

Evaluating the frequency and severity of ovarian venous congestion on adult computed tomography

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Abstract

Purpose: While pelvic congestion syndrome and chronic pelvic pain are relatively common in women, no large- or medium-sized studies have been conducted to our knowledge to evaluate the frequency and severity of ovarian vein dilatation (OVD) on computed tomography (CT). The purpose of our study was therefore to analyze a large number of consecutive abdominal and pelvic CT scans in adult women to determine OVD frequency and severity.

Methods: An IRB-approved, single-institution retrospective analysis of 1042 consecutive abdominal and pelvic CT scans in women ages 25–65 was performed. Scans were evaluated for the presence and severity of OVD and association with “nutcracker anatomy.” A gradation scheme was developed based on quartile analysis.

Results: 143 of the CT scans had OVD (13.7%). Of the positive scans, 96 were bilateral, 29 were left-side only, 18 were right-side only, and 18 had nutcracker-type compression of the left renal vein (14.4% of scans with left or bilateral OVD). In positive scans, the mean and median left OVD were 7.5 and 7 mm, respectively, and right-side were 7.2 and 7 mm, respectively. Based on quartile analysis, OVD grading was mild (< 6 mm), moderate (6–8 mm), or severe (> 8 mm), with moderate including the middle 50% of patients.

Conclusions: OVD was found on 13.7% of 1042 consecutive female abdominal and pelvic CT scans, with “nutcracker anatomy” present in 14.4% of the scans

with left OVD. Moderate dilatation was defined as an OVD of 6–8 mm at the iliac crests.

Key words: Ovarian vein dilatation—Pelvic congestion syndrome—Computed tomography

Computed tomography (CT) of the abdomen and pelvis is a commonly utilized examination in the evaluation of female abdominal and/or pelvic pain, and may precede or follow pelvic ultrasonography. In some cases, no cause for the pain is uncovered, and the CT may show dilatation of the ovarian vein(s), commonly on the left, and sometimes bilaterally. It is estimated that 30–45% of women with chronic pelvic pain may have symptoms related to pelvic congestion syndrome (PCS), but this is generally considered to be a diagnosis of exclusion [1, 2]. CT is most likely to be the imaging modality by which dilated gonadal veins are diagnosed due to its widespread use, as ultrasound may not allow for adequate visualization of these structures based on their location, and MRI is performed less frequently in evaluation of abdominal and pelvic pain. In patients with CT findings (or findings on another imaging examination) suggestive of PCS who have corresponding symptoms, conventional venography for confirmation and definitive treatment with venous embolization can be considered [3].

Currently, to our knowledge, there are no guidelines or recommendations regarding how to and whether to specifically report these findings, i.e., report which side is prominent/dilated, document an exact size measurement, and/or report the location of such a measurement. There have been several small published studies which have documented this apparently incidental finding of dilated gonadal veins on cross-sectional imaging, particularly on

CT, with rates in adult women ranging from 16% to upward of nearly half of all women imaged, all in studies containing fewer than 100 patients [4, 5].

Although CT is frequently used to evaluate abdominal and pelvic pain in women, it is utilized in adult women for numerous other indications as well (e.g., trauma, tumor staging, etc.), and although chronic pelvic pain is relatively common in women, which in part may be due to PCS, no large- or even medium-sized studies have been conducted, to our knowledge, to evaluate the frequency of gonadal vein varicosities/dilatation in women. While some publications have suggested a general size threshold for a normal gonadal vein, most of these studies were small and underpowered, with reported size cutoffs ranging from 2.6 to 7 mm [4, 6]. The generally accepted maximum diameter for a normal ovarian vein is 5 mm [7, 8]. In addition, to our knowledge, no study has graded the severity of such findings. The purpose of our study, therefore, was to analyze a relatively large number of consecutive body CT scans in adult women to determine the frequency and degree of gonadal vein dilatation.

Methods

After receiving Institutional Review Board approval, a HIPAA-compliant single-institution radiology information system database query was performed of all intravenous contrast-enhanced and nonenhanced CT scans of the abdomen and pelvis performed on women ages 25–65 during a 6-month period, including all inpatient/emergency departments and outpatient scans (August 2016 through January 2017). Patients under the age of 25 were excluded as pelvic congestion is not as frequently seen in patients younger than this, with studies demonstrating PCS is most common in multiparous women of reproductive age [2, 9]. This resulted in 1042 CT scans exposed to review. All reviewed scans were performed on different patients, and repeat scans on the same patient during this time period were excluded. All scans were obtained on one of four 128-slice Definition AS or Edge CT scanners (Siemens Medical Solutions USA, Inc., Malvern, Pennsylvania). CT protocol included 3 mm axial image acquisition, with coronal reformatted images also reviewed. Omnipaque-300 (GE Healthcare, Little Chalfont, UK) was utilized as the intravenous contrast agent, with portal venous phase imaging acquired for the contrast-enhanced examinations. Each scan was retrospectively reviewed independently by one of three radiology residents (two PGY-3 and one PGY-5 level), and then confirmed by one of two board-certified radiology attending physicians (with 8 and 21 years of experience). Scans were evaluated for the presence and degree of unilateral or bilateral ovarian vein dilatation (OVD) via a single transverse measurement in the largest axial dimension manually obtained at the level of the iliac

crests (Fig. 1), with a size cutoff of 5 mm or greater used to define a dilated gonadal vein [7, 8]. Bilateral right or left ovarian veins that were borderline in measurement and appearance were noted by the residents and then either included or excluded by one of two radiology attending reviewers during their analysis. In addition, the scans were evaluated for association with “nutcracker anatomy,” defined as focal narrowing of the left renal vein as it crosses between the superior mesenteric artery and the abdominal aorta, resulting in a dilated “upstream” portion of the left renal vein.

Data were compiled and analyzed using a commercially available data spreadsheet (Microsoft Excel, Microsoft Corporation, Redmond, Washington). Binomial proportion was used to estimate the proportion with 95% CI of gonadal vein dilatation in this population and to provide the overall rate with a 95% CI of left-sided, right-sided, and bilateral gonadal vein dilatation. We present descriptive statistics for gonadal vein dilatation with total number of all patients demonstrating dilatation of 5 mm or greater, number of patients with right-sided only, left-sided only and bilateral dilatation. The mean, median, minimum and maximum measurements were calculated in each category as well as an interquartile range of all patients included in the study. All analyses were done using SAS 9.4[®]. A grading scheme was then developed based on percentile analysis.

Additional evaluation of the positive cases was undertaken to determine patient symptoms at the time of the CT scan. This included focused chart review to determine the signs and symptoms at the time of the CT scan as well as review of the remainder of the CT images to determine if any specific explanation for the patient’s pain was evident. Out of the 145 patients who had OVD measuring greater than or equal to 5 mm, 26 patients (18%) had no identifiable cause for their abdominal pain. One patient within this group with otherwise normal CT examination of the abdomen/pelvis was excluded as the study was done for malignancy follow up and the patient did not have pain or abdominal symptoms. Out of these 26 patients, all but one patient had either bilateral or left-sided dilatation (left = 4, bilateral = 21, right = 1) and, 4 patients demonstrated “nutcracker anatomy.” More than one third of the patients without identifiable cause demonstrated OVD > 8 mm and were in the severe category ($n = 10$, 38%). Only 19% of patients without identifiable cause were in the mild category with ovarian vein measuring 5–6 mm ($n = 5$). Further, in the 143 positive patients, with and without identifiable causes, 7 reports mentioned the presence of OVD.

Results

Out of the 1042 abdomen and pelvic CT scans reviewed, 143 (13.7%) had dilatation of one or both gonadal veins, measuring equal to or greater than 5 mm. The average

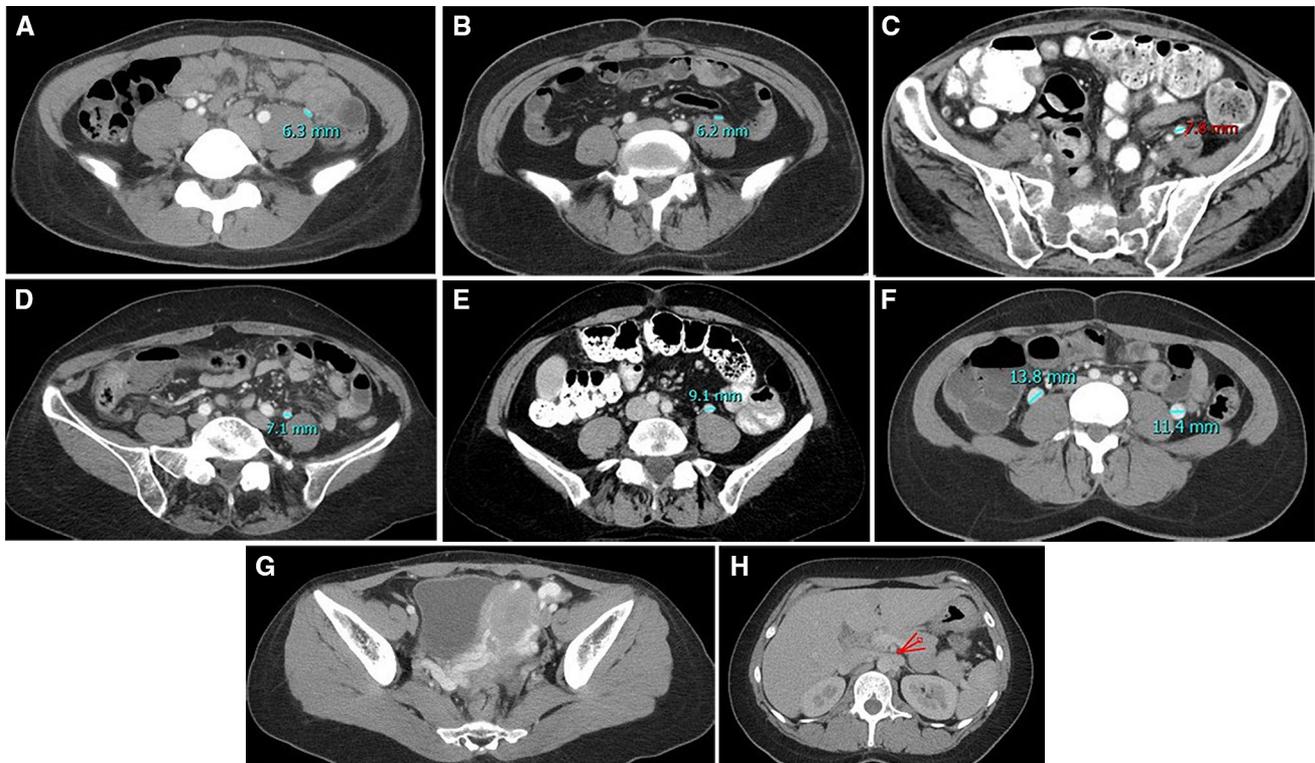


Fig. 1. Examples of gonadal vein dilatation. Mild left OV dilatation in a 29-year-old woman (6 mm, **A**) and a 39-year-old woman (6 mm, **B**). Moderate OV dilatation in a 60-year-old woman (7 mm, **C**) and a 64-year-old woman (7 mm, **D**). Severe OV dilatation in a 69 year-old woman (left 9 mm, **E**) and in a 31-year-old woman (right 13 mm and left 11 mm, **F**).

There are prominent parauterine veins associated with the same patient's bilateral gonadal vein dilatation (**G**). Nutcracker anatomy with red arrow demonstrating compression of the left renal vein between the aorta and SMA (**H**). This patient was also found to have marked dilatation of both ovarian veins.

age for all patients was 47.2 years, whereas that of women with gonadal vein dilatation was 44.4 years. Out of the 143 positive scans, 18 had dilatation of only the right gonadal vein, 29 scans had dilatation of only the left gonadal vein, and 96 had bilateral gonadal vein dilatation (Table 1). The median size of the dilated right gonadal vein was 7 mm ($n = 114$, range 5–14 mm), and the median size of the dilated left gonadal vein was 7 mm ($n = 125$, range 5–13 mm). Out of the 125 patients with left gonadal vein dilatation, 18 had “nutcracker anatomy,” ranging in age from 25 to 64 with mean age of 44.2 years and a mean and median vessel size of 8 and 7 mm, respectively. Descriptive statistics for gonadal vein dilatation based on percentile analysis are included in Table 2, which includes the minimum, maximum, median, percentile and quartile measurements. Based on percentile analysis, a gonadal vein dilatation grading scheme of mild (5–6 mm), moderate (6–8 mm), and severe (> 8 mm) is suggested. Examples of mild, moderate, and severe OVD are provided in Fig. 1. An example of associated “nutcracker anatomy” is also demonstrated.

Table 1. Binomial proportion analysis used to evaluate overall frequency of female gonadal vein dilatation based on 1042 abdominal and pelvic CT scans, further subdivided into left-sided, right-sided, and bilateral dilatation

| | Rate (%) | 95% CI (%) |
|--|----------|------------|
| Overall gonadal vein dilatation (143 out of 1042 patients) | 13.7 | 11.7–15.9 |
| Left-side only ($n = 29$) | 2.8 | 1.8–3.8 |
| Right-side only ($n = 18$) | 1.7 | 0.9–2.5 |
| Bilateral ($n = 96$) | 9.2 | 7.5–11.1 |
| Within gonadal vein dilatation group ($n = 143$) | | |
| Left-side only ($n = 29$) | 20.3 | 13.6–26.7 |
| Right-side only ($n = 18$) | 12.6 | 7.1–17.9 |
| Bilateral ($n = 96$) | 67.1 | 59.7–75.0 |

Discussion

PCS is typically a diagnosis of exclusion, requiring a relatively extensive and costly clinical evaluation before this diagnosis can be suggested. Even though PCS is thought to be primarily a clinical diagnosis, it is often

Table 2. Percentile analysis of gonadal vein size in 143 female patients with gonadal vein dilatation (GVD)

| | Minimum | 10th Percentile | Lower quartile | 33rd Percentile | Median | 66th Percentile | Upper quartile | 90th Percentile | Maximum |
|----------|---------|-----------------|----------------|-----------------|--------|-----------------|----------------|-----------------|---------|
| GVD size | 5 | 5 | 6.00 | 6.00 | 7.00 | 8.00 | 8.00 | 10.00 | 14.00 |

found in conjunction with vulvar and/or pelvic varices on imaging [2]. While abdominal and pelvic CT scans are one of the most common imaging examinations utilized on a daily basis in current clinical medicine, with tens of millions being performed every year in the US as well as elsewhere [10], to our knowledge, there is a paucity of studies in the radiology literature which evaluate the frequency of gonadal vein dilatation in females. Furthermore, to our knowledge, no grading scheme exists which allows the diagnostic radiologist to more clearly quantify the degree of dilatation. While some effort has been made to promote noninvasive imaging as part of the work-up for chronic pelvic pain [7, 11, 12], the absence of a grading scheme results in a potentially low utility of imaging, particularly for CT, for diagnosing and quantifying PCS.

In previous publications, the generally accepted maximum diameter for a normal ovarian vein on cross-sectional imaging has been reported to be 5 mm [7, 8]. However, there is some variability in the accepted normal, with other publications using any value less than 7 mm as normal [4]. Other studies of the pelvic vasculature have placed the average size of competent ovarian veins at 2.6 mm for nulliparous women, and 3.4 mm in parous women [6]. All of these studies involved CT as the cross-sectional imaging modality, but were performed on old scanners made more than 15 years ago, with a few of them even 25 years ago, and therefore the quality and overall diagnostic capabilities of the equipment used for these studies are inferior to those currently in practice.

Thus, our goal was to evaluate a relatively large number of abdominal and pelvic CT scans in women to determine the incidence of gonadal vein dilatation, and to develop a grading scheme which could allow radiologists to better quantify the degree of gonadal vein dilatation. A cutoff of 5 mm was used to define dilatation in terms of gonadal vein size, based on the literature described above. Based on our percentile analysis, we suggest utilizing a gonadal vein dilatation grading scheme of mild (5–6 mm), moderate (6–8 mm), and severe > 8 mm).

This grading scheme can potentially serve as a foundation upon which radiologic criteria for the diagnosis of PCS can be built, and used in conjunction with patient clinical history. While some investigators prefer investigation of PCS with transvaginal Doppler ultrasound technique to evaluate parametrial vasculature, CT allows for evaluation of both parametrial varices, degree of ovarian vein dilatation, and associated findings such as

nutcracker anatomy or retroperitoneal masses that may be causing venous congestion. CT also excludes the user-dependent variable of ultrasound imaging. Previous studies which have criticized the utility of ovarian diameter as a diagnostic tool for PCS have been underpowered, and thus their utility and relevance to current practice are uncertain [4, 13, 14]. Those three studies evaluated gonadal vein size in a total of 75 patients between the studies, and concluded that gonadal vein dilatation can occur in asymptomatic women, and did not aim to develop a grading system. Our study is substantially larger than these older studies in the literature, and was performed using newer CT technology, and should hopefully have more utility in the creation of such a grading scheme. In addition, multiple studies have documented the utility of time-resolved magnetic resonance angiography to evaluate gonadal vein size and reflux [15, 16]. Specifically, the sensitivity of this tool has been documented to range from 67% to 75% [17]. However, this study also utilized a small patient population of 19 women. While MRA can be a useful tool to further evaluate gonadal veins and the presence of reflux using time-resolved techniques, this typically is not used as a screening tool. Conversely, CT is routinely used as a screening and evaluation tool for a wide range of signs and symptoms, thus it is much more commonly performed. For this reason, we believe that our analysis of a large number of consecutive CT scans (over 1000) in women is an important addition to the radiology literature, as it allows for the development of a more objective grading scheme that can be used to document the degree of gonadal vein dilatation.

Our study has several limitations. While a uniform approach was used to measure each gonadal vein at a specific location in the abdomen and the measurement was confirmed by one radiology resident and one radiology attending physician, there is no reliable standard that dictates the location of the most reliable location to measure the vein. As such, neither the variability of the measurement in various locations of the abdomen and pelvis on CT is known, nor is the relevance of dilatation in one section of the ovarian vein versus another. A recent study while assessing the size of normal gonadal veins in patients without evidence of PCS chose to record the largest diameter of the vein after following its entire course, but did not report the most common location of maximum gonadal vein size [18]. In our study, we measured the ovarian vein at the level of the iliac crests for reproducibility. Statistical analysis of interobserver

variability was not performed, but there were no cases where measurements were changed by the attending, and there were no discrepancies where one person thought the vein was dilated and the other did not. In addition, while a limited chart review was performed to further evaluate the patients who had gonadal vein dilatation on the CT scan, it is difficult to determine the clinical significance of these findings. While additional prospective studies are needed to determine if the degree of gonadal vein dilatation correlates with the likelihood of a patient having PCS and/or with the severity of PCS symptoms, we believe that using a grading scheme will allow the radiologist to provide more objective detail about the degree of dilatation and then allow referrers to correlate with any known symptoms. Finally, while only 7 of the 143 cases with gonadal vein dilatation specifically had the dilatation documented in the CT report, it is uncertain as to whether this documentation rate is reproducible across institutions as well as if and how a higher rate of reporting could impact patient care.

In conclusion, OVD is a relatively common finding on CT. In our study, this was present in 13.7% of 1042 consecutive female abdominal and pelvic CT scans, with nutcracker-type left renal venous compression present in 14.4% of the scans with left ovarian vein involvement. Based on percentile analysis, we define moderate dilatation as an ovarian vein measuring 6–8 mm in diameter at the iliac crests. Additional studies are needed to determine the larger-scale utility of this grading system, as well as the clinical relevance of the degree of unilateral and bilateral OVD, if present.

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Compliance with ethical standards

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Conflict of interest All the authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional and/or National Research Committee and with the 1964 Helsinki Declaration and its later amendments of comparable ethical standards.

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