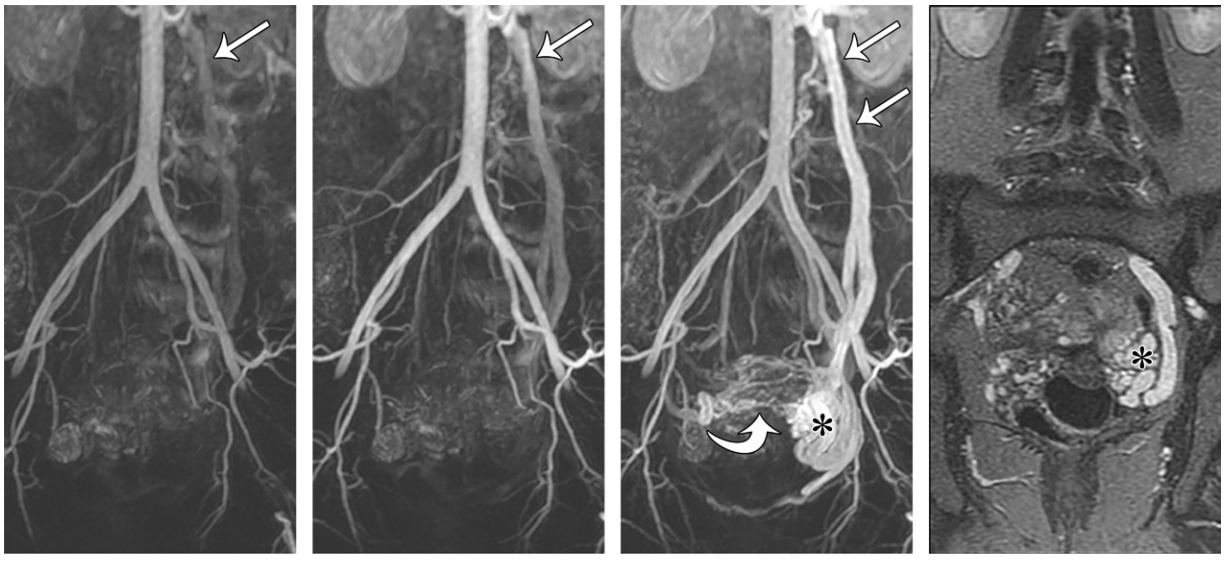
MRI for PVCS Workup

MRI provides exquisite soft-tissue contrast and allows excellent evaluation of the pelvic organs. Table 2 describes the protocol used at our institution for patients suspected of having PVCS, which is optimized for both pelvic anatomic and dynamic vascular evaluation. Three-plane high-temporal-resolution small-field-of-view T2-weighted MRI and multiplanar nonenhanced and contrast material–enhanced multiplanar T1-weighted MRI are essential for evaluation of other causes of chronic pelvic pain and the morphologic changes of PVCS. However, in our opinion, high-temporal-resolution dynamic time-resolved MR angiography is essential for evaluation of gonadal vein reflux and pelvic venous connection. Time-resolved MR angiography is a widely available MRI sequence offered by vendors of multiple MRI units (eg, time-resolved angiography with interleaved stochastic trajectories [TWIST]; Siemens Healthineers, Erlangen, Germany; and time-resolved imaging of contrast kinetics [TRICKS], GE Healthcare) and has been shown to be a valuable noninvasive tool for detecting gonadal vein reflux (35–37). A study (37) in which the grade of reflux seen at time-resolved MR angiography was compared with that at conventional venography showed specificity, sensitivity, and accuracy of 67%–75%, 100%, and 79%–84%, respectively, which demonstrates excellent agreement between the two imaging modalities. At our institution, time-resolved MR angiography is performed with craniocaudal coverage from the kidneys through the vulvar region. Dynamic imaging is performed with the patient's arms up during quiet free breathing starting 8 seconds after contrast material injection and continuing for 2 minutes, with a time resolution of approximately 3–5 seconds (Fig 8). Phase-contrast MRI also has been shown to allow

Table 2: MR Imaging Protocol for PVCS

Sequence	Plane	TR/TE (msec)	FOV (mm)	FA	ST (mm)	Gap (%)	Matrix	NSA
Single-shot fast spin echo	C	Min/85	440	90	5	0	384 × 288	1
3D dual echo	A	6/min	300–360	15	3.4	0	256 × 224	1
T2-weighted RT	S, A, C	RT/85	240	111	4	12	416 × 224	2
T2-weighted fast spin RT	A	RT/85	240	111	4	12	416 × 224	2
Diffusion weighted*	A	2000/min	280	90	5	0	128 × 128	. . .
Time-resolved MR angiography	C	4.3/min	440	30	2.4	0	416 × 320	0.75
MR venography	C	4.3/min	440	25	2	0	320 × 224	0.75
Contrast-enhanced LAVA-Flex†	A	5.5/min	360	12	2.2	0	320 × 320	2
Contrast-enhanced LAVA-Flex†	C, S	5/min	280–360	15	4–5	0	256 × 224	1
FIESTA†	A	3.2/min	360	12	5	0	224 × 256	1

Note.—A = axial, C = coronal, FA = flip angle, FIESTA = fast imaging employing steady-state acquisition, FOV = field of view, LAVA-Flex = liver acquisition with volume acceleration (a two-point Dixon method for water-fat separation), min = minimum possible, NSA = number of signals acquired, RT = respiratory triggered, S = sagittal, ST = section or slab thickness, TE = echo time, 3D = three-dimensional, TR = repetition time.
*b values = 50, 100, and 800 sec/mm^2.
†GE Healthcare, Waukesha, Wis.



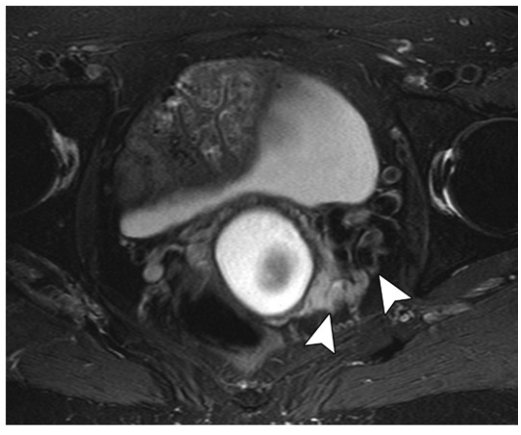


Figure 8. MRI findings of PVCS in a 45-year-old woman. **(a–c)** Select dynamic time-resolved MR angiograms obtained at 28 **(a)**, 33 **(b)**, and 43 **(c)** seconds after contrast material injection show reflux of contrast material into the left gonadal vein (straight arrows) and subsequently into dilated left parauterine vessels (∗ in **c**), bridging arcuate uterine veins (curved arrow in **c**), and vulvar varices. (See also Movie.) **(d, e)** Coronal MR angiogram **(d)** and axial T2-weighted MR image **(e)** also show dilated parauterine vessels (arrowheads in **e**, ∗ in **d**) as contrast material–filled structures and as heterogeneous and hyperintense T2-weighted serpentine structures **(e)**.

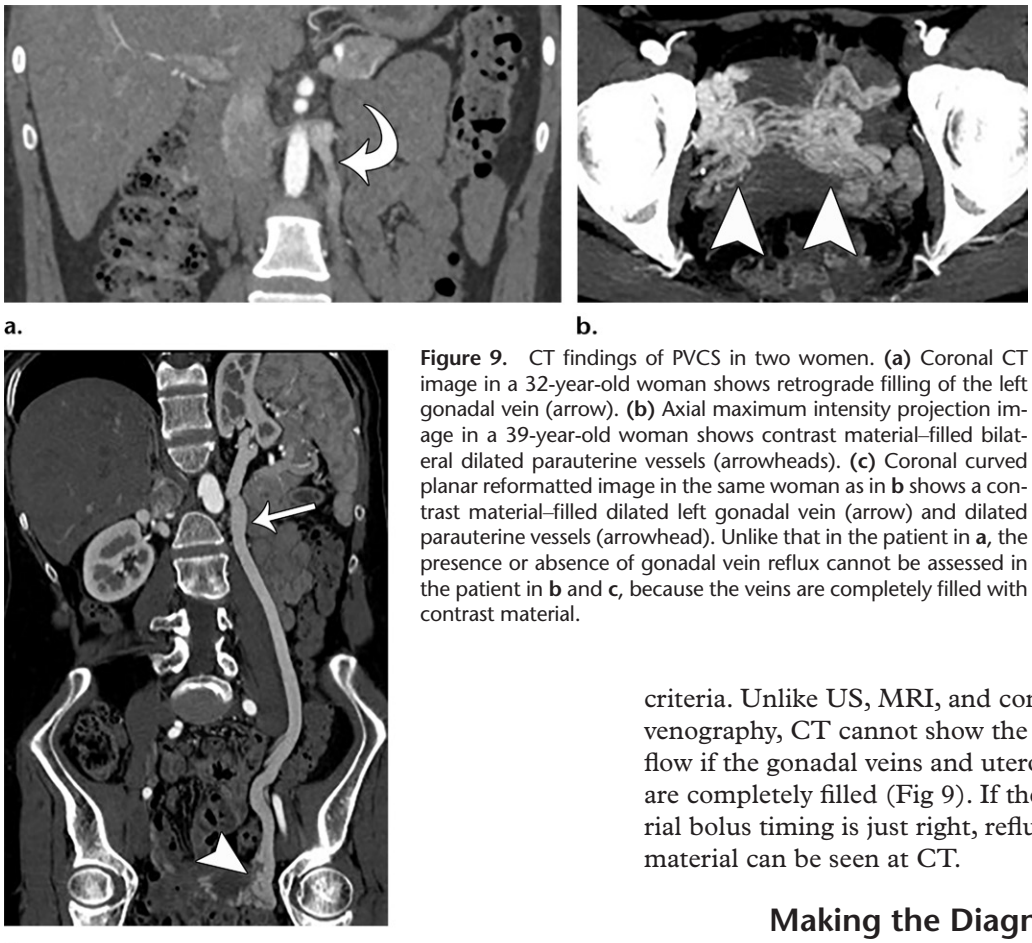


Figure 9. CT findings of PVCS in two women. **(a)** Coronal CT image in a 32-year-old woman shows retrograde filling of the left gonadal vein (arrow). **(b)** Axial maximum intensity projection image in a 39-year-old woman shows contrast material–filled bilateral dilated parauterine vessels (arrowheads). **(c)** Coronal curved planar reformatted image in the same woman as in **b** shows a contrast material–filled dilated left gonadal vein (arrow) and dilated parauterine vessels (arrowhead). Unlike that in the patient in **a**, the presence or absence of gonadal vein reflux cannot be assessed in the patient in **b** and **c**, because the veins are completely filled with contrast material.

detection of retrograde caudal flow and flow velocity in the gonadal veins, with sensitivity of 100% but with low specificity of 50% (38).

At our institution, any retrograde flow seen at time-resolved MR angiography in the gonadal veins is reported as abnormal. The presence of retrograde flow into the internal iliac vessels and pelvic varices, including the vulvar varices, also is reported. In addition, our protocol allows for complete evaluation of the pelvis for other causes of pelvic pain, including endometriosis and adenomyosis. The disadvantages of MRI include its high cost, long examination time, and supine patient position.

CT for PVCS Workup

CT has a limited role for PVCS workup; however, it may be the test of choice when a structural abnormality is suspected. CT venography or even standard contrast-enhanced CT shows venous anatomy, venous dilatation, and varices. Criteria suggested by Coakley et al (39) include the presence of at least four ipsilateral tortuous parauterine veins (at least one > 4 mm in diameter) or a gonadal vein diameter greater than 8 mm. To our knowledge, no sensitivity or specificity values have been reported for these proposed criteria. Unlike US, MRI, and conventional venography, CT cannot show the direction of the flow if the gonadal veins and utero-ovarian arcade are completely filled (Fig 9). If the contrast material bolus timing is just right, reflux of contrast material can be seen at CT.

Making the Diagnosis

Table 3 summarizes the common diagnostic criteria suggested for PVCS. The most important imaging feature for diagnosis of PVCS is the presence of retrograde caudal flow in one or both gonadal veins, and which may be detected with transabdominal Doppler US, time-resolved MR angiography, phase-contrast MRI, or conventional venography. Dilated parauterine veins and gonadal veins have been shown to have high sensitivity, although the criterion for dilatation varies according to modality and desired sensitivity. If present, a dilated vein crossing the midline in the uterine body is the most specific finding of PVCS. All imaging features and criteria should be applied in the appropriate clinical setting. In addition, structural causes of PVCS and other causes of pelvic pain should be excluded. At our institution, MRI (including time-resolved MRI) is the preferred noninvasive method for evaluation for PVCS and is performed primarily in patients for whom there is a high clinical suspicion of PVCS.

Minimally Invasive Treatment

Medical and surgical therapies have been shown to be less effective than catheter-based embolization methods (40) when PVCS is due to PVI. Medical treatment with nonsteroidal anti-inflammatory drugs and/or pharmacologic ovarian suppression is

Table 3: Diagnostic Criteria and Findings that Suggest Pelvic Venous Insufficiency

Modality	Imaging Findings
Conventional venography (4)	Dilated gonadal, uterine, and utero-ovarian arcade veins >5 mm in diameter
	Retrograde caudal flow in the gonadal vein (unilateral or bilateral)
	Filling of the pelvic veins across the midline via the utero-ovarian arcade
	Opacification of vulvovaginal and/or thigh varices
	Stagnation of contrast material in the pelvic veins
Transvaginal US (6,31)	Multiple dilated parauterine varices
	Diameter >4 mm
	Slow flow ≤3 cm/sec
	Dilated arcuate vein in the myometrium, crossing the midline
	Polycystic ovarian configuration
Transabdominal US (6)	Retrograde flow in a dilated right or left gonadal vein
	Dilated gonadal vein >5 mm
MRI (4,6,37,39)	Retrograde caudal flow of contrast material at time-resolved MR angiography
	Dilated parauterine varices
	Heterogeneous or T2-hyperintensity due to slow flow
	Presence of an arcuate vein crossing the midline, vulvar and/or thigh varices
	Polycystic ovarian configuration
	Absence of an obstructing mass or structural obstruction
	No evidence of endometriosis (although superficial endometriosis deposits may not be seen at MRI or with other imaging modalities)
CT (39)	Four ipsilateral tortuous and dilated parauterine veins (at least one >4 mm)
	Dilated gonadal vein (diameter >8 mm, unilateral or bilateral)
	Absence of obstructing mass or structural obstruction

Note.—Numbers in parentheses in the first column are references.

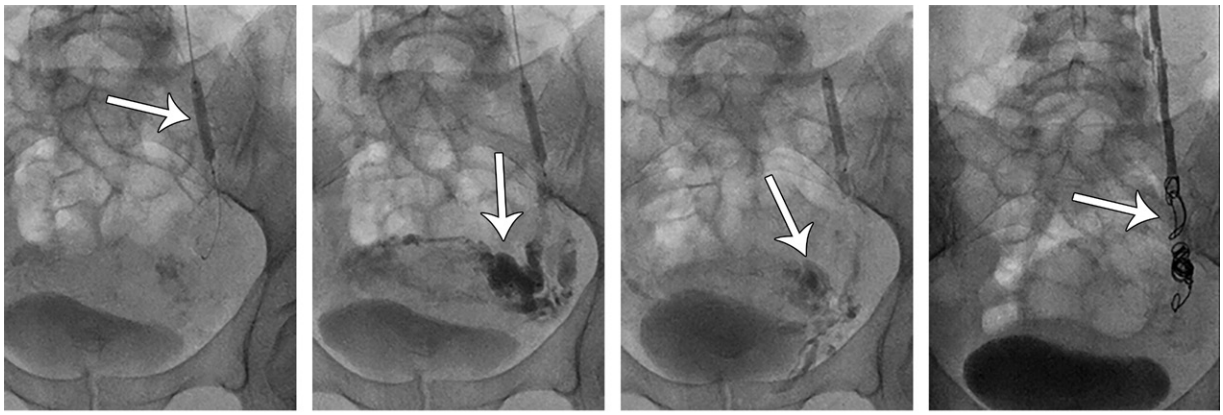
often attempted first and is required by some insurance companies before minimally invasive methods are performed; however, patients may find these treatments difficult to tolerate because of adverse effects such as weight gain and bloating. Surgical therapy including hysterectomy and salpingoophorectomy also does not provide long-term symptom relief and certainly has a higher cost and morbidity (even if temporary) compared with minimally invasive methods. Therefore, minimally invasive methods are the focus of this discussion.

Edwards et al (41) reported the first published case of gonadal vein embolization for pelvic congestion syndrome in 1993. Since then, the literature (42,43) has shown excellent treatment efficacy after embolization. After treatment of bilateral gonadal and internal iliac veins, patients report 93%–96% symptom improvement. Similarly, after treatment of bilateral gonadal veins alone, patients report 82%–100% symptom improvement (40,44). Treatment of unilateral gonadal vein and associated varices may suffice in certain clinical scenarios for which there are no contralateral varices and the contralateral gonadal vein is small (45). A small percentage of patients report no change in symptoms, and even fewer report worsening symptoms. Complications including migration of coils to the pulmonary artery, thrombophlebitis, and pain are rare and are reported at a rate of 0%–4% (46,47).

Endovascular Treatment Procedure

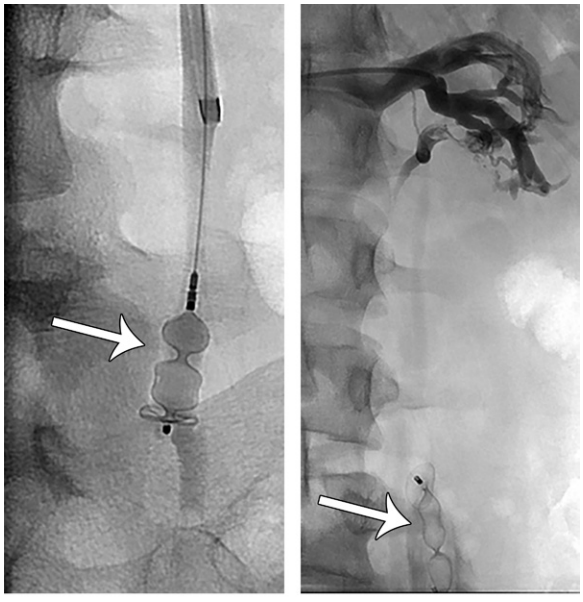
Venography and subsequent catheter-directed therapy typically is performed in an outpatient setting with the patient under moderate sedation. By means of either the right internal jugular vein or the femoral vein, bilateral pelvic venography (ie, venography of the common iliac vein, external iliac vein, and selective internal iliac vein) is performed to evaluate for reflux in the internal iliac veins and for narrowing of the common iliac vein (eg, May-Thurner configuration). Placing a stent in the left common iliac vein rather than performing internal iliac vein embolization may be considered if there is hemodynamically significant stenosis of the common iliac vein.

Subsequently, venography of the left renal vein is performed to look for narrowing caused by nutcracker configuration and for reflux into the left gonadal vein. If reflux is seen in the gonadal



a. b. c. d.

Figure 10. Catheter-based treatment of PVCS. **(a–c)** Coronal digital subtraction venograms show the balloon (arrow in **a–c**) inflated in the left gonadal vein for temporary occlusion **(a)**, subsequent injection of contrast material into the parauterine varices **(b)**, and injection of a foam sclerosing agent **(c)** with the displacement method to determine the volume of injection. **(d)** Finally, embolization coils (arrow) are placed for permanent occlusion of the left gonadal vein.



a. b.

Figure 11. Vascular plug occlusion of the left gonadal vein in a 35-year-old woman. Venograms show a vascular plug used instead of embolization coils for permanent occlusion in the left gonadal vein (arrow) during **(a)** and after **(b)** placement. Note the absence of reflux into the occluded left gonadal vein.

vein, selective gonadal venography is performed again to look for reflux into the dilated visceral venous plexi and bridging arcuate uterine veins to the contralateral side. At our institution, foam sclerotherapy of the visceral venous plexus is performed before gonadal vein coil embolization. The ipsilateral gonadal vein is occluded either by temporary balloon occlusion or coils in the upstream ipsilateral gonadal vein before injection of the sclerosing agent. Foamed 3% sodium tetradecyl sulfate is then injected into varices with the use of a contrast material displacement method to measure the capacity of the varices. Subsequently, additional coils are placed in the gonadal vein in a cephalad position to the initial coils (Fig 10). Instead of embolization coils in the gonadal vein, a vascular plug also may be used for gonadal vein occlusion (48,49) (Fig 11).

The process is repeated for the right gonadal vein. Selective right gonadal venography is performed instead of right renal venography, because the right gonadal vein typically flows together directly with the IVC (Fig 12). The procedure is concluded with left renal vein and right gonadal vein venography, which shows the absence of reflux to ensure adequate treatment.

The patient is discharged after recovery from sedation and when hemostasis is achieved at the access site. The patient is counseled to expect mild to moderate pain for approximately 5 days after the procedure and is instructed to undergo a follow-up examination in 3–6 months to evaluate for a change in chronic symptoms. Clinical success is measured as long-term resolution of pelvic pain.

At our institution, in the absence of brisk reflux into other venous pathways, embolization typically is performed in stages, first in the gonadal veins; embolization of the associated pelvic varices is performed at subsequent clinical reevaluation. If symptoms persist, repeat imaging (Fig 13) and potential embolization of additional venous pathways such as branches of the internal iliac veins (Fig 14) may be indicated. Similarly, if vulvar varices do not decrease in size or resolve, they also may be treated directly with percutaneous sclerotherapy.

Percutaneous Sclerotherapy

Percutaneous sclerotherapy of vulvar varices may be used to supplement endovascular treatment, particularly when original or first-line

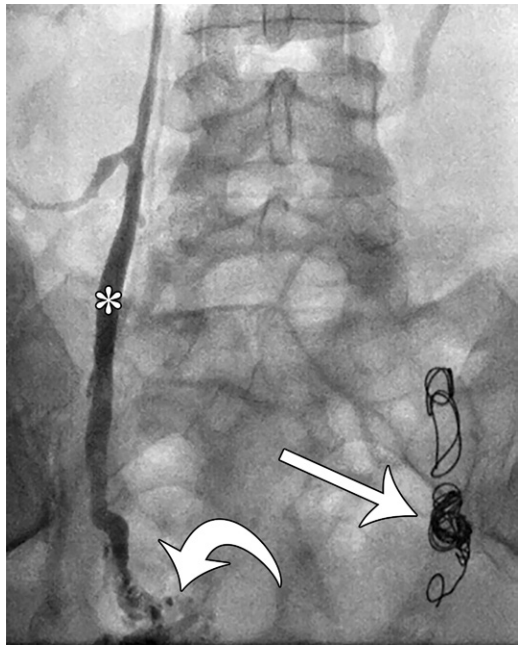
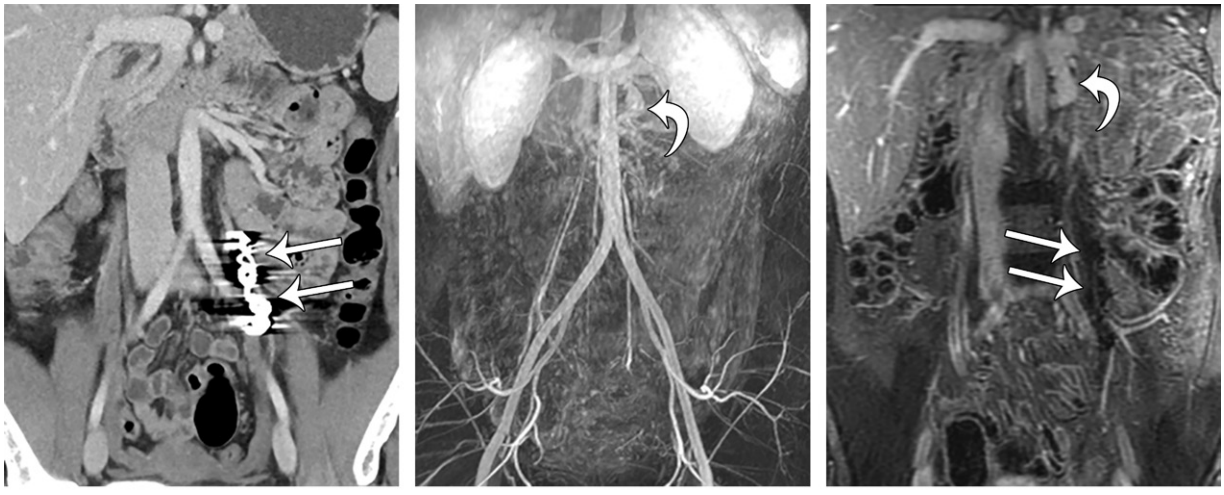


Figure 12. Coil embolization in a 23-year-old woman. Venogram of the right gonadal vein shows reflux of contrast material into the gonadal vein caudal to the catheter (*) and the parauterine varices (curved arrow). Note embolization coils in the left gonadal vein (straight arrow).



a. **b.** **c.**

Figure 13. Repeat imaging in a 35-year-old woman who underwent left gonadal vein embolization. **(a, b)** Coronal CT image **(a)** shows embolization coils in the left gonadal vein (arrows). **(b)** Time-resolved MR angiogram **(b)** obtained approximately 70 seconds after contrast material injection shows a residual left gonadal vein without caudal filling (arrow) and no parauterine varices. **(c)** Coronal MR venogram shows a signal intensity void from embolization coils (straight arrows) and a remnant gonadal vein at the level of a large lumbar vein (curved arrow) but no caudal dilated left gonadal vein.

treatment has been ineffective or symptoms have recurred (Fig 15). Treatment of vulvar varices alone in patients with PVI is thought to be insufficient and therefore should be used as adjunct therapy. To our knowledge, no randomized controlled trials have been performed for evaluation of treatment of vulvar varicosities; however, several case reports (50,51) have shown success. Percutaneous access may be obtained with US guidance to cannulate superficial collateral veins (eg, perilabial region). Contrast material should be injected under fluoroscopic guidance to confirm placement and large collateral veins. Embolization with 3% sodium tetradecyl sulfate foam is performed by means of the displacement method.

Practical Considerations

A barrier for broad application of gonadal vein embolization for PVI is the challenge of obtaining reimbursement from insurance companies. Some insurance companies consider gonadal vein embolization for PVCS due to PVI as an investigational treatment, despite the moderately strong evidence in nonrandomized studies and at least one randomized study (40,52). The Society of Interventional Radiology provides a standard letter for appealing a denied preapproval claim.

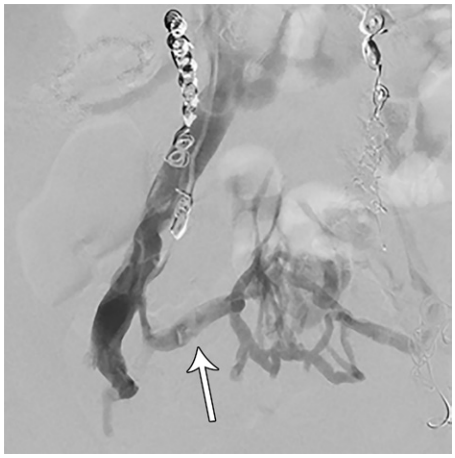


Figure 14. Reflux from the right internal iliac vein into parauterine vessels in a 45-year-old woman with persistent pelvic pain. Venogram shows the right internal iliac vein (arrow) after bilateral gonadal vein embolization.

a. **b.** **c.**

Figure 15. Percutaneous sclerotherapy of vulvar varices. Axial nonenhanced CT image **(a)** shows right vulvar varices (arrow) in a 30-year-old woman with persistent pelvic pain after bilateral sclerotherapy of the gonadal veins (not shown). **(b, c)** Fluoroscopic images show percutaneous contrast material injection **(b)** and sclerotherapy of perilabial and labial varices **(c)**.

Conclusion

Pelvic venous congestion syndrome is a complex, underdiagnosed cause of chronic pelvic pain in female patients. Both static and dynamic imaging are imperative to rule out other causes of pelvic pain and to evaluate for gonadal vein reflux. Noninvasive diagnosis may be made with transvaginal duplex US or dynamic time-resolved MR angiography. Recognizing structural causes of pelvic congestion such as nutcracker syndrome and May-Thurner configuration is important for determining the correct treatment. PVCS due to PVI is treated with minimally invasive embolization and sclerotherapy with excellent clinical improvement. Because of the treatable nature of PVI, recognizing the imaging findings and communicating with the ordering providers, diagnostic radiologists, and interventional radiologists are important.

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