Diagnosis and treatment of the pelvic congestion syndrome

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Background: Chronic pelvic pain accounts for up to 30% of outpatient gynecologic visits in the United States, potentially affecting up to 40% of the female population during their lifetime. Pelvic congestion syndrome (PCS) is defined as chronic pelvic pain resulting from reflux or obstruction of the gonadal, gluteal, or perineal veins, sometimes associated with perineal or vulvar varices. It can also be caused by compression of the left renal vein (LRV) between the superior mesenteric artery and the aorta, also known as the nutcracker syndrome. Whereas PCS accounts for up to 30% of patients presenting with chronic pelvic pain, it is frequently under-diagnosed. We reviewed the literature to investigate the current state of the diagnosis and treatment of this disorder.

Methods: An online database search was performed with MEDLINE. MeSH headings included PCS, chronic pelvic pain, ovarian vein reflux, nutcracker syndrome, renal vein obstruction, pelvic varicosities, labial varicosities, embolization, treatment, and therapies.

Results: Our MEDLINE search revealed more than 3756 references to chronic pelvic pain. Specific references to PCS, pelvic chronic pain, ovarian vein reflux, nutcracker syndrome, renal vein obstruction, pelvic varicosities, labial varicosities, embolization, treatment, and therapies.

Conclusions: Diagnosis of PCS requires a careful history, physical examination, and noninvasive imaging. Several large case series have demonstrated the efficacy of embolotherapy in the reduction of pelvic pain; thus, it is the most favored treatment option for patients with PCS. For patients with outflow obstruction due to nutcracker syndrome, a limited number of studies have demonstrated remission of symptoms with stenting of the LRV as an alternative to open surgery.

Chronic pelvic pain is described as the presence of lower abdominal or pelvic pain for longer than 6 months. Chronic pelvic pain accounts for up to 30% of outpatient gynecologic visits in the United States, potentially affecting up to 40% of the female population during their lifetime. Pelvic congestion syndrome (PCS) is defined as chronic pelvic pain often associated with perineal or vulvar varices resulting from reflux or obstruction of the gonadal, gluteal, or perineal veins. First described clinically by Richet in 1857, the existence of pelvic varicosities was documented in 1949 by Taylor. PCS accounts for up to 30% of patients presenting with chronic pelvic pain and is characterized by symptoms of dysmenorrhea, dysuria, and dyspareunia. It can often be found in conjunction with vulvar and pelvic varices in women and with varicoceles in men. In addition to causing a fair amount of physical pain and discomfort, PCS also carries a psychological burden and is often found in conjunction with increased levels of anxiety, stress, and depression. Patients with PCS are primarily premenopausal and range in age from 20 to 45 years, although most present in their second and third decades of life. Genetic or ethnic predilections are unclear; however, a family history and multiparity are both risk factors. Venous outflow obstruction resulting from left renal vein (LRV) compression due to either the superior mesenteric artery (SMA) in nutcracker syndrome or uterine malposition is also an important although less common factor in the development of PCS. Treatment of PCS consists of hormone therapy, embolotherapy, sclerotherapy, and endovascular and open surgery. Although no randomized prospective trials have studied the efficacy of such therapies, several studies from single institutions have demonstrated efficacy for...
interventions that have alleviated symptoms related to the disease.

ANATOMY

The ovaries and uterus are drained by both the internal iliac and gonadal veins (Fig 1). The internal iliac vein passes slightly medial and posterior to the internal iliac artery, joining the external iliac to form the common iliac vein. Its tributaries are divided into parietal and visceral. Parietal tributaries are the superior and inferior gluteal, sciatic, sacral, ascending lumbar, and obturator veins. Visceral tributaries are the internal pudendal, middle hemorrhoidal, and vesicoprostatic plexuses in men and the uterine, gonadal, and vesicovaginal plexuses in women. In 27% of cases, the internal iliac vein drains by means of two separated trunks. Rarely, it can drain directly into the inferior vena cava (IVC). Valves are found infrequently on the internal iliac veins (10% of cases on the main trunk and 9% on its tributaries).

Ovarian veins provide drainage of the parametrium, cervix, mesosalpinx, and pampiniform plexus, forming a rich anastomotic venous plexus with the paraovarian, uterine, vesical, rectal, and vulvar plexuses (Fig 1). Two or three trunks form a single ovarian vein at L4, with the left ovarian vein draining into the LRV and the right ovarian vein draining directly into the IVC in the majority of women. In up to 10% of women, the right ovarian vein may also drain into the right renal vein instead of the IVC. Studies have shown that normal ovarian veins have an average diameter of less than 5 mm. Valves are present in these veins, mainly in the distal third. Ahlberg et al found no ovarian vein valves on the left side in 15% and none on the right side in 6%. In those in whom valves are present, they are incompetent in 40% on the left and in 35% on the right. Ovarian vein reflux has been reported in 10% of female renal transplant donors, up to 60% of whom develop PCS. Up to 47% of asymptomatic parous women have left ovarian reflux and enlarged mean ovarian diameters ranging from 7 to 12 mm on computed tomography (CT) scan. Thus, because of variation in anatomy and the variability of correlation between both anatomic and functional imaging and clinical symptoms, the diagnosis of PCS is primarily a clinical one that is often deduced from a process of elimination in conjunction with imaging suggestive of venous incompetence or obstruction. On the basis of clinical presentation and hemodynamic pathophysiologic findings, four main types of pelvic venous circulation disorders have been recognized: vulvar varices without accompanying symptoms of pelvic congestion (although vulvar varices may be seen with any type of pelvic congestion), isolated insufficiency of the hypogastric vein and its tributaries, gonadal vein reflux, and obstruction of the gonadal outflow by mesoaortic compression of the LRV (nutcracker syndrome). The most common of these is gonadal vein reflux due to incompetent valves.

PATHOPHYSIOLOGY

Because of the paucity of functioning valves and the proximity of the pelvic veins to several structures, pelvic varicosities can develop by two mechanisms, reflux caused by incompetent valves and obstruction. The cause of valvular incompetence is unknown, although hormonal factors are thought to play a significant role. During pregnancy, estradiol inhibits vasoconstriction and induces uterine enlargement with selective dilation of the ovarian and uterine veins, placing more stress on the valves. Multiparous women are more likely to develop pelvic venous incompetence. Conversely, vasoconstrictors have shown some efficacy in alleviating the symptoms of PCS by improving venous return through compression of the vein. In women diagnosed with PCS, the injection of dihydrolergotamine produces a 35% reduction in diameter of the pelvic veins and a decrease in pain.

PCS may also result from obstruction of ovarian vein outflow. The most common cause of obstruction is the compression of the LRV between the SMA and the aorta, also known as the nutcracker syndrome (Fig 2). Distal obstruction can lead to increased venous pressure and subsequent venodilation, valvular incompetence, and tortuosity of the ovarian vein, resulting in the development of an elevated pressure gradient between the LRV and the vena cava, a finding that is normally absent. The presence of an elevated LRV-IVC pressure gradient may be suggestive...
of nutcracker syndrome, but not in isolation without symptoms or evidence of varicosities, as will be further discussed. Uterine malposition with ovarian kinking is another although less common cause of outflow obstruction along with May-Thurner syndrome, a condition in which the left common iliac vein is compressed by the right common iliac artery. This compression can sometimes lead to deep venous thrombosis. Regardless of the etiology, the end result of ovarian vein outflow obstruction is the development of numerous refluxing varicosities, cross-pelvic venous collaterals, and painful venous congestion of the perineal vasculature (Fig 3).

**PRESENTATION**

Patients with PCS have usually seen primary care and gynecologic specialists before being referred to a vascular specialist. Many patients will present with chronic, dull, lower abdominal pain often accompanied by dyspareunia and bladder irritability and urgency. The pain is typically relieved by lying down and exacerbated by standing up or increased intra-abdominal pressure, such as during pregnancy and the premenstrual period. Pain during intercourse or during the postcoital period is not uncommon. Other symptoms of pelvic congestion are nonspecific and variable in intensity. Affected women may have fullness in the legs, generalized lethargy, depression, abdominal or pelvic tenderness, vaginal discharge, dysmenorrhea, swollen vulva, lumbosacral neuropathy, rectal discomfort, and nonspecific gastrointestinal symptoms. Differential diagnosis in these patients is lengthy and includes pelvic inflammatory disease, endometriosis, pelvic tumors, interstitial cystitis, and inflammatory bowel disease.

Clinical examination often reveals vulvar varicosities (Fig 3) together with an engorged cervix and pain on
of ovarian vein dilation, clinical symptoms, and these venographic findings: dilated tortuous arcuate veins in the myometrium that communicate with bilateral pelvic varicoses, slow blood flow (<3 cm/s), and reversed caudal or retrograde venous blood flow in the left ovarian vein, the patient can be referred directly for pelvic venography and embolotherapy. If US is nondiagnostic, the patient should undergo multidetector computed tomography (MDCT) with subsequent venography and embolotherapy if results are suggestive or diagnostic of PCS. Patients should be followed up in the clinic for improvement of symptoms and may also benefit from adjunctive psychotherapy.

Fig 4. Algorithm for workup of pelvic congestion syndrome (PCS). Patients present to primary care physicians with complaints of chronic pelvic pain and possibly dysmenorrhea, dysuria, and dyspareunia. A thorough physical and pelvic examination should be conducted, looking for perineal, vulvar, and lower extremity varicosities and ovarian point tenderness. The patient should then be referred to a vascular laboratory for pelvic and lower extremity (LE) duplex ultrasound (US) examination, performed preferably while standing. If US demonstrates an ovarian vein of more than 6 mm, dilated tortuous arcuate veins in the myometrium that communicate with bilateral pelvic varicoses veins, slow blood flow (<3 cm/s), and reversed caudal or retrograde venous blood flow in the left ovarian vein, the patient can be referred directly for pelvic venography and embolotherapy. If US is nondiagnostic, the patient should undergo multidetector computed tomography (MDCT) or time-resolved magnetic resonance angiography (TR-MRA) with subsequent venography and embolotherapy if results are suggestive or diagnostic of PCS. Patients should be followed up in the clinic for improvement of symptoms and may also benefit from adjunctive psychotherapy.

A pelvic US examination with color duplex imaging can be performed with transabdominal 5-MHz and transvaginal probes after 3 days of a no-residue diet and an empty stomach. Criteria for the sonographic diagnosis of varices include the visualization of dilated ovarian veins, generally >6 mm, although 7 mm has also been suggested as a cutoff. Park et al found the positive predictive value of a 6-mm-diameter ovarian vein for the diagnosis of PCS caused by the ovarian vein to be 83.3%, and this number has been widely accepted since. In truth, whereas an ovarian vein size criterion is one component of PCS, its diagnosis is favored on the basis of a combination of ovarian vein dilation, clinical symptoms, and these venographic findings: dilated tortuous arcuate veins in the myometrium that communicate with bilateral pelvic varicoses veins, slow blood flow (<3 cm/s), and reversed caudal or retrograde venous blood flow in the left ovarian vein. Recent data demonstrate that duplex imaging has a sensitivity approaching 100% for the diagnosis of left ovarian vein dilation (specificity 57%) but a sensitivity of only 67% (specificity 90%) for the diagnosis of right ovarian dilation. Several studies recommend that the patient stand during duplex US examination because of the collapsed nature of the pelvic veins when supine.
Both the internal iliac and the genital veins should be imaged to look for dilation and reflux, including imaging with the Valsalva maneuver. The obturator, sciatic, and internal pudendal veins should also be imaged. Collateral pathways can be found in patients with PCS. In addition, duplex scanning should evaluate the common iliac veins, IVC, and renal veins to search for venous obstruction. The authors think that all patients suspected of having PCS should also undergo lower extremity duplex scan looking for common femoral vein reflux into the perineum through tributary veins even in the absence of lower extremity symptoms, given that the absence of lower extremity varicosities does not necessarily preclude the diagnosis of PCS.\(^6,11,12\)

If pelvic US with color duplex imaging is highly suggestive of PCS, proceeding to venography and potential intervention is not unreasonable. However, in patients with normal or nondiagnostic findings on pelvic US and persistent symptoms, MDCT venography and MRV should be considered as they have a higher sensitivity for lower pelvic varices and also yield more discriminating information about the surrounding anatomy. First described as tools for the diagnosis of pelvic varicosities in 1999, traditional CT venography and MRV provide useful anatomic data in the diagnosis of PCS, particularly if the cause is compressive, as with May-Thurner or nutcracker syndrome.\(^17\) The abrupt narrowing of the LRV with an acute angle (beak sign) has been shown to have 91.7% sensitivity and 88.9% specificity in diagnosis of nutcracker syndrome.\(^17\) The limitations to traditional CT and magnetic resonance imaging (MRI) are that static images provide few data about the direction of flow within pelvic veins. These studies are normally conducted while the patient is lying down, so they may underestimate the extent of collateral networks or ovarian vein enlargement. The emergence of MDCT and time-resolved MRV (TR-MRV), however, has bridged the gap between static anatomic and dynamic functional imaging.

CT venography with three-dimensional reconstruction has been shown to be an effective road map before varicose vein surgery and in the visualization of venous webs, such as those found in May-Thurner syndrome.\(^17\) The procedure should be timed for evaluation of the portal, genital, and renal veins, and separate imaging should be performed later for evaluation of the pelvic and iliofemoral veins. Pelvic varices are imaged as dilated, tortuous, enhanced tubular structures around the uterus and ovary, with possible extension into the broad ligament and pelvic side wall. They can also involve the paravaginal venous plexus. An ovarian vein is considered incompetent if it is completely opacified during the arterial phase of CT angiography.\(^5\)

Time-resolved MRA (TR-MRA) is particularly helpful for the detection of PCS because of its ability to accurately determine whether anterograde or retrograde flow in the ovarian vein is present. Patients are placed in the supine position with their arms at the side. Kim et al describe a protocol for single-pulse TR-MRA whereby imaging of the pelvis is performed in the coronal plane at rapid 2- to 5-second intervals for 1 to 3 minutes after peripheral intravenous injection of 0.1 mmol/kg body weight of nondiluted gadopentetate dimeglumine or gadobenate dimeglumine at a rate of 2 mL/s. This is followed by a saline bolus of 20 mL at 2 mL/s. Maximum intensity projections of each three-dimensional data set are generated in both the coronal and sagittal planes. Compared with T2/T2-weighted MRI, TR-MRV has a better image conspicuity to discriminate ovarian vein reflux. Most recently, the sensitivity, specificity, and accuracy of TR-MRA were compared with those of conventional venography, with results demonstrating excellent agreement and the implication that TR-MRA is the best noninvasive means for diagnosis of pelvic venous reflux and PCS in symptomatic patients.\(^14\)

One caveat to MRI, however, is that follow-up imaging with magnetic resonance can be limited because of the artifacts of embolization coils placed endovascularly.

Venography is the “gold standard” for diagnosis of PCS; however, it should be reserved for concomitant intervention or if noninvasive imaging is equivocal (Fig 5). It is performed under local anesthesia through the common femoral or basilic vein approach.\(^11\) Patients should have a urinary catheter inserted to prevent the bladder from filling with contrast medium and obscuring visualization of the pelvic venous drainage. It should image the four veins responsible for venous return from the pelvis: both internal iliac veins and both gonadal veins. The study should be performed with and without a Valsalva maneuver and preferably with a tilt table in reverse Trendelenburg.\(^1\) Venography should not be used as the primary imaging mode for diagnosis of PCS but rather reserved for patients who have suspected PCS necessitating intervention based on prior noninvasive imaging or in patients whose noninvasive imaging is equivocal (Fig 4).

### Nonsurgical Treatment

Reports have varied in the literature over the decades on nonsurgical treatment of PCS, including progestins, danazol, phlebotonics, gonadotropin-releasing hormone (GnRH) receptor agonists with hormone replacement therapy, dihydroergotamine, nonsteroidal anti-inflammatory drugs, and psychotherapy. Whereas psychotherapy has been used in conjunction with ovarian suppression to treat the symptoms of PCS,\(^16\) there are no studies to show that patients who have been diagnosed with PCS will benefit from psychotherapy in isolation. For women with chronic pelvic pain of unknown etiology, the benefits of a multidisciplinary approach have been described, yet the utility of psychological intervention to alleviate pain is unclear.\(^19\)

With medical therapy, the primary goal is either to suppress ovarian function or to cause vasoconstriction of dilated veins. Medroxyprogesterone acetate (MPA) and the GnRH analogue goserelin have been used with limited effects (Table 1). MPA may be given orally 30 mg/day for 6 months. Goserelin acetate is dosed as an injection of 3.6 mg monthly during a 6-month period.\(^20\) As chemical ovarian ligation has numerous side effects, estrogen replacement therapy is frequently required as well.
Although these therapies provide some relief, their effects are transient, particularly those of MPA. Results from studies using daily oral administration of MPA demonstrate visual analog scale for pain score improvements while receiving therapy, but stable results 9 months after treatment were obtained only when psychotherapy was coadministered with MPA.\textsuperscript{18} This result reinforces early observations on the close relationship between the psychological and somatic symptoms of PCS. When GnRH agonists were compared with daily MPA, both showed efficacy, with GnRH agonists showing more improvements in pain symptoms, depressive symptoms, and sexual function 12 months after completion of treatment. Side effects from progestins principally included bloating and an average 5-pound weight gain during 4 to 6 months; GnRH agonists were associated with hot flashes, night sweats, vaginal dryness, and mood changes.\textsuperscript{8,18,20} Because of these side effects, combined with limited efficacy, medical therapy is not favored for long-term treatment of PCS. Medical treatment also often diminishes fertility. On the other hand, for patients with mild to moderate symptoms who would like to delay endovascular or surgical treatment, medical therapy is not an unreasonable choice. A discussion with the patient about the positives and negatives of medical therapy vs intervention with potential adjuvant psychotherapy should be a part of treatment, addressing the side effects and benefits of these options.

**SURGICAL TREATMENT**

Surgical treatment of PCS is still an accepted therapy for a select group of patients who have debilitating symptoms, are acceptable surgical candidates, and are refractory to medical or endovascular therapy. Surgery for ovarian reflux can provide symptomatic relief for patients, with the drawbacks of scarring, morbidity, prolonged hospital stay, and extended healing time (Table I). Extraperitoneal resection of the left ovarian vein to treat PCS was first reported by Rundqvist et al\textsuperscript{21} in 1984. In properly selected patients, this operative method was shown to provide symptomatic improvement in two thirds of patients with PCS.\textsuperscript{10} In 2003, Gargiulo et al\textsuperscript{22} published the largest series of laparoscopic transperitoneal ovarian vein ligation in 23 women with a 1-year follow up. They reported complete resolution of the patient’s symptoms with this technique. This technique involves accessing the right ovarian vein by incising the posterior peritoneum below the mesentericoparietal fossa and accessing the left ovarian vein by reflecting medially the left colon and incising the posterior peritoneum covering the aorta below the inferior duodenal to proximal aspect. Note circumaortic left renal vein (LRV). C, Right ovarian vein dilation and reflux shown on selective injection. (Reprinted from Cords PR, Eclavea A, Buckley PJ, DeMaioribus CA, Cockerill ML, Yeager TD. Pelvic congestion syndrome: early clinical results after transcatheter ovarian vein embolization. J Vasc Surg 1998;28:862-8, with permission from Elsevier.)
fold. The drawbacks to this procedure include higher surgical morbidity and several complications, such as deep venous thrombosis, retroperitoneal hematoma, paralytic ileus, and mechanical ileus caused by intestinal adhesion. Hospital stay and recovery time are also limiting factors with surgical ovarian vein ligation.22 Surgery should be considered in patients with lifestyle-limiting symptoms that have recurred despite embolotherapy.

**EMBOLOTHERAPY**

Since its introduction in 1993, transcatheter ovarian vein embolization (Fig 5) has become the mainstay for treatment of PCS secondary to ovarian and pelvic venous incompetence.23 Several embolic agents, including sclerosant foam,24 glue,7 Amplatzer plugs,25 and coils,2,11,26 have been described. Whereas a fairly large body of data regarding transcatheter ovarian vein embolization exists, these studies are limited to relatively small clinical series and retrospective reviews. The success rates for the reduction of chronic pelvic pain in these studies range from 47% to 94% with average follow-ups of 12 to 36 months (Table 1).

First described by Edwards et al23 in 1993 with a single case report of bilateral ovarian vein embolization, the technique has grown and been used widely with relative success. Sichlau et al27 reported on ovarian vein coil embolization in 1994, citing success in three patients with one recurrence after 1 year. Cordts et al28 described nine women undergoing ovarian vein embolization in 1998, 89% of whom demonstrated relief of symptoms with two recurrences at 2 years of follow-up. Interestingly, no published data demonstrate a significant difference in outcomes between unilateral and bilateral ovarian vein embolization. A study of 41 patients using enbucrilate and lipiodized oil as embolic agents demonstrated a nearly 60% total symptomatic relief with no difference in outcome between bilateral and unilateral ovarian vein embolization.7

**Table I. Summary of treatment modalities for pelvic congestion syndrome (PCS)**

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Patients</th>
<th>Treatment</th>
<th>Time, months</th>
<th>Complications</th>
<th>% Clinical improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farquhar et al (1989)</td>
<td>22</td>
<td>MPA vs MPA + psychotherapy</td>
<td>9</td>
<td>Weight gain, bloating</td>
<td>73</td>
</tr>
<tr>
<td>Reginald et al (1989)</td>
<td>84</td>
<td>MPA vs placebo</td>
<td>9</td>
<td>Weight gain, bloating</td>
<td>75</td>
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<tr>
<td><strong>Embolotherapy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edwards et al (1993)</td>
<td>1</td>
<td>Coils</td>
<td>12</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Sichlau et al (1994)</td>
<td>3</td>
<td>Coils</td>
<td>22.8</td>
<td>1 recurrence</td>
<td>67</td>
</tr>
<tr>
<td>Cordts et al (1998)</td>
<td>9</td>
<td>Coils, coils and gelatin</td>
<td>15.4</td>
<td>2 recurrences</td>
<td>88.9</td>
</tr>
<tr>
<td>Maleux et al (2000)</td>
<td>41</td>
<td>Sclerosing agents</td>
<td>19.9</td>
<td>Glue migration 4%</td>
<td>58.5</td>
</tr>
<tr>
<td>Venbrux et al (2002)</td>
<td>56</td>
<td>Sclerosing agents</td>
<td>22.1</td>
<td>3.6% coil migration; 5.4% recurred</td>
<td>65</td>
</tr>
<tr>
<td>Scultetus et al (2002)</td>
<td>57</td>
<td>Coils, sclerosing agents, excision</td>
<td>25-288</td>
<td>None</td>
<td>75.4</td>
</tr>
<tr>
<td>Pieri et al (2003)</td>
<td>33</td>
<td>Sclerosing agent</td>
<td>6.5</td>
<td>None</td>
<td>61</td>
</tr>
<tr>
<td>Kim et al (2006)</td>
<td>127</td>
<td>Sclerosing agent and coils</td>
<td>45</td>
<td>5% recurrence</td>
<td>83</td>
</tr>
<tr>
<td>Kwon et al (2007)</td>
<td>67</td>
<td>Coils</td>
<td>48</td>
<td>None</td>
<td>82</td>
</tr>
<tr>
<td>Creton et al (2007)</td>
<td>24</td>
<td>Coils and phlebectomy</td>
<td>36</td>
<td>4.2% recurrence, 4.2% coil migration</td>
<td>76</td>
</tr>
<tr>
<td>Ascitutto et al (2009)</td>
<td>35</td>
<td>Coils</td>
<td>45</td>
<td>None</td>
<td>47</td>
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<tr>
<td>Castenmiller et al (2013)</td>
<td>43</td>
<td>Coils</td>
<td>None</td>
<td>None</td>
<td>88</td>
</tr>
<tr>
<td>Hocquelet et al (2013)</td>
<td>33</td>
<td>Coils</td>
<td>26</td>
<td>1 failure to catheterize</td>
<td>61</td>
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<tr>
<td>Laborda et al (2013)</td>
<td>202</td>
<td>Coils</td>
<td>60</td>
<td>3% groin hematoma, 2% coil migration, 0.5% reaction to contrast material</td>
<td>93.8</td>
</tr>
<tr>
<td><strong>Surgery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rundqvist et al (1984)</td>
<td>15</td>
<td>Extraperitoneal resection of left ovarian vein</td>
<td>67.2</td>
<td>6.7% wound infection, 6.7% bleeding</td>
<td>73.3</td>
</tr>
<tr>
<td>Mathis et al (1995)</td>
<td>1</td>
<td>Transperitoneal laparoscopic ligation of ovarian vein</td>
<td>None</td>
<td>None</td>
<td>100</td>
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</tbody>
</table>

GnRH, Gonadotropin-releasing hormone; MPA, medroxyprogesterone acetate.
similar results with ovarian vein embolization succeeded by internal iliac vein treatment and a follow-up of 38 months. Of note, patients with isolated ovarian vein reflux had outcomes superior to those of patients with isolated internal iliac vein reflux or combined disease. Ovarian vein embolization did result in a significant improvement of symptoms for those with isolated ovarian reflux, but the results of embolization with combined reflux did not reach statistical significance.

Patients with vulvar and lower extremity varicosities have been studied with regard to regression of varicose veins after embolotherapy for PCS. There has been more success in the regression of vulvar than of lower extremity varicosities after ovarian vein embolization. To date, there has been no large study that demonstrates a significant change in clinical, etiologic, anatomic, and pathologic (CEAP) classification after embolotherapy for PCS, although several studies report >80% reduction in vulvar varicosities and symptoms after embolization for ovarian vein insufficiency.

Right femoral vein access is the most common approach for venography and embolization, although transjugular, basilic, and transbrachial approaches have been reported in technical success. The average number of coils per vein has been reported at six, with spring coils being the most common form of embolization.

The technique of transcatheter embolotherapy for ovarian and pelvic varicities is straightforward, although there is some variation in the literature. With a femoral or right internal jugular approach, a 6F sheath is guided into the vena cava. For assessments of the left or right ovarian vein, access is facilitated with a Cobra or Sim 1 catheter. Once access is obtained, the sheath is guided into the renal vein for coaxial support. Next, with use of a glide wire and glide catheter, the ovarian vein is catheterized. An injection of 10 mL of contrast material with the patient in the reverse Trendelenburg position is performed. Incompetent ovarian veins will show venous dilation and reflux of contrast material into the pelvis. The guidewire and catheter should then be moved down the ovarian vein to just above the pelvic brim. Another injection confirms reflux of contrast material into the pelvic veins, cross-pelvic collaterals, and any thigh or vulvar varicocities.

Modern embolotherapy of the main trunk of the ovarian vein or the iliac veins is facilitated by a microcatheter system and microcoils. In general, framing coils are placed first, followed by gel coils to promote venous thrombosis. Sclerotherapy of the hypogastric veins can be used adjunctively. With a balloon occlusion technique, sclerosants such as sodium tetradecyl sulfate are injected (Fig 2).

One major drawback to coil embolization is undoubtedly coil migration into the pulmonary system, which has been reported in 2% of patients after coiling of the internal iliac vein. Larger caliber veins (>12 mm) increase the risk of this complication. To prevent coil migration to the pulmonary artery, the diameter of the coils should be at least 30% or 50% larger than the diameter of the left internal iliac veins. Other complications include perforation of the ovarian vein, flank pain, postprocedural fevers, and venipuncture site hematomas.

For male patients with varicocele or female patients with mild vulvar varices, sclerotherapy has proved to be an effective treatment. Several groups in Europe use sclerosants exclusively for embolization of the spermatic vein in men with varicocele. The most frequently used sclerosants are 3% to 5% sodium tetradecky sulfate (liquid or foam) and polidocanol. A catheter is placed into the refluxing segment of the spermatic vein and injected with 3 or 4 mL of sclerosant during a Valsalva maneuver. Deposition of sclerosant in the pelvic segment of the vein is more effective than at a lumbar level. The catheter is then left at the orifice of the spermatic vein for 2 or 3 minutes to minimize egress of the sclerosant. Scultetus et al reported success with local excision and sclerotherapy for women with vulvar varices, whereas a paper from Australia reports successful US-guided foam sclerotherapy of vulvar varicocities secondary to ovarian vein reflux.

Ultimately, there remains an uncertainty as to the optimal technique for ovarian vein embolization, although a combination of coils and sclerosants has demonstrated clinical efficacy in a number of studies described before and is the most common published technique for ovarian vein embolization (Table 1). There is currently no evidence to suggest a difference in symptomatic relief with regard to unilateral vs bilateral ovarian vein embolization.

NUTCRACKER SYNDROME

For patients with PCS secondary outflow obstruction from nutcracker syndrome, treatment should focus on relieving anatomic compression rather than embolization of outflow tracts. Diagnosis of nutcracker syndrome, as described before, is based on a constellation of factors, including symptoms of pelvic congestion as well as flank pain, microhematuria, and suggestive imaging. An acute narrowing of the LRV, termed the beak sign, has a high sensitivity for diagnosis of nutcracker syndrome. In addition, the ratio of the LRV at its narrowed vs its dilated portion is often used as a diagnostic criterion, with the high end of normal being around 4:1; one study demonstrated that a value >4.9 correlates strongly with the presence of LRV compression. In addition, there is conflicting evidence regarding the utility of LRV pressure gradients in the diagnosis of nutcracker syndrome.
syndrome as studies have classified it as compensated or noncompensated, with the compensated syndrome being characterized by LRV hypertension. The normal pressure gradient between the LRV and IVC is 1 mm Hg or lower, and various studies have identified LRV hypertension as a gradient >3 mm Hg. Therefore, whereas LRV hypertension is not diagnostic of nutcracker syndrome, measuring the pressure gradient during venography and stenting does provide a way to monitor the technical success of the procedure and has utility in some cases.

Surgery for nutcracker syndrome has been reported widely (Table II). For young patients in good health with severe pain and persistent symptoms, open surgery has advantages of success and durability. LRV transposition, SMA transposition,4 SMA transposition,4 SMA transposition, abdominal aortic transposition, and inferior mesenteric vein—gonadal vein bypass have all been described with relative success, although in small numbers (Table II). Surgical morbidity and renal ischemia time are both drawbacks to open surgery. More recently, several studies have reported success in relieving the symptoms of nutcracker syndrome by stenting the LRV.

LRV stenting for treatment of nutcracker syndrome and PCS was first described in 2005,38 and since then, studies primarily from China have demonstrated the safety and efficacy of the procedure, particularly with self-expanding nitinol stents (Table II).39 Follow-up times have not exceeded 1 year. Although deployment of a renal stent is less invasive than open surgery, the postoperative complications can include stent migration into the right atrium, stent protrusion into the IVC, and stent migration into the hilar LRV. Wang et al recommended stent oversizing by 20% based on the diameter of the LRV at the hilum as measured on US and MRI. Smaller stents, particularly 10- and 12-mm stents, are more likely to migrate, according to Hartung et al. Chen et al recommended a stent length of 60 mm for stability within the first large branch of the LRV, postulating that if migration does occur, the proximal end of the longer stent will probably stay at the opposite wall of the IVC with the distal end remaining at the stenotic segment of the LRV to prevent migration into the heart.

The decision of open surgery vs endovascular treatment for nutcracker syndrome is also undoubtedly based on anatomy. With anterior nutcracker syndrome, in which the LRV is compressed between the SMA and aorta, stenting may prove to be sufficient to relieve symptoms. However, in the case of posterior nutcracker syndrome, in which the LRV is compressed between the aorta and a vertebral body, transposition may be necessary to relieve the obstruction. Ultimately, surgery can provide a long-term solution. The outcomes for endovascular treatment are encouraging; however, stents are not permanent solutions, and for this reason, in very young patients, surgery may be preferred.

CONCLUSIONS

The diagnosis and management of PCS continue to evolve. PCS remains an underdiagnosed cause of chronic

Table II. Summary of treatment modalities for nutcracker syndrome

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Patients</th>
<th>Treatment</th>
<th>Time, months</th>
<th>Complications</th>
<th>% Clinical Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endovascular</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wei et al (2003)</td>
<td>1</td>
<td>Stent</td>
<td>3</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>D’Archembeau et al (2004)</td>
<td>40</td>
<td>Embolization</td>
<td>N/A</td>
<td>4% failure to catheterize</td>
<td>75</td>
</tr>
<tr>
<td>Hartung et al (2005)</td>
<td>5</td>
<td>Stent</td>
<td>14.3</td>
<td>40% stent migration</td>
<td>40</td>
</tr>
<tr>
<td>Kim et al (2005)</td>
<td>1</td>
<td>Stent</td>
<td>24</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Basile et al (2007)</td>
<td>3</td>
<td>Stent</td>
<td>16</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Zhang et al (2007)</td>
<td>20</td>
<td>Stent</td>
<td>15</td>
<td>6.7% migration</td>
<td>100</td>
</tr>
<tr>
<td>Cohen et al (2009)</td>
<td>1</td>
<td>Stent</td>
<td>12</td>
<td>In-stent restenosis Required bypass</td>
<td></td>
</tr>
<tr>
<td>Chen et al (2011)</td>
<td>61</td>
<td>Stent</td>
<td>66</td>
<td>3.2% stent migration, 1.6% maldeployment, 1.6% IVC protrusion</td>
<td>96.7</td>
</tr>
<tr>
<td>Wang et al (2012)</td>
<td>30</td>
<td>Stent</td>
<td>36</td>
<td>6.7% migration</td>
<td>100</td>
</tr>
<tr>
<td>Surgery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thompson et al (1992)</td>
<td>1</td>
<td>SMA transposition</td>
<td>12</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Shokeir et al (1994)</td>
<td>2</td>
<td>Autotransplantation</td>
<td>12</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Hohenfellner et al (2002)</td>
<td>8</td>
<td>LRV transposition</td>
<td>66.4</td>
<td>8.5% hematoma, 8.3% DVT</td>
<td>87.5</td>
</tr>
<tr>
<td>Shen et al (2004)</td>
<td>2</td>
<td>LRV transposition</td>
<td>3</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Wang et al (2009)</td>
<td>7</td>
<td>LRV transposition</td>
<td>42.6</td>
<td>14% ileus, 29% hematoma</td>
<td>85.7</td>
</tr>
<tr>
<td>Vinyarjot et al (2009)</td>
<td>1</td>
<td>Transperitoneal laparoscopic gonadal vein ligation</td>
<td>12</td>
<td>None</td>
<td>100</td>
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<tr>
<td>Marone et al (2011)</td>
<td>1</td>
<td>LRV anterior transposition</td>
<td>6</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Gong et al (2012)</td>
<td>3</td>
<td>Left spermatic vein ligation, lilar vein anastomosis</td>
<td>3</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Li et al (2012)</td>
<td>1</td>
<td>Abdominal aortic transposition</td>
<td>38</td>
<td>None</td>
<td>100</td>
</tr>
<tr>
<td>Xu et al (2013)</td>
<td>2</td>
<td>Laparoscopic inferior mesenteric—gonadal vein bypass</td>
<td>3</td>
<td>None</td>
<td>100</td>
</tr>
</tbody>
</table>

DVT, Deep venous thrombosis; IVC, inferior vena cava; LRV, left renal vein; N/A, not applicable; SMA, superior mesenteric artery.
pelvic pain because of the difficulty in identifying varicosities and ovarian vein reflux in patients who are supine. The symptoms of PCS are often lifestyle limiting, consisting of chronic lower abdominal pain exacerbated by sitting or standing, dyspareunia, dysuria, vulvar and lower extremity varicosities, and pelvic tenderness. Nutcracker syndrome can also be manifested with hematuria and flank pain. Vascular surgeons in academic and community settings can improve the diagnosis of PCS by educating primary care physicians through in-service or continuing education seminars on the signs and symptoms of PCS. Because PCS is frequently a diagnosis of exclusion, an awareness of its prevalence within the primary care patient population can ultimately increase the referral of appropriate patients to vascular specialists for further workup. Diagnosis of PCS requires a careful history, physical examination, and noninvasive imaging with either transvaginal or transabdominal US with color duplex imaging to visualize dilated and tortuous ovarian veins. MDCT with three-dimensional reconstruction and time-resolved MR angiographies are also useful noninvasive tests with the advantage of providing information about the surrounding anatomy as well as functional information about retrograde flow. Once diagnosed, patients with PCS should be offered embolotherapy as a primary treatment option. Although conservative medical therapy with MPA or GnRH agonists has been reported, its effects are limited. Whereas the data in favor of embolotherapy are limited to a number of clinical series, successful reduction in pelvic pain can be achieved in 70% to 85% of patients who undergo embolization. Coil embolization of one or both ovarian veins with sclerosing therapy of its effects are limited. Whereas the data in favor of embolotherapy are limited to a number of clinical series, successful reduction in pelvic pain can be achieved in 70% to 85% of patients who undergo embolization. Coil embolization of one or both ovarian veins with sclerosing therapy of branching varicosities is the most widely reported and minimally invasive technique for alleviation of the symptoms of PCS due to gonadal vein reflux. For patients with outflow obstruction due to nutcracker syndrome, a limited number of studies have demonstrated remission of symptoms with stenting of the LRV. Open surgery involving renal vein transposition carries high success rates but should be reserved for patients who are young and suitable surgical candidates.

AUTHOR CONTRIBUTIONS

Conception and design: DG
Analysis and interpretation: DG, MO
Data collection: DG, MO
Writing the article: DG, MO
Critical revision of the article: DG, MO
Final approval of the article: DG
Statistical analysis: Not applicable
Obtained funding: Not applicable
Overall responsibility: DG

REFERENCES