JMeXFRI

Journal of the Mexican Federation of Radiology and Imaging

Check for updates

FULL RESEARCH ARTICLE

Ultrasound diagnostic criteria and grades of pelvic congestion syndrome and asymptomatic pelvic venous congestion: a structured report

Mauricio Figueroa-Sanchez[1,2,3,a], M. Lourdes Garcia-Colmenero[1,2], and Miguel A. Sanchez-Rueda[1,2]*

[1]Radiology and Imaging Department, Antiguo Hospital Civil of Guadalajara "Fray Antonio Alcalde"; [2]University Center of Health Sciences, Universidad of Guadalajara; [3]Laboratorio Vascular S.C., Guadalajara, Jalisco, Mexico

ORCID: [a]0000-0001-7042-5221

ABSTRACT

Introduction: *Quantitative ultrasound criteria for diagnosing pelvic congestion syndrome (PCS) and asymptomatic pelvic venous congestion (APVC) have not been sufficiently studied. This study evaluated the quantitative ultrasound findings in PCS and APVC, and proposed a graded classification and a standardized structured report.* **Material and Methods:** *This cross-sectional study conducted from November 2010 to June 2022 enrolled multiparous women (≥ 2 pregnancies) with suspected PCS (group 1) and asymptomatic, multiparous women with atypical varicose veins and suspected APVC (group 2). Pelvic vein diameter (mm) and reflux were assessed with grayscale ultrasound (US), duplex Doppler, color Doppler, power Doppler, and B-flow. Diagnostic ultrasound criteria were dilation and reflux of the left and/or right gonadal vein (≥ 5 mm), left and/or right external pudendal vein (> 4 mm), and the presence of unilateral or bilateral adnexal varices (≥ 5 mm), vulvar varices (> 2 mm), and parauterine crossing veins (> 4 mm). The US protocol included transabdominal (TAUS), pelvic (PelUS), transvaginal (TVUS), both thighs (ThighUS), and translabial (TLUS) examination.* **Results:** *A total of 133 women were included, 84 with PCS and 49 with APVC. The mean ages were 40.9 ± 9.36 years and 39.9 ± 8.39 years, respectively. Reflux and abnormal mean diameters (mm) were observed in the left gonadal vein (9.65 ± 1.45 and 10.76 ± 2.06), the right gonadal vein (8.98 ± 1.59 and 10.13 ± 2.20), the left adnexal plexus (7.25 ± 0.78 and 5.9), the bilateral adnexal plexus (8.10 ± 1.55 and 8.38 ± 1.44), the left external pudendal vein (9.14 ± 1.34 and 8.24 ± 1.23), the right external pudendal vein (8.79 ± 1.31 and 8.34 ± 1.77), the vulvar varices (6.51 ± 1.61 and 6.40 ± 1.28), and parauterine crossing veins (> 4 mm) in 15 and 10 women with PCS and APVC, respectively. The pelvic vein abnormalities of PCS and APVC were classified into four grades. The report format included the diagnostic ultrasound criteria and grades.* **Conclusion:** *Dilation and reflux of the left and/or right gonadal vein, presence of unilateral or bilateral adnexal varices, dilation and reflux of the right and/or left external pudendal vein, presence of vulvar varices, and parauterine crossing veins were quantitative ultrasound findings of PCS and APVC. A 4-grade classification and a structured format for standardized reporting are proposed for the first time.*

Keywords: *Chronic pelvic pain. Pelvic congestion syndrome. Asymptomatic pelvic venous congestion. Primary PCS. Secondary PCS.*

INTRODUCTION

Pelvic congestion syndrome (PCS) is a cause of chronic pain with vein abnormalities and no evidence of pelvic organ pathology[1]. The main imaging feature for diagnosing PCS is dilation with reflux in one or both gonadal veins. These changes have also been described in parous women with asymptomatic pelvic venous congestion (APVC)[2–4]. The International

***Corresponding author:**
Mauricio Figueroa-Sanchez
E-mail: figueroa_sanchez@hotmail.com

Received for publication: 18-08-2022
Accepted for publication: 29-09-2022
DOI: 10.24875/JMEXFRI.M22000035

Available online: 16-12-2022
J Mex Fed Radiol Imaging. 2022;1(4):222-235
www.JMeXFRI.com

2696-8444 / © 2022 Federación Mexicana de Radiología e Imagen, A.C. Published by Permanyer. This is an open access article under the CC BY-NC-ND (https://creativecommons.org/licenses/by-nc-nd/4.0/).

Working Group on Pelvic Venous Disorders classification, states that in addition to symptomatic patients with a recognized venous etiology of PCS, women with APVC should also be considered[5].

PCS is underdiagnosed because symptoms are nonspecific, and the diagnosis is usually made by excluding other pelvic pathologies[3,6,7]. Conventional venography is the gold standard for diagnosis. Alternative methods with comparable diagnostic accuracy include computed tomography angiography (CTA) and magnetic resonance angiography (MRA). Transabdominal ultrasound (TAUS), transvaginal ultrasound (TVUS), and pelvic ultrasound (PelUS) are the initial diagnostic methods for assessing the anatomy and characteristics of pelvic venous flow[8].

Quantitative criteria for abnormal diameter of gonadal veins and other pelvic vessels have been proposed for diagnosing PCS with various imaging modalities such as venography,[9,10] computed tomography,[11] MRI[1,6,12–15], and ultrasound[7,10,16–20]. The ultrasound parameters that define abnormalities in the diameter of the pelvic veins vary. Dilation of the right or left gonadal vein (diameter ≥ 5 mm) and caudal reflux were detected at TAUS with a sensitivity of 100%[3]. Using TVUS, a vein > 5 mm crossing the uterine body has a specificity of 91%, and adnexal varices a sensitivity and specificity of 100% and 83-100%, respectively. Bilateral adnexal varices > 5 mm have been described by venography with a sensitivity of 100%[7]. Quantitative ultrasound-based criteria for diagnosing PCS and APVC have not been sufficiently studied. Ultrasound offers several advantages, such as being easily accessible, more readily available, noninvasive, noncontrast, nonradiative, and combines anatomic, hemodynamic, and dynamic vascular assessments of the pelvic veins. This study evaluated the diagnostic criteria for quantitative ultrasound findings of PCS and APVC, proposed a grading classification system and a standardized structured report.

MATERIAL AND METHODS

This cross-sectional study was conducted from November 2010 to June 2022 at the Department of Radiology and Imaging of the Antiguo Hospital Civil of Guadalajara "Fray Antonio Alcalde" and the Laboratorio Vascular S.C., in Guadalajara, Jalisco, Mexico. We included parous (≥ 2 pregnancies) women with chronic pelvic pain ≥ 6 months referred by angiologists with suspected PCS after exclusion of other diagnoses (group 1), and asymptomatic, parous women with chronic venous insufficiency of the lower extremities, and atypical varicose veins (group 2) who were evaluated for suspected APVC. Women with a history of pelvic endovascular therapy or surgical treatment for PCS, or an incomplete ultrasound protocol were excluded. Data were collected during routine medical care, therefore, informed consent was not obtained for data analysis and publication. The protocol was approved by the institutional research ethics and research committees.

Description of variables

The following vascular structures were evaluated: the left and right gonadal veins, the adnexal venous plexus, the left and right external pudendal veins, the vulvar veins, the arcuate veins, the parauterine crossing veins, and the left renal vein. The diameter (mm), reflux (yes/no), patency (yes/no) and abnormal findings (stenosis or compression) were recorded. All diameter measurements were made with grayscale US during the Valsalva maneuver on both vessel inner walls in the transverse axis. Uterine and ovarian characteristics were also assessed.

Definitions

Pelvic congestion syndrome (PCS): chronic, noncyclic pelvic pain in the hypogastric, lumbosacral, or perineal region in women for more than 6 months, and no evidence of pelvic organ pathology.

Asymptomatic pelvic venous congestion (APVC): dilation and reflux of the pelvic veins without chronic pelvic pain or other associated symptoms in parous women with atypical varicose veins

Primary PCS or APVC: pathologic gonadal vein dilation and reflux due to primary valvular or parietal vein insufficiency with no identifiable cause[4]. Furthermore, the author (MFS) suggested dilation with reflux of the left and/or right external pudendal vein with the presence of vulvar varices as a criterion, even in the absence of dilation in the gonadal veins.

Secondary PCS or APVC: dilation with reflux of the pelvic veins because *obstruction* of the left renal vein (Nutcracker syndrome) or compression of the left common iliac vein by the right common iliac artery (May-Thurner or Cockett syndrome)[4].

Quantitative ultrasound diagnostic criteria

Dilated right or left gonadal vein (diameter ≥ 5 mm): measured at the site of greatest dilation[6,7]. Other authors define it as the ovarian vein[7,9,11,17,20].

Venous reflux: retrograde flow associated with dilation during Valsalva's maneuver[5,16]. A spectral inversion lasting > 1 second and a change from blue to red on color Doppler were demonstrated.

Adnexal varices or abnormal pelvic venous plexus (large vessel, diameter ≥ 5 mm): presence of three or more dilated circular or linear venous structures tortuous around the ovary and uterus[1,7]. Other authors define this finding as pelvic plexus, uterine and ovarian venous plexus, and parauterine plexus[17].

Dilated arcuate veins (diameter > 4 mm): abnormal intrauterine vessels that cross the myometrium and may or may not communicate with the adnexal plexus[21]. Other authors define this finding as a dilated arcuate vein in the myometrium[7,21].

Dilated external pudendal vein (diameter > 4 mm): definition based on the author's experience (MFS).

Vulvar varices (diameter > 2 mm): dilated and tortuous veins in the labia majora and vulvoperineal region. This finding was defined based on the author´s experience (MFS).

Parauterine crossing veins (diameter > 4 mm): based on the author's experience (MFS). This term describes the parauterine vessels connecting the adnexal varices from left to right or vice versa.

Image acquisition protocol

Grayscale US, duplex Doppler, color Doppler, power Doppler, and B-flow with venous presetting were performed. B-Flow is a real-time grayscale ultrasound modality that detects small vessels and demonstrates hemodynamically complex flow and collateral pathways with high-quality vascular anatomic images[22]**.** All examinations were performed by a single radiologist who is an expert in vascular Doppler US and has 28 years of experience (MFS). The following equipment was used, an Aloka 4000S (Aloka Co. Tokyo, Japan), with 10 and 13-MHz linear transducers, a 2-6-MHz convex transducer, and a 9-MHz endovaginal transducer; a LOGIG E9 (GE, Milwaukee, WI, USA) with 10 and 16-MHz linear transducers, a 3-6-MHz convex transducer, and a 9-MHz endovaginal transducer; an Acuson S2000TM (Siemens, Mountain View, CA, USA) with 9, 14, and 18-MHz linear transducers, a 6-MHz convex transducer, and a 9-MHz endovaginal image transducer.

Imaging studies were performed with the patient in the supine position performing the Valsalva maneuver. Figure 1 describes the complete protocol, which included different US modalities, TAUS, PelUS, TVUS, both thighs (ThighUS) and translabial (TLUS) in transverse and longitudinal projections of anatomical sites to perform a complete examination. Six hours of fasting, a previous trichotomy of the genitalia, a full urinary bladder for PelUS, and an empty urinary bladder for TVUS were required. The time required to examine patients with suspected PCS or APVC ranged from 100 to 120 minutes.

The examination started with TAUS at the inferior vena cava (IVC), including the supradiaphragmatic region and hepatic veins. We recommend an examination of the entire IVC to check its patency throughout its course and to detect obstructive pathologies, including congenital anomalies affecting the pelvic veins, and showing the confluence of the right gonadal vein. Examination of the suprahepatic veins is not part of the TAUS protocol, but the authors also assessed them. The left renal vein was visualized in all its course to the IVC ostium, the origin and course of the gonadal veins, the origin and course of the common iliac veins, and the external iliac vein, focusing on the passage of the left common iliac vein between the right iliac artery and the spine.

PelUS and TVUS continued, examining the uterus, both ovaries, arcuate vessels, pelvic venous plexus, and the presence of parauterine crossing veins. Next, ThighUS visualized the saphenous-femoral junction and the external pudendal veins. Finally, TLUS was performed to evaluate the presence of vulvar and perineal varices. Figure 2 shows the normal ultrasound findings of the anatomic sites assessed in the pelvic venous congestion protocol.

Statistical analysis

The mean, standard deviation, median, minimum, and maximum normal and abnormal diameters of gonadal veins, pudendal veins, adnexal varices, vulvar varices, parauterine crossing veins, and arcuate vessels were calculated based on the quantitative parameters of the diagnostic criteria in patients with PCS and APVC. Normal and abnormal diameters were compared using Student's *t*-test and the Mann-Whitney U-test. Analysis was performed with SPSS version 20.0 (IBM Corp. Armonk, NY, USA).

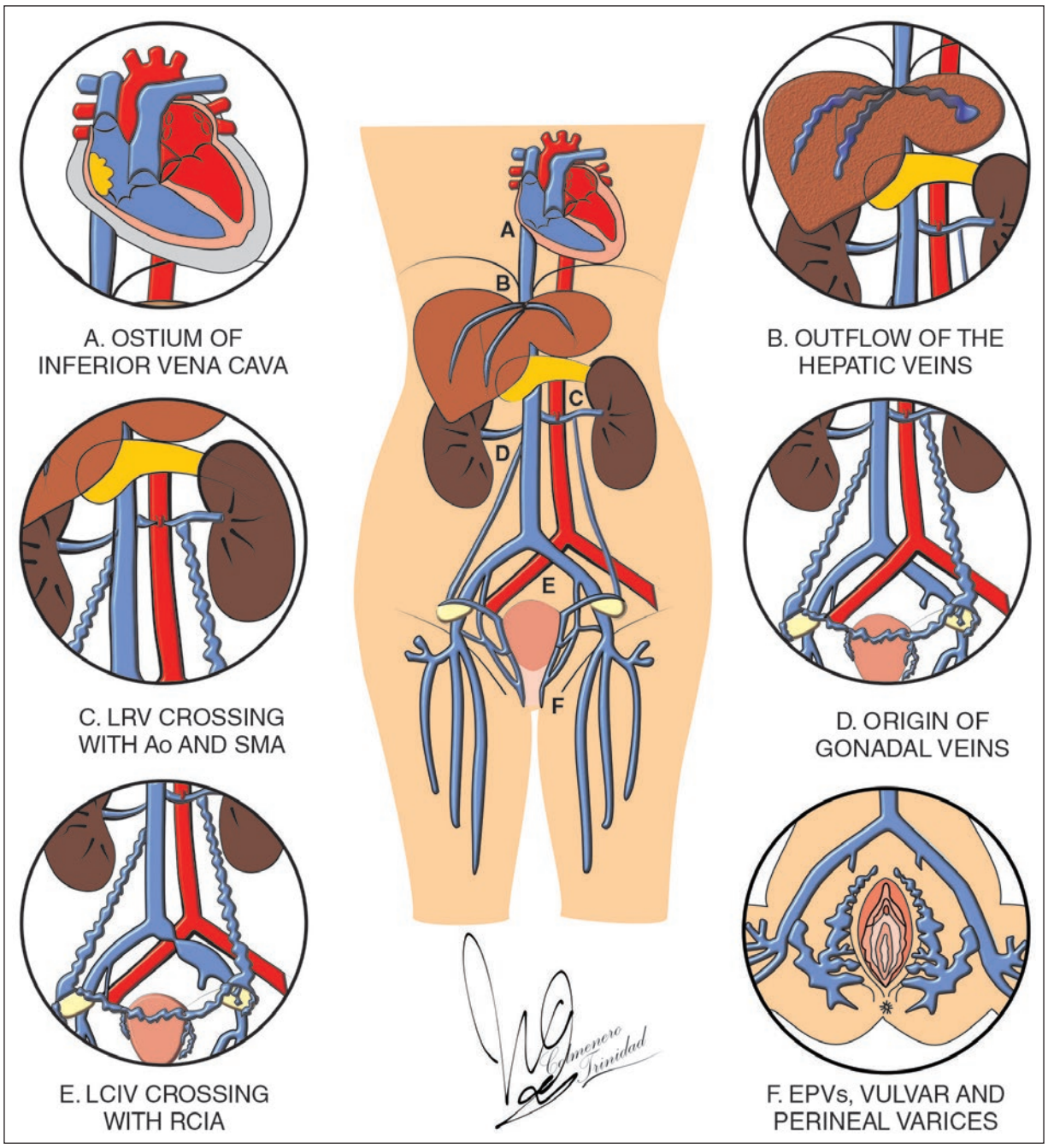


Figure 1. The anatomic sites were examined with a complete US protocol that included different modalities, such as TAUS, PelUS, TVUS, ThighUS and TLUS in transverse and longitudinal projections to perform a complete examination and diagnosis. The diameter (mm) and presence of reflux were assessed. We started with TAUS at the IVC. **A:** the supradiaphragmatic region and IVC ostium. **B:** the infradiaphragmatic area, hepatic veins. **C:** the pancreatic region. The LRV was visualized throughout its course to the IVC ostium, with special attention at the crossing between of the Ao and SMA. **D:** the infrarenal region, origin and course of the gonadal veins. **E:** the bifurcation of the iliac veins, origin and course of the common iliac veins and the external iliac vein, focusing on the crossing of the LCIV between the RCIA and the spine. PelUS and TVUS continued, examining the uterus, both ovaries, arcuate vessels, pelvic venous plexus, and the presence of parauterine crossing veins. **F:** next, a ThighUS visualized the saphenous-femoral junction and EPVs. Finally, TLUS was performed to assess the presence of vulvar and perineal varices.

Ao: aorta; APVC: asymptomatic pelvic venous congestion; EPVs: external pudendal veins; IVC: inferior vena cava; LCIV: left common iliac vein; LRV: left renal vein; PCS: pelvic congestion syndrome; PelUS: pelvic ultrasound; RCIA: right common iliac artery; SMA: superior mesenteric artery; TAUS: transabdominal ultrasound; ThighUS: both thighs ultrasound; TLUS: translabial ultrasound; TVUS: transvaginal ultrasound.

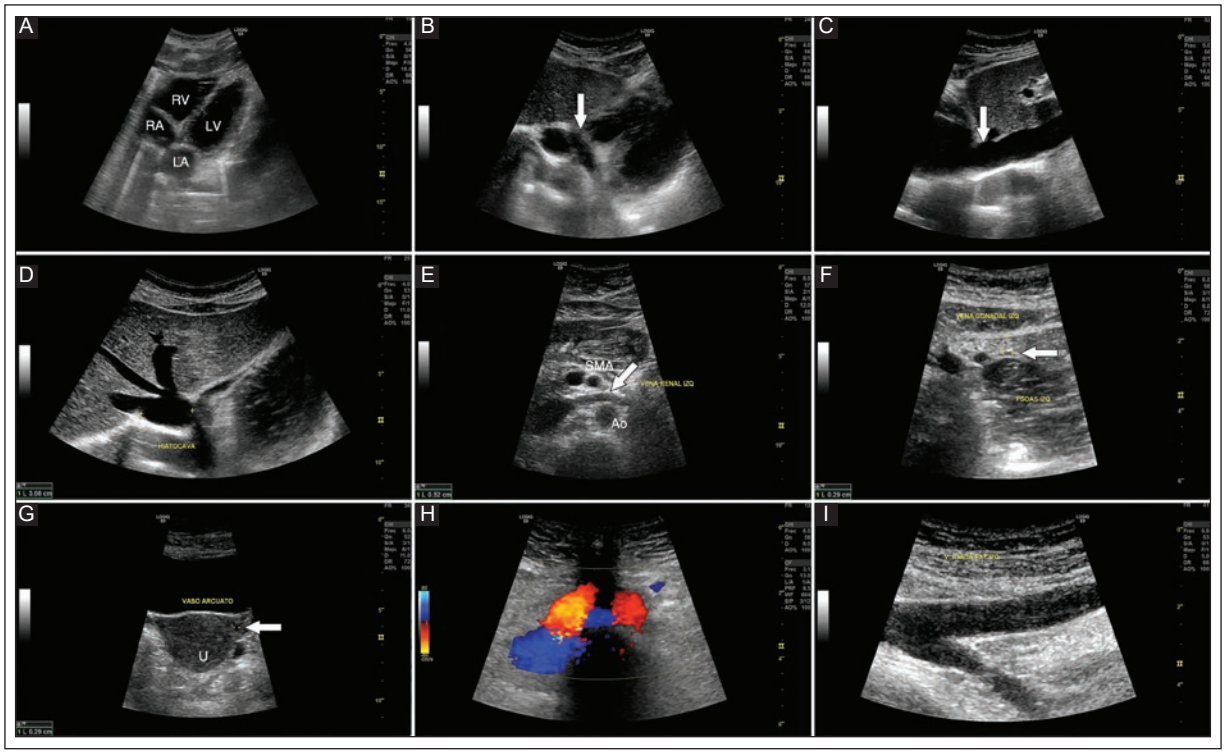


Figure 2. Normal findings on grayscale and color Doppler US with normal diameters at the anatomic sites examined in the complete US protocol. **A:** transverse view, heart, four chambers. **B:** transverse view, ostium of IVC (arrow). **C:** longitudinal view, right atrium and supradiaphragmatic segment of the IVC (arrow). **D:** transverse view, suprahepatic veins – IVC. **E:** transverse view, left renal vein, and normal proximal segment between Ao and SMA (arrow). **F:** transverse view, left gonadal vein, anterior to the psoas muscle, with a diameter of 2.9 mm (arrow). **G:** transverse view, arcuate vessels in the myometrium with a diameter of 2.9 mm (arrow). **H:** transverse view, bifurcation of Ao and IVC. **I:** longitudinal view, confluence of primitive iliac vein into the external and internal iliac vein.

Ao: aorta; IVC: inferior vena cava; LA: left atrium; LV: left ventricle; PCS: pelvic congestion syndrome; RA: right atrium; RV: right ventricle; SMA: superior mesenteric artery; U: uterus; US: ultrasound.

RESULTS

A total of 138 patients were eligible. Five women were excluded because of a history of endovascular therapy and/or surgical treatment for PCS. One hundred thirty-three women were included, 84 with PCS and 49 with APVC. The mean ages were 40.9 ± 9.36 and 39.9 ± 8.39 years, respectively.

Diagnostic criteria

Diagnostic ultrasound criteria for PCS and APVC were dilation and reflux of the left and/or right gonadal vein (≥ 5 mm), left and/or right external pudendal vein (> 4 mm), and the presence of unilateral or bilateral adnexal varices (≥ 5 mm), vulvar varices (> 2 mm), and parauterine crossing veins (> 4 mm). The diagnosis of PCS (n = 84) and APVC (n = 49) was confirmed by quantitative ultrasound criteria. No additional imaging studies were performed.

PCS and APVC ultrasound findings

A comparison of normal and abnormal diameters based on the PCS and APVC diagnostic criteria is shown in Table 1. The mean abnormal diameter for PCS and APVC, of the left (9.65 ± 1.45 mm and 10.76 ± 2.06 mm, respectively) and right (8.98 ± 1.59 mm and 10.13 ± 2.20 mm, respectively) gonadal veins was comparable in both groups. The difference between normal and abnormal diameters was statistically significant. Reflux was detected in all patients with dilation. Abnormal parameters of the pelvic veins were present with different frequencies in each group. In the cases of normal diameter of the left (3.70 ± 0.37 mm and 3.55 ± 0.07 mm, respectively) and right (3.62 ± 0.48 mm and 3.93 ± 0.10 mm, respectively) gonadal veins, comparable results were observed in both groups. The pelvic plexus was normal in 12 patients in the PCS group and 6 in the APVC group, whereas the diameter was abnormal (≥ 5 mm) in 72 and 43 cases, respectively, mainly with bilateral impairment.

Table 1. Comparison of quantitative ultrasound findings using diagnostic criteria to define normal and abnormal diameter in women with PCS or APVC

Parameters	PCS (n = 84)					APVC (n = 49)				
	n	Normal diameter	n	Abnormal diameter	*p value*	n	Normal diameter	n	Abnormal diameter	*p value*
Left gonadal vein[a], mm	6	3.70 ± 0.37 (3.0, 3.8, 4.0)	78	9.65 ± 1.45 (5.9, 9.8, 13.0)	< 0.001	2	3.55 ± 0.07 (3.5, 3.5, 3.6)	47	10.76 ± 2.06 (5.0, 10.7, 15.0)	< 0.001
Right gonadal vein[a], mm	6	3.62 ± 0.48 (3.0, 3.9, 4.0)	78	8.98 ± 1.59 (5.0, 9.0, 15.2)	< 0.001	4	3.93 ± 0.10 (3.8, 3.9, 4.0)	45	10.13 ± 2.20 (6.0, 9.8, 16.0)	< 0.001
Left pelvic venous plexus[bc], mm	12	2.65 ± 0.90 (1.3, 2.4, 4.5)	2	7.25 ± 0.78 (6.7, 7.25, 7.8)	-	6	1.32 ± 0.40 (1.0, 1.2, 2.2)	1	5.9	-
Bilateral pelvic venous plexus[bc], mm	12	2.65 ± 0.90 (1.3, 2.4, 4.5)	70	8.10 ± 1.55 (5.0, 8.0, 13.0)	-	6	1.32 ± 0.40 (1.0, 1.2, 2.2)	42	8.38 ± 1.44 (5.0, 8.3, 12.0)	-
Left external pudendal vein[d], mm	3	2.47 ± 0.50 (2.0, 2.4, 3.0)	81	9.14 ± 1.34 (6.0, 8.9, 13.0)	< 0.001	4	2.25 ± 0.81 (1.2, 2.3, 3.1)	45	8.24 ± 1.23 (4.4, 8.2, 11.1)	< 0.001
Right external pudendal vein[d], mm	4	2.65 ± 0.64 (2.0, 2.7, 3.2)	80	8.79 ± 1.31 (4.7, 8.7, 12.1)	= 0.08	6	2.17 ± 1.18 (0.0, 2.3, 3.2)	43	8.34 ± 1.77 (5.3, 8.3, 13.0)	= 0.04
Vulvar veins[ef], mm	2	1.00 ± 0.0 (1.0, 1.0, 1.0)	81	6.51 ± 1.61 (3.5, 6.2, 11.0)	< 0.001	0	-	46	6.40 ± 1.28 (4.4, 6.2, 9.6)	-
Arcuate veins[gh], mm	55	2.61 ± 0.61 (1.0, 2.4, 4.0)	18	4.97 ± 0.49 (4.4, 5.0, 6.0)	< 0.001	18	2.28 ± 0.67 (1.0, 2.2, 3.2)	25	4.99 ± 0.52 (4.2, 5.0, 6.2)	< 0.001
Parauterine crossing veins[i]	69	-	15	-	-	39	-	10	-	-

[a]Dilation and reflux proximal left or right gonadal vein (diameter ≥ 5 mm); [b]Abnormal pelvic venous plexus or adnexal varices: presence of three or more dilated veins circular or linear venous structures of greater diameter ≥ 5 mm, that were tortuous around the ovary and uterus, left or bilateral; [c]Of the 133 patients, only 18 had normal diameter of the pelvic venous plexus (12 from the PCS group and 6 from APVC), 3 had left adnexal varices (2 from the PCS group and 1 from APVC), and the remainder (112) had bilateral adnexal varices (70 from the PCS group and 42 from APVC); [d]Dilation and reflux left or right external pudendal vein (diameter > 4 mm); [e]Presence of vulvar varices (diameter > 2 mm); [f]Four patients did not undergo translabial US examination, no analysis of vulvar varices was performed; [g]Dilation of arcuate vessels with diameter > 4 mm; [h]Seventeen patients with a history of hysterectomy, arcuate vessels were not examined. [i]Presence of parauterine crossing veins (diameter > 4 mm) (abnormal) in 25 patients; values refer to mean ± SD (min, med, max) unless otherwise stated.

APVC: asymptomatic pelvic venous congestion; n: number; p: p-value; PCS: pelvic congestion syndrome.

In both groups, the mean abnormal diameter of the left external pudendal vein (9.14 ± 1.34 mm and 8.24 ± 1.23 mm) was comparable to the right (8.79 ± 1.31 mm and 8.34 ± 1.77 mm) in the PCS and APVC groups.

The mean abnormal diameter of the vulvar vein was 6.51 ± 1.61 mm in the PCS group, similar to 6.40 ± 1.28 mm in the APVC group. TLUS was not performed in four patients because they did not consent the trichotomy. On the other hand, the mean normal and abnormal diameter of the arcuate vessels was comparable in both groups with statistically significant differences ($p < 0.001$). A previous hysterectomy was reported in 17 women, so the arcuate vessels were not evaluated. Parauterine crossing veins, with a diameter > 4 mm, were identified in 25 women, 15 with PCS and 10 with APVC. Only the presence or absence of parauterine crossing veins was recorded. Figure 3 shows the TAUS of a 36-year-old woman with PCS who had dilated gonadal veins, the presence of bilateral adnexal varices, and dilated arcuate vessels. Figure 4 shows the ThighUS and TLUS of a 32-year-old female patient with APVC who showed dilation and reflux of the left external pudendal vein and bilateral vulvar varices demonstrated with power Doppler and B-flow US.

Primary and secondary PCS and APVC

There were 116 (87.2%) primary cases, 70 in the PCS group and 46 in the APVC group (Table 2). Seventeen (12.8%) cases were secondary, 14 with PCS and 3 with APVC. Abnormal pelvic vein diameter was comparable between cases with primary and secondary syndromes. The secondary cases were Nutcracker syndrome (n = 14) (Figure 5), May-Thurner syndrome (n = 2) (Figure 6), and one case with Nutcracker and May-Thurner syndrome.

PCS and APVC grade classification

A 4-grade classification is proposed based on the pathophysiological changes and quantitative ultrasound findings of PCS and APVC (Table 3)

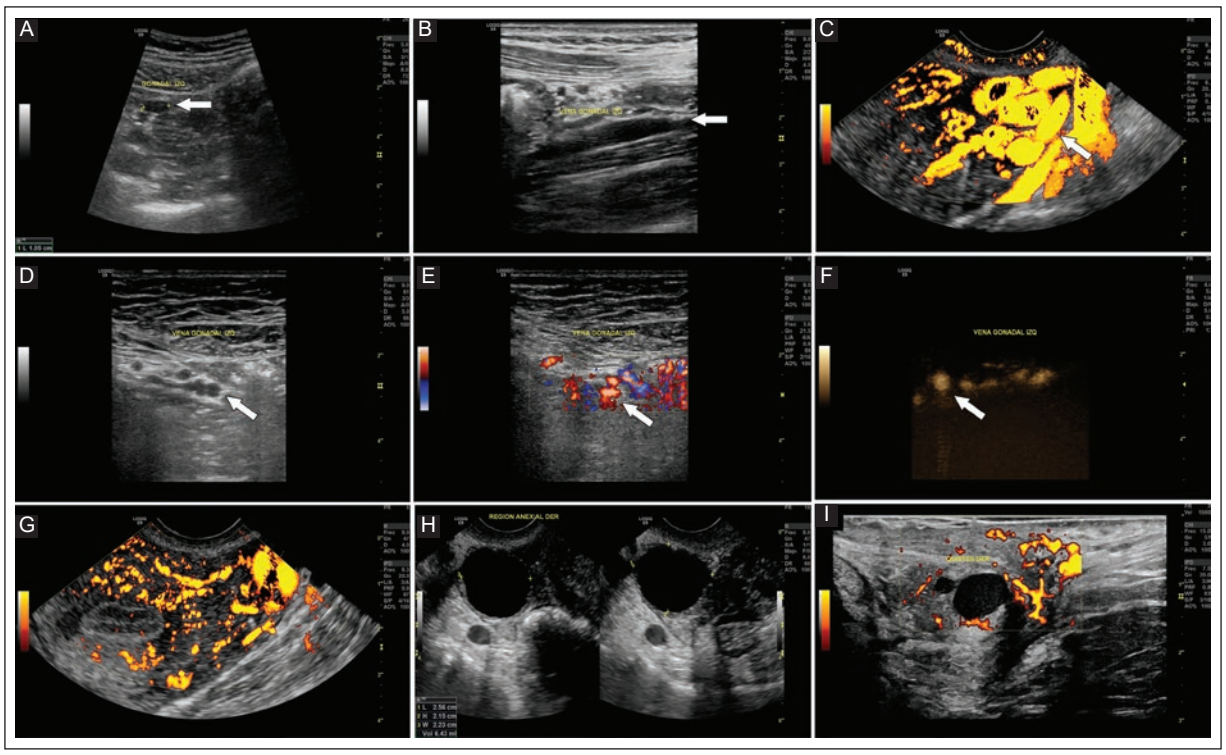


Figure 3. A 36-year-old woman with chronic pelvic pain. Diagnosis of PCS. US in grayscale, **A:** transverse. **B:** longitudinal views, showing left gonadal vein with a diameter of 10.5 mm (arrow). **C:** power Doppler US, transverse view, left adnexal varices are observed, with a diameter > 8 mm (arrow). **D:** grayscale US. **E:** color Doppler US. **F:** B-flow showing dilated left gonadal vein and collateral circulation (arrows). **G:** power Doppler US, transverse view, shows dilated arcuate vessel crossing myometrium and communicating with left adnexal varices. **H:** grayscale US, transverse and longitudinal view, showing an anechoic image dependent on the right ovary, without septa, avascular (not shown) associated with a simple ovarian cyst (6.43 cm^3). **I:** power Doppler US, transverse view, showing an anechoic image, circumscribed margin, without septa, avascular, with posterior enhancement, in the right labia majora corresponding to a Bartholin cyst.

PCS: pelvic congestion syndrome; US: ultrasound.

(Figures 7 and 8). No differences in the abnormal diameter of pelvic veins were observed in relation to the grades. Grade 1 included proximal dilation and reflux of the left and/or right gonadal vein (diameter ≥ 5 mm) and/or dilation and reflux of the left and/or right external pudendal vein (diameter > 4 mm) with the presence of vulvar varices (diameter > 2 mm). Grade 1 requires at least one criterion. Grade 2 includes dilation throughout and reflux of the left and/or right gonadal vein (diameter ≥ 5 mm), and/or another grade 1 criterion plus the presence of unilateral adnexal varices (≥ 5 mm). At least two criteria are required, and the presence of unilateral adnexal varices is essential. Grade 3 includes grade 1 and 2 criteria and adds the presence of bilateral adnexal varices (≥ 5 mm). At least two criteria are required, and the presence of bilateral adnexal varices is essential. Grade 4 includes criteria for grades 1, 2, and 3 and adds the presence of parauterine crossing veins (diameter > 4 mm). At least two criteria are required, and the presence of parauterine crossing veins is essential.

Structured and standardized reporting of diagnostic ultrasound criteria and grades for PCS and APVC

A structured and standardized reporting format for quantitative ultrasound findings in PCS and APVC based on diagnostic criteria and grades is shown in Table 4. In the first column of the upper segment of the format, the diameter (mm) is recorded based on the ultrasound findings of the case being evaluated. Then, the diagnostic criteria present are defined, and based on the classification grades given in the lower segment of the format, the grade of PCS or APVC of the case is assigned.

DISCUSSION

In our study, dilation and reflux of the left and/or right gonadal vein, presence of unilateral or bilateral adnexal varices, dilation and reflux of the external right and/or left pudendal vein, presence of vulvar varices, and presence of parauterine crossing veins were identified based on

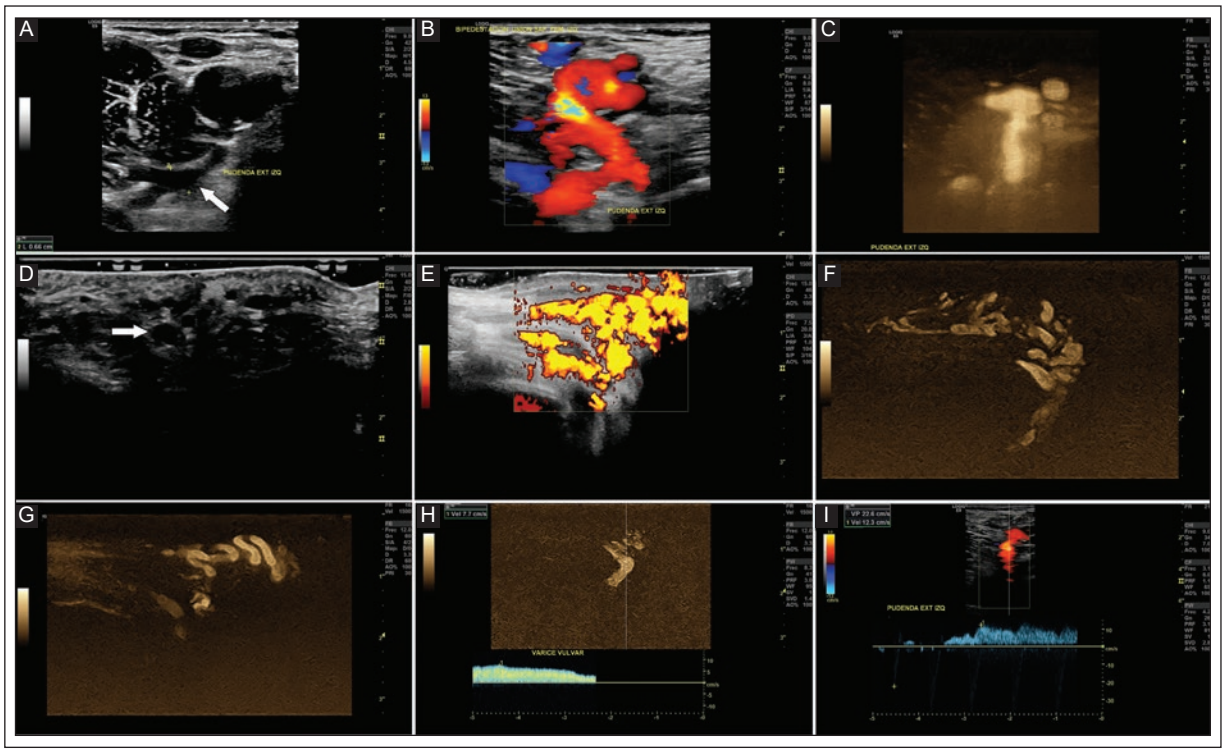


Figure 4. ThighUS and TLUS in a 32-year-old woman with APVC. **A:** grayscale US. **B:** color Doppler. **C:** B-flow; transverse view, showing left external pudendal vein with a diameter of 6.6 mm (arrow). **D:** Grayscale US. **E:** power Doppler. **F-G:** B-flow; transverse view showing vulvar varices with a diameter of 5.6 mm. **H:** duplex Doppler US in B-flow, transverse view, showing vulvar varices veins with spectral inversion and a velocity of 7.7 cm/sec. **I:** duplex Doppler US, transverse view, shows spectral inversion and a velocity of 12.3 cm/sec of the left external pudendal vein.
APVC: asymptomatic pelvic venous congestion; ThighUS: both thighs ultrasound; TLUS: translabial ultrasound; US: ultrasound.

Table 2. Comparison of ultrasound diagnostic criteria in women with PCS or APVC of primary or secondary etiology

Parameters	Primary PCS or APVC[a] (n = 116) Mean ± SD (min, med, max)	Secondary PCS or APVC[b] (n = 17) Mean ± SD (min, med, max)
Dilation and reflux of the left gonadal vein[c], mm	9.64 ± 2.39 (5.0, 10.0, 15.0)	9.93 ± 1.60 (8.0, 10.0, 13.0)
Dilation and reflux of the right gonadal vein[c], mm	9.52 ± 1.96 (5.0, 9.25, 16.0)	8.65 ± 1.36 (7.0, 8.8, 11.2)
Presence of left adnexal[d] varices, mm	6.80 ± 0.95 (5.9, 6.7, 7.8)	-
Presence of bilateral adnexal[d] varices, mm	8.16 ± 1.53 (5.0, 8.0, 13.0)	8.43 ± 1.39 (5.1, 8.7, 10.0)
Dilation and reflux of the left external pudendal vein[e], mm	8.82 ± 1.42 (4.4, 8.9, 13.0)	8.78 ± 0.94 (7.2, 8.7, 11.0)
Dilation and reflux of the right external pudendal vein[e], mm	8.64 ± 1.53 (4.7, 8.7, 13.0)	8.58 ± 1.33 (6.8, 8.4, 11.2)
Presence of vulvar varices[fg], mm	6.46 ± 1.49 (3.5, 6.2, 11.0)	6.60 ± 1.60 (4.0, 6.68, 9.6)
Presence of parauterine crossing veins[h], n	21	4

[a]Seventy patients with PCS and 46 with APVC were primary; [b]Fourteen patients with secondary PCS and 3 with secondary APVC; [c]Proximal dilation and reflux left or right gonadal vein (diameter ≥ 5 mm); [d]Abnormal pelvic venous plexus or adnexial varices: three or more dilated veins circular or linear venous structures of greater diameter ≥ 5 mm, that were tortuous around the ovary and uterus, uni or bilateral; [e]Dilation and reflux left or right external pudendal vein (diameter > 4 mm); [f]Vulvar varices (diameter > 2 mm); [g]Four patients did not undergo translabial US study, no analysis of vulvar varices was performed; [h]Presence of parauterine crossing veins (diameter > 4 mm) (abnormal) in 25 patients, 21 corresponded to 12 with primary PCS and 9 primary APVC or 4 to secondary PCS in 3 and secondary APVC in one.
APVC: asymptomatic pelvic venous congestion; n: number; PCS: pelvic congestion syndrome.

quantitative ultrasound criteria for the diagnosis of PCS or APVC. A 4-grade classification was defined, and a structured format for standardized reporting of ultrasound findings of PCS and APVC was proposed for the first time.

There is no consensus on defining quantitative diagnostic criteria for PCS and APVC based on dilated gonadal veins, dilated external right and/or left pudendal vein, adnexal varices, vulvar varices and parauterine

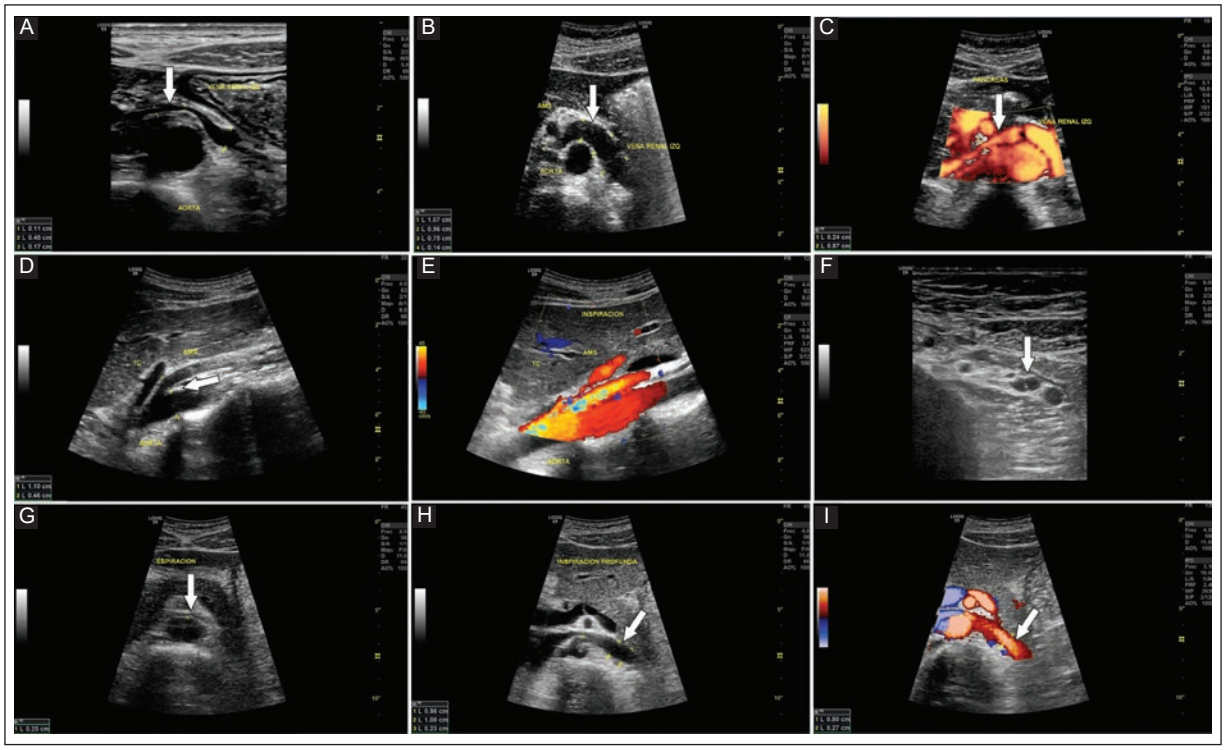


Figure 5. A 34-year-old woman with Nutcracker syndrome (secondary PCS). **A:** grayscale US, transverse view showing left renal vein with stenosis (1.1 mm) between SMA and Ao (arrow). **B:** grayscale US, transverse view showing the left renal vein with prestenotic dilation (10.7 mm) (arrow). **C:** power Doppler US, transverse view showing the left renal vein with stenosis (2.4 mm) between SMA and Ao with prestenotic dilation (8.7 mm) (arrow). **D-E:** US in grayscale and color Doppler, longitudinal view, showing decreased angle (< 30º) between SMA and Ao (arrow). **F:** US in grayscale, transverse view showing dilated left gonadal vein and collateral circulation (arrow). A 42-year-old woman with Nutcracker syndrome (secondary PCS). **G:** grayscale US, transverse view showing left renal vein with stenosis (2.5 mm) between SMA and Ao (arrow). **H:** grayscale US, transverse view showing the left renal vein with prestenotic dilation (10 mm) (arrow). **I:** color Doppler, transverse view showing the left renal vein with prestenotic dilation (8 mm) (arrow).

Ao: aorta; PCS: pelvic congestion syndrome; SMA: superior mesenteric artery; US: ultrasound.

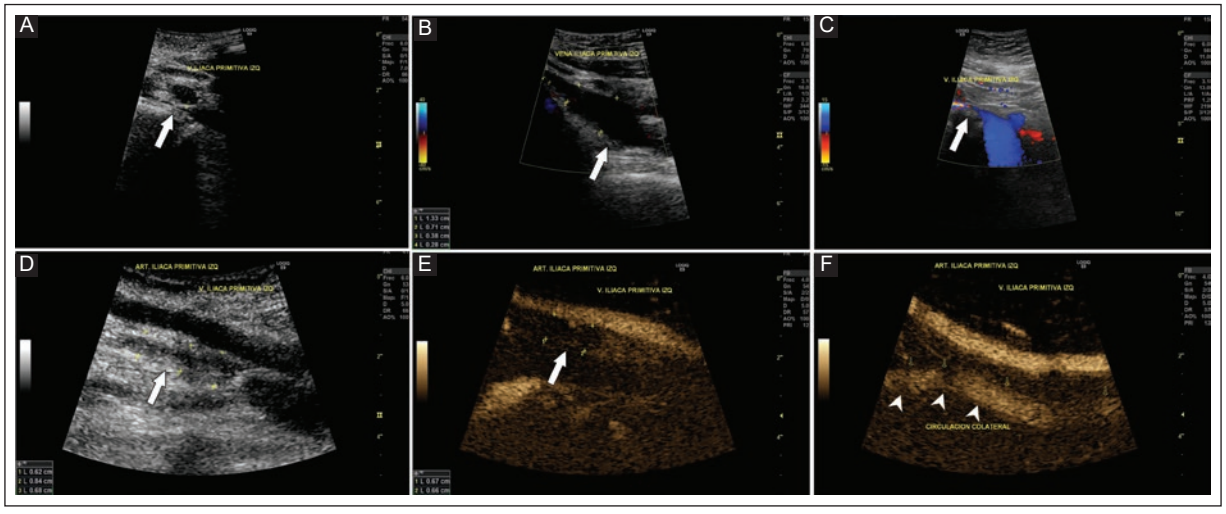


Figure 6. A 33-year-old woman with May-Thurner syndrome (secondary PCS). **A:** grayscale US, transverse view showing stenosis (1.2 mm, measure not shown) (arrow) of the left primitive iliac vein between the right primitive iliac artery and vertebral body. **B:** grayscale US. **C:** color Doppler; longitudinal view, left primitive iliac vein showing a prestenotic dilation (13.3 mm), permeable, without a thrombus. A 28-year-old woman with May-Thurner syndrome (secondary PCS). **D:** grayscale US. **E:** B-flow, longitudinal view showing left primitive iliac vein with endoluminal echogenic material, fixed throughout, without flow, associated with chronic thrombosis, non-recanalized (arrows). **F:** B-flow, longitudinal view showing collateral circulation associated with chronic thrombosis (arrowheads).

PCS: pelvic congestion syndrome; US: ultrasound.

Table 3. A 4-grade classification based on diagnostic ultrasound criteria and abnormal mean diameter values of pelvic vessels in 133 women with PCS or APVC

Parameters	Grade 1[a] (n = 18)	Grade 2[b] (n = 3)	Grade 3[c] (n = 87)	Grade 4[d] (n = 25)
Dilation and reflux of the left gonadal vein[e], mm	10.39 ± 1.53 (6.9, 11.0, 12.0)	9.63 ± 0.92 (9.0, 9.2, 10.7)	10.03 ± 1.82 (5.0, 10.0, 15.0)	10.10 ± 1.86 (5.9, 10.0, 14.0)
Dilation and reflux of the right gonadal vein[e], mm	9.14 ± 2.10 (5.2, 9.1, 12.0)	8.43 ± 0.74 (7.6, 8.7, 9.0)	9.56 ± 1.99 (5.0, 9.3, 16.0)	9.10 ± 1.62 (5.9, 9.0, 13.0)
Presence of unilateral adnexal varices[f], mm	NR	6.80 ± 0.95 (5.9, 6.7, 7.8)	NR	NR
Presence of bilateral adnexal varices[f], mm	NR	NR	8.08 ± 1.50 (5.0, 8.0, 12.0)	8.64 ± 1.47 (5.1, 8.4, 13.0)
Dilation and reflux of the left external pudendal vein[g], mm	8.44 ± 1.72 (4.4, 8.2, 11.1)	9.67 ± 1.35 (8.3, 9.7, 11.0)	8.81 ± 1.32 (6.0, 8.8, 13.0)	8.99 ± 1.25 (6.9, 8.7, 12.0)
Dilation and reflux of the right external pudendal vein[g], mm	8.83 ± 1.81 (5.4, 8.8, 13.0)	10.00 ± 2.43 (8.0, 9.3, 12.7)	8.56 ± 1.48 (4.7, 8.5, 12.1)	8.59 ± 1.22 (6.0, 8.7, 11.4)
Presence of vulvar varices[h], mm	6.20 ± 1.45 (3.6, 6.1, 8.4)	6.57 ± 1.69 (4.7, 7.0, 8.0)	6.34 ± 1.42 (3.5, 6.2, 10.0)	7.10 ± 1.68 (4.4, 6.9, 11.0)
Presence of parauterine crossing veins[i], n	NR	NR	NR	25

[a]Twelve patients with grade 1 were symptomatic and 6 with APVC; [b]Two with grade 2 were symptomatic and 1 with APVC; [c]Fifty-five patients with grade 3 had PCS and 32 APVC; [d]Fifteen with grade 4 had PCS and 10 with APVC; [e]Dilation and reflux proximal left or right gonadal vein (diameter ≥ 5 mm); [f]Abnormal pelvic venous plexus or adnexal varices: presence of three or more dilated veins circular or linear venous structures of greater diameter ≥ 5 mm, that were tortuous around the ovary and uterus, uni or bilateral; [g]Dilation and reflux left or right external pudendal vein (diameter > 4 mm); [h]Presence of vulvar varices (diameter > 2 mm); [i]Presence of parauterine crossing veins (diameter > 4 mm) (abnormal) in 25 patients, 108 patients were graded with absence of parauterine crossing veins; values refer to mean ± SD (min, med, max), unless otherwise stated.

APVC: asymptomatic pelvic venous congestion; NR: not required; PCS: pelvic congestion syndrome.

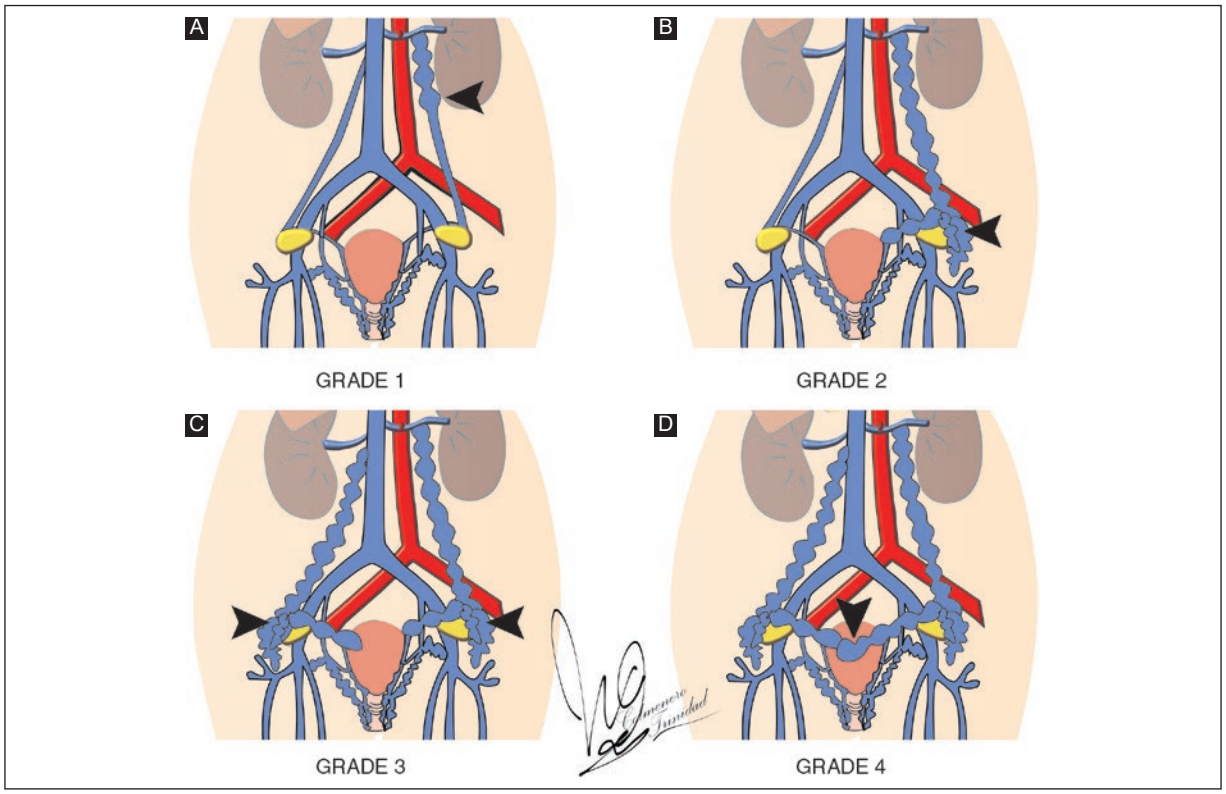


Figure 7. The 4-grade classification of PCS and APVC. **A:** grade 1, proximal dilation and reflux of the left and/or right gonadal vein (diameter ≥ 5 mm) (arrowhead), dilation and reflux of the left and/or right external pudendal vein (diameter > 4 mm) with presence of vulvar varices (diameter > 2mm). Requires at least one criterion. **B:** grade 2 dilation throughout and reflux of the left and/or right gonadal vein (diameter ≥5 mm), and/or another grade 1 criterion plus the presence of unilateral adnexal varices (≥ 5 mm) (arrowhead). Requires at least two criteria; the presence of unilateral adnexal varices is essential. **C:** grade 3 includes the criteria of grade 1 and 2, and the presence of bilateral adnexal varices (≥ 5 mm) (arrowheads). At least two criteria are required, and the presence of bilateral adnexal varices is essential. **D:** grade 4 includes criteria for grades 1, 2, and 3 plus the presence of parauterine crossing veins (diameter > 4 mm) (arrowhead). At least two criteria are required; presence of parauterine crossing veins is essential.

APVC: asymptomatic pelvic venous congestion; PCS: pelvic congestion syndrome.

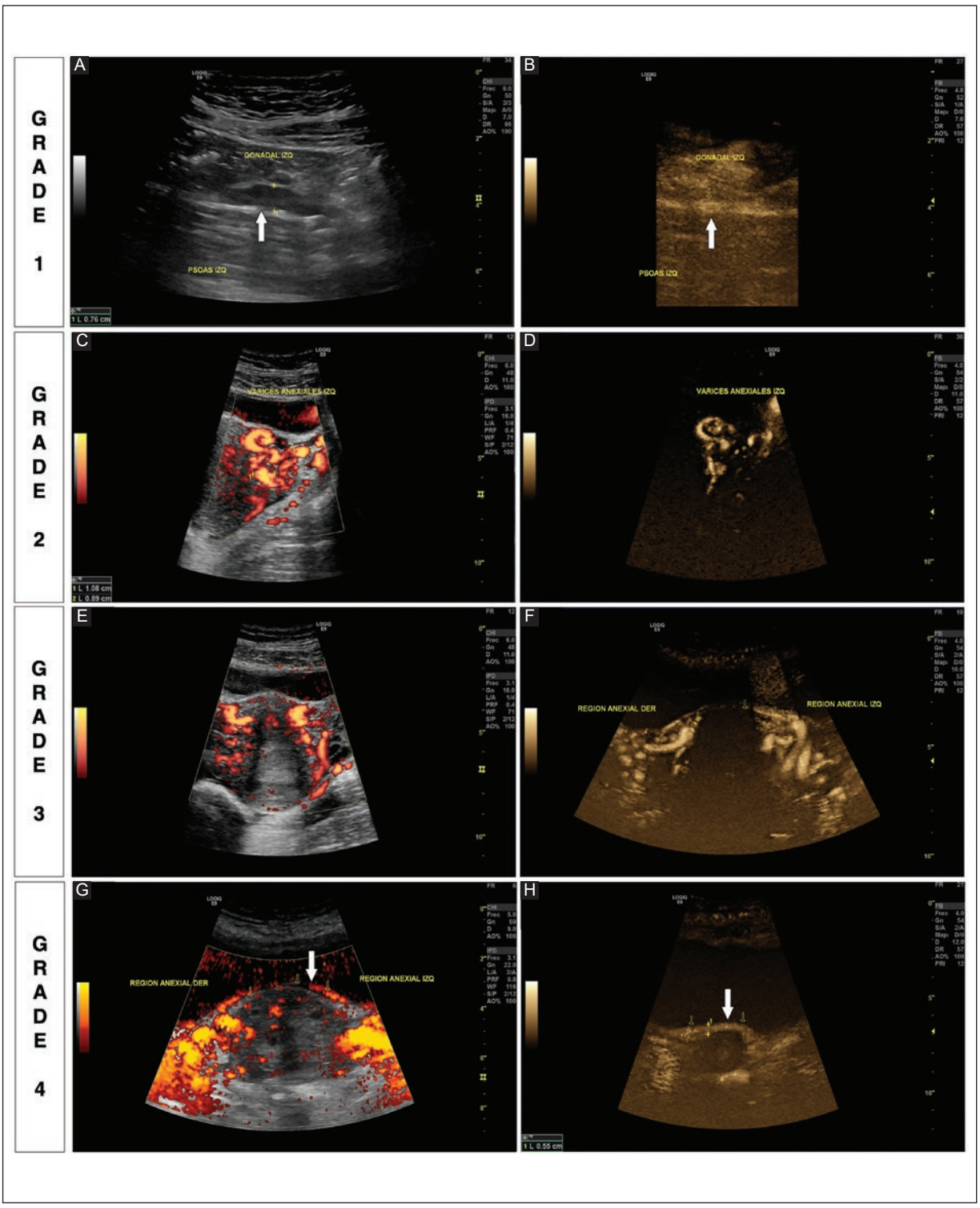


Figure 8. Ultrasound findings of the 4-grades classification of PCS and APVC. **A:** grayscale US. **B:** B-flow, longitudinal view, grade 1 showing proximal dilation of the left gonadal vein (7.6 mm) and reflux with Valsalva maneuver (arrows). **C:** power Doppler US. **D:** B-flow, transverse views, grade 2 showing unilateral left adnexal varices (10.8 mm). **E:** power Doppler US. **F:** B-flow, transverse view, grade 3 showing bilateral adnexal varices. **G:** power Doppler US, and **H:** B-flow, transverse view, grade 4 showing parauterine crossing veins (5.5 mm) (arrows) communicating with bilateral adnexal varices.

APVC: asymptomatic pelvic venous congestion; PCS: pelvic congestion syndrome; US: ultrasound.

Table 4. Structured and standardized reporting format of ultrasound criteria for diagnosis and grading of women with PCS[a] or APVC

A. Diagnostic criteria	Patient data (diameter, mm)	Criterion present: Yes/No
Dilation and reflux of the left gonadal vein (diameter ≥ 5 mm)		
Dilation and reflux of the right gonadal vein (diameter ≥ 5 mm)		
Presence of unilateral adnexal varices[b] (diameter ≥ 5 mm)		
Presence of bilateral adnexal varices[b] (diameter ≥ 5 mm)		
Dilation and reflux of the left external pudendal vein (diameter > 4 mm)		
Dilation and reflux of the right external pudendal vein (diameter > 4 mm)		
Presence of vulvar varices (diameter > 2 mm)		
Presence of parauterine crossing veins (diameter > 4 mm)		
	Grade	

4-grade classification of PCS and APVC: the grade is chosen based on the diagnostic criteria present in the case. For each grade, the required and essential criteria are indicated

A. Parameters of the grade classification	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
Proximal dilation and reflux of the left and/or right gonadal vein (diameter ≥ 5 mm), Dilation and reflux of the left and/or right external pudendal vein (diameter > 4 mm) with presence of vulvar varices (diameter >2 mm). *Requires at least one criterion.*				
Dilation throughout and reflux of the left and/or right gonadal vein (diameter ≥ 5 mm), and/or another grade 1 criterion. **Add the presence of unilateral adnexal varices (diameter ≥ 5 mm).** *Require at least two criteria,* *and the presence of unilateral adnexal varices is essential.*				
It includes grade 1 and 2 criteria, **Add the presence of bilateral adnexal varices (diameter ≥ 5 mm).** *Requires at least two criteria,* *and the presence of bilateral adnexal varices is essential.*				
It includes grade 1, 2, and 3 criteria, **Add the presence of parauterine crossing veins (diameter > 4 mm).** *Requires at least two criteria,* *and the presence of parauterine crossing veins is essential.*				

[a]Chronic pelvic pain (≥6 months); [b]Abnormal pelvic venous plexus or adnexal varices: three or more dilated circular veins or linear venous structures ≥5 mm in diameter that were tortuous around the ovary and uterus, unilaterally or bilaterally.

Comment: vascular compression causing secondary PCS or APVC, such as Nutcraker syndrome and/or May-Thurner syndrome, should be considered in the etiologic diagnosis of PCS or APVC.

APVC: asymptomatic pelvic venous congestion; PCS: pelvic congestion syndrome.

crossing veins. TAUS, PelUS, and TVUS have been proposed as an alternative to the gold standard as the initial diagnostic examination in patients with suspected PCS[8]. In our study, the protocol included TAUS, PelUS, TVUS, ThighUS, and TLUS for a complete evaluation of the abdominal and pelvic venous systems. Our quantitative ultrasound parameter results in PCS and APVC are comparable to those previously reported[3,7,19,20] with abnormal diameters of gonadal veins, adnexal varices, and parauterine crossing veins. On the other hand, we propose for the first-time, quantitative parameters for dilation of the external pudendal vein (> 4 mm) and vulvar varices (> 2 mm). The combination of several quantitative ultrasound parameters may increase the diagnostic accuracy of pelvic vein abnormalities for the diagnosis of PCS and APVC, along with the technological development, high resolution of current ultrasound equipment, and an experienced operator in vascular imaging.

Pelvic vein abnormalities comparable by ultrasound examination of PCS have been described in multiparous asymptomatic women with APVC[5]. In a study of 34 healthy asymptomatic women, kidney donors with an average age of 33 years, an abdominopelvic helical CT examination was performed[2]. Dilation and reflux of the left (9.1 mm) and right (8.8 mm) gonadal veins were found in 16 (47.0%) women; fifteen (93.7%) were parous women and only one non-parous ($p < 0.05$). These results are comparable to the findings in the APVC group of our study with left (10.76 mm) and right (10.13 mm) gonadal vein dilation. Multiparity seems to be the main feature conditioning abnormal ultrasound findings in both groups. The impact of the diagnosis of APVC is not defined. Follow-up in individualized cases eligible for treatment is recommended.

The grades of pelvic venous system congestion in women with PCS or APVC have been proposed based on ultrasound findings[10,23]. The 4-grade classification of PCS and APVC that we presented is comparable to that published by Hiromura et al.[11] of 3 grades based on tomographic findings in patients with PCS. In grades 1 and 2, the diagnostic criteria were similar in the two classifications. In contrast, in our 4-grade classification, included bilateral adnexal varices in grade 3, and parauterine crossing veins in grade 4, whereas Hiromura et al.[11] included both criteria in grade 3. The progression defined based on grade classification may have implications for follow-up and therapeutic decisions of women with PCS or APVC.

The structured and standardized reporting of quantitative ultrasound findings that we propose may help systematize the evaluation, diagnosis, and follow-up of patients with PCS or APVC, with implications for patient care, education, and research. The reporting format, based exclusively on ultrasound findings that combine different modalities such as TAUS, PelUS, TVUS, ThighUS, and TLUS may be useful in low- or medium-resource countries where the infrastructure and economic resources to perform venography, CTA, or MRA are limited, in addition to the inherent advantages of US.

The strengths of the study are related to the large sample size and the fact that the evaluation of patients was performed by a single radiologist with expertise in vascular ultrasound. In addition, the study protocol was complete with multiple modalities, including TAUS, PelUS, TVUS, ThighUS, and TLUS for the evaluation of abdominal, pelvic, vaginal, thighs, and translabial veins. Weaknesses of the study include the cross-sectional design and the fact that no healthy control group was included. The ultrasound results were not compared with conventional venography, the gold standard, or alternative methods such as CTA or MRA. Ultrasound is operator-dependent, and formal training in vascular imaging is required to achieve diagnostic accuracy in this imaging modality. Our protocol did not include an assessment of reflux of the internal iliac vein and its branches, which may be associated with PCS or APVC. On the other hand, interobserver and intraobserver concordance were not defined. The proposed standardized structured reporting format should be validated before its routine clinical application in different populations with and without PCS or APVC.

CONCLUSION

A 4-grade classification of PCS and APVC based on quantitative ultrasound diagnostic criteria and a structured, standardized report of findings of abnormal pelvic vein diameter and reflux are proposed. Application of these criteria in the evaluation of patients with suspected PCS or APVC may confirm the diagnosis and support the decision to treat. The time required to evaluate patients with suspected PCS or APVC is approximately 120 minutes and may be a limitation in public institutional settings with high demand and limited time for patient care. The proposed standardized structured report allows an accurate description of ultrasound findings by radiologists, confirmation of the diagnosis of PCS or APVC, improves communication with referring physicians, and may be used in multicenter prospective studies of the diagnosis of PCS and APVC.

Acknowledgments

The authors thank Professor Ana M. Contreras-Navarro for her guidance in preparing and writing this scientific paper.

Funding

This study was supported with funds from the National Quality Postgraduate Program of the Consejo Nacional de Ciencia y Tecnología de México (Conacyt).

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Ethical disclosures

Protection of Individuals. This study was conducted in compliance with the Declaration of Helsinki (1964) and its subsequent amendments.

Confidentiality of Data. The authors declare they followed their center's protocol for sharing patient data.

Right to privacy and informed consent. Informed consent was not required for this observational study of information collected during routine clinical care.

REFERENCES

1. Antignani PL, Lazarashvili Z, Monedero JL, Ezpeleta SZ, Whiteley MS, Khilnani NM. Diagnosis and treatment of pelvic congestion syndrome: UIP consensus document. Int Angiol. 2019; 38(4):265-283. doi: 10.23736/S0392-9590.19.04237-8.
2. Rozenblit AM, Ricci ZJ, Tuvia J, Amis ES Jr. Incompetent and dilated ovarian veins: a common CT finding in asymptomatic parous women. AJR Am J Roentgenol. 2001; 176(1):119-122. doi: 10.2214/ajr.176.1.1760119.
3. Steenbeek MP, van der Vleuten CJM, Schultze Kool LJ, Nieboer TE. Noninvasive diagnostic tools for pelvic congestion syndrome: a systematic review. Acta Obstet Gynecol Scand. 2018; 97(7):776-786. doi: 10.1111/aogs.13311.
4. Gómez-Arbeláez D, Ansuátegui M, Comanges A, Ibarra G, Sánchez-Guerrero A, Villar R et al. Pelvic congestion syndrome: an updated review of the literature. Angiology. 2020; 72(5):229-239. https://dx.doi.org/10.20960/angiologia.00130.
5. Meissner MH, Khilnani NM, Labropoulos N, Gasparis AP, Gibson K, Greiner M, et al. The Symptoms-Varices-Pathophysiology classification of pelvic venous disorders: A report of the American Vein & Lymphatic Society International Working Group on Pelvic Venous Disorders. J Vasc Surg Venous Lymphat Disord. 2021; 9(3):568-584. doi: 10.1016/j.jvsv.2020.12.084.
6. Labropoulos N, Jasinski PT, Adrahtas D, Gasparis AP, Meissner MH. A standardized ultrasound approach to pelvic congestion syndrome. Phlebology. 2017; 32(9):608-619. doi: 10.1177/0268355516677135.
7. Park SJ, Lim JW, Ko YT, Lee DH, Yoon Y, Oh JH. Diagnosis of pelvic congestion syndrome using transabdominal and transvaginal sonography. AJR Am J Roentgenol. 2004;182(3):683-688. doi: 10.2214/ajr.182.3.1820683.
8. Expert Panel on Women's Imaging:, Maturen KE, Akin EA, Dassel M, Deshmukh SP, Dudiak KM, Henrichsen TL, et al. ACR Appropriateness Criteria® Postmenopausal Subacute or Chronic Pelvic Pain. J Am Coll Radiol. 2018;15(11S): S365-S372. doi: 10.1016/j.jacr.2018.09.023.
9. Beard RW, Highman JH, Pearce S, Reginald PW. Diagnosis of pelvic varicosities in women with chronic pelvic pain. Lancet. 1984; 2(8409):946-949. doi: 10.1016/s0140-6736(84)91165-6.
10. Halligan S, Campbell D, Bartram CI, Rogers V, El-Haddad C, Patel S. Transvaginal ultrasound examination of women with and without pelvic venous congestion. Clin Radiol. 2000; 55(12):954-958. doi: 10.1053/crad.2000.0602.
11. Hiromura T, Nishioka T, Nishioka S, Ikeda H, Tomita K. Reflux in the left ovarian vein: analysis of MDCT findings in asymptomatic women. AJR Am J Roentgenol. 2004; 183(5):1411-1415. doi: 10.2214/ajr.183.5.1831411.
12. Yang DM, Kim HC, Nam DH, Jahng GH, Huh CY, Lim JW. Time-resolved MR angiography for detecting and grading ovarian venous reflux: comparison with conventional venography. Br J Radiol. 2012; 85(1014):117-122. doi: 10.1259/bjr/79155839.
13. Kim CY, Miller MJ Jr, Merkle EM. Time-resolved MR angiography as a useful sequence for assessment of ovarian vein reflux. AJR Am J Roentgenol. 2009; 193(5):458-463. doi: 10.2214/AJR.09.2557.
14. Coakley FV, Varghese SL, Hricak H. CT and MRI of pelvic varices in women. J Comput Assist Tomogr. 1999; 23(3):429-434. doi: 10.1097/00004728-199905000-00018.
15. Kuligowska E, Deeds L 3rd, Lu K 3rd. Pelvic pain: overlooked and underdiagnosed gynecologic conditions. RadioGraphics. 2005; 25(1):3-20. doi: 10.1148/rg.251045511.
16. Giacchetto C, Cotroneo GB, Marincolo F, Cammisuli F, Caruso G, Catizone F. Ovarian varicocele: ultrasonic and phlebographic evaluation. J Clin Ultrasound. 1990; 18(7):551-555. doi: 10.1002/jcu.1870180705.
17. Malgor RD, Adrahtas D, Spentzouris G, Gasparis AP, Tassiopoulos AK, Labropoulos N. The role of duplex ultrasound in the workup of pelvic congestion syndrome. J Vasc Surg Venous Lymphat Disord. 2014; 2(1):34-38. doi: 10.1016/j.jvsv.2013.06.004.
18. Knuttinen MG, Xie K, Jani A, Palumbo A, Carrillo T, Mar W. Pelvic venous insufficiency: imaging diagnosis, treatment approaches, and therapeutic issues. AJR Am J Roentgenol. 2015; 204(2):448-458. doi: 10.2214/AJR.14.12709.
19. Szary C, Wilczko J, Zawadzki M, Grzela T. Hemodynamic and Radiological Classification of Ovarian Veins System Insufficiency. J Clin Med. 2021;10(4):646. doi: 10.3390/jcm10040646.
20. Valero I, Garcia-Jimenez R, Valdevieso P, Garcia-Mejido JA, Gonzalez-Herráez JV, Pelayo-Delgado I. Identification of Pelvic Congestion Syndrome Using Transvaginal Ultrasonography. A Useful Tool. Tomography. 2022; 8(1):89-99. doi: 10.3390/tomography8010008.
21. Bookwalter CA, VanBuren WM, Neisen MJ, Bjarnason H. Imaging Appearance and Nonsurgical Management of Pelvic Venous Congestion Syndrome. RadioGraphics. 2019; 39(2):596-608. doi: 10.1148/rg.2019180159.
22. Barois V, Stoopen M, Cruz E. B-Flow and its clinical applications. Mexico City (MX): GE Healthcare LATAM; 2015. 8p.
23. Campbell D, Halligan S, Bartram CI, Rogers V, Hollings N, Kingston K, et al. Transvaginal power Doppler ultrasound in pelvic congestion. Acta Radiol. 2003; 44(3):269-274. doi: 10.1034/j.1600-0455.2003.00063.x.