

Role of Grey Scale and Doppler Ultrasound in Evaluation of Abdomino-Pelvic Causes of Lower Limb Varicose Veins

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ABSTRACT

Background: Varicose veins, if left untreated, can result in ulcers, bleeding, and skin changes, and severe forms may indicate chronic venous insufficiency.

Aim: This study aimed to evaluate the role of Doppler ultrasound in detecting abdomino-pelvic causes of lower limb varicosities and to propose grading systems for key pelvic venous insufficiency syndromes.

Methods: A prospective study that was conducted on 41 patients clinically suspected to have abdomino-pelvic causes of lower limb varicosities. Patients were referred from Vascular Surgery and Obstetrics & Gynecology Departments, Faculty of Medicine, Menoufia University Hospitals to the Radiodiagnosis and Medical Imaging Department for Duplex ultrasound examination. Detailed demographic, occupational, and risk factor data were collected using Doppler ultrasound (both abdominal and transvaginal approaches).

Results: Common symptoms included pelvic pain (43.9%) and leg swelling/heaviness (41.5%). Venous reflux was nearly universal (95.1%). Doppler identified dilated gonadal veins in 41.5%, left renal vein compression in 36.6%, reversed flow in 39%, internal iliac vein reflux in 19.5%, and May-Thurner syndrome in 14.6%. Moderate to severe grades were predominant across all syndromes. Nutcracker syndrome was definitive in 4.9% and suspected in 36.6%. Significant overlap between venous insufficiency syndromes was observed, with pelvic pain and lower limb varicosities frequently coexisting.

Conclusion: Abdomino-pelvic venous disorders are important and under-recognized cause of lower limb varicosities, often presenting with overlapping syndromes and recurrent varicosities. Doppler ultrasound is a valuable, non-invasive diagnostic tool for identifying these conditions, enabling earlier diagnosis and improved treatment planning. Implementing systematic pelvic venous assessment may enhance diagnostic accuracy and optimize outcomes in patients with atypical or recurrent varicose veins.

Keywords: Varicose veins, Pelvic venous insufficiency, Doppler ultrasound, Lower limb varicosities.

INTRODUCTION

Varicose veins can cause ulcer, bleeding and skin discoloration if left untreated. Severe varicose veins may be a sign of chronic venous insufficiency. This condition affects veins ability to pump blood to the heart. There are various causes of varicose veins in the lower extremities. Among the causes are venous insufficiencies of the saphenofemoral junction, saphenopopliteal junction, or usual perforating veins ⁽¹⁾. Primary varicose veins usually involve the greater saphenous system (75%) or the short saphenous system (20%) with other occasional perforating veins ⁽²⁾.

Doppler ultrasonography (US) has been used for evaluation of varicose veins. Sometimes, varicose veins arise from an unexpected anatomic source ⁽³⁾.

The varicose veins were classified to typical and atypical forms, the typical one is caused by incompetent sapheno-femoral valve or incompetent perforators. While, the atypical form exhibits unusual causes including vulvoperineal varicosity, intraosseous perforating vein incompetence, round ligament varicosity, persistent sciatic vein incompetence, Nutcracker syndrome and May-Thurner syndrome ⁽⁴⁾.

The precise etiology of Pelvic venous insufficiency (PVI) is poorly understood. The underlying mechanism is reflux of blood in the pelvic

and/or ovarian veins. The primary defect is the absence of functioning valves, resulting in retrograde blood flow and eventual venous dilatation ⁽⁵⁾. Atypical causes of varicose veins, particularly those originating from abdominal and pelvic venous disorders, are frequently overlooked in clinical practice, as evaluation often focuses only on superficial or lower limb venous insufficiency ⁽⁶⁾.

Failure to identify underlying causes such as iliac vein obstruction, pelvic congestion, or abnormal venous shunts can lead to recurrent or persistent varicosities despite standard treatment. Detecting these atypical sources is crucial, as accurate diagnosis not only guides appropriate management but also prevents unnecessary interventions, improves patient outcomes, and reduces the risk of recurrence ⁽⁷⁾.

Some anatomical, hemodynamic and hormonal conditions, which can occur concomitantly, may, as a result of the excessive pressure produce, generate or exacerbate venous disease with venous insufficiency, which causes varicosities of the lower limbs and/or pelvic varicoceles ⁽⁸⁾.

Doppler ultrasound is usually the first modality of examination for pelvic veins insufficiency evaluation. The diagnosis can be made effectively with its typical

sonographic and Doppler findings that can detect veins caliber, flow direction and vascular compression syndromes. Findings can lead to an early and accurate diagnosis of the cause, thereby potentially reducing the delay in getting the definitive treatment ⁽⁹⁾.

This study aimed to investigate the role of Doppler ultrasound in detecting abdomino-pelvic causes of lower limb varicosities.

PATIENTS AND METHODS

This prospective study was carried out on 41 patients who were clinically suspected for atypical presentation of varicose veins or chronic pelvic pain. They were referred to The Radio-diagnosis and Medical Imaging Department from Vascular Surgery Department of Menoufia University Hospitals for duplex ultrasound examination.

Inclusion criteria: Male or female patients clinically suspected to have pelvic veins insufficiency on basis of clinical data or other investigations. Patients with recurrent varicose veins after treatment. Patients with superficial varicose veins at the lower limbs with atypical presentation. Patients with chronic pelvic pain. Patients with dyspareunia or urinary symptoms with no visible causes.

Exclusion criteria: Pregnant females and previous deep venous thrombosis [DVT].

Methods: All patients were subjected to the following: **Demographic data recording (age, gender and occupation).**

Full history taking including clinical manifestations e.g., abdominal pains within the left iliac fossa, flanks and hypochondrium. Past history with emphasis on history related to multiple pregnancies or varicoceles and also risk factors such as obesity, prolonged standing and smoking. Review of the results of previous laboratory and radiological investigations.

Clinical examination done by the treating physician. The examination was performed using **high-resolution ultrasound systems (Mindray Resona N9 and GE Voluson P7)** equipped with color and spectral Doppler functions. A standardized protocol was applied, combining transabdominal and sometimes transvaginal approaches to provide a comprehensive assessment of the pelvic and lower limb venous systems. This dual approach allows for precise visualization of the gonadal veins, internal iliac veins, and peri-uterine venous plexuses, in addition to evaluation of collateral venous channels that may contribute to atypical varicose vein presentation.

Positioning was carried out in a stepwise manner to optimize venous assessment and dynamic reflux detection. The study commenced with the patient in the supine position for baseline visualization of the gonadal and iliac veins. The patient was then turned into the right lateral decubitus position, followed by the left

lateral decubitus position, to evaluate the effect of gravity and positional changes on venous caliber and reflux. Finally, a transvaginal examination was performed in some cases with the patient in the dorsal lithotomy position, enabling high-resolution imaging of the uterine, ovarian, and peri-uterine venous plexuses. Both lower limbs were also examined in the supine and lateral positions to establish correlation between pelvic venous abnormalities and peripheral varicose changes. This combined protocol is particularly valuable in identifying atypical and often overlooked causes of varicose veins.

These include gonadal vein incompetence with pelvic venous reflux, internal iliac vein insufficiency and pelvic venous compression syndromes such as Nutcracker phenomenon or May-Thurner syndrome. The technique also facilitates detection of collateral pathways between the pelvic and lower limb venous systems, as well as peri-uterine or parametrial venous dilatation contributing to pelvic congestion syndrome. By integrating positional changes with duplex evaluation, this method enhanced the sensitivity of ultrasound for detecting venous reflux of pelvic origin and provides a more complete diagnostic pathway than routine lower limb venous Doppler studies.

Ethical approval: This study was approved by **Ethical Committee of Faculty of Medicine, Menoufia University, and all participants gave written consents to be enrolled in this study. (Ethics committee approval number 114720245). We followed The Declaration of Helsinki through its execution.**

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 25.0 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). Qualitative data were described using number and percent. The Shapiro-Wilk test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation, and median. Significance of the obtained results was judged at the 5% level. The used tests were Paired student t-test; used for comparison between related sample.

RESULTS

The age of the patients ranged from 29 to 51 years with a mean age of 40 years. Thirty one patients were females (75.6 %) and 10 were males (24.4 %). Pelvic pain (43.9%) and leg swelling/heaviness (41.5%) dominate, reflecting pelvic and lower limb involvement. Smoking was significantly higher in males ($p=0.003$), while family history trends higher in females (Table 1).

Table (1): Demographic characteristics, frequency of presenting symptoms and risk factors by gender

Demographic Characteristics	Frequency	Percentage (%)
Sex		
Male	10	24.4%
Female	31	75.6%
Age (years)		
20–29	1	2.4%
30–39	14	34.1%
40–49	21	51.2%
50–51	5	12.2%
Mean Age	41.2	-
Std. Deviation	5.7	-
Frequency of Presenting Symptoms		
Pelvic pain	18	43.9%
Flank pain	9	22.0%
Abdominal pain	7	17.1%
Leg swelling/heaviness	17	41.5%
Hematuria	4	9.8%
Testicular/scrotal pain	4	9.8%
Mild varicosities	5	12.2%
Dyspareunia	2	4.9%
Sciatica	2	4.9%
Risk Factor	Male (n=10)	Female (n=31)
Smoking	7 (70%)	5 (16.1%)
Obesity	5 (50%)	15 (48.4%)
Diabetes	3 (30%)	5 (16.1%)
Hypertension	5 (50%)	10 (32.3%)
Family History	1 (10%)	11 (35.5%)
		p-value (Chi-square)
		0.003
		0.923
		0.332
		0.306
		0.135

Patients can present with more than one symptom:

Venous reflux (95.1%) was the most prevalent finding followed by dilated gonadal veins (41.5%) and compressed left renal vein (36.6%) indicating significant venous pathology across the cohort. Reversed flow (39.0%) and May-Thurner syndrome (14.6%) are notable, while sciatic plexus dilation (4.9%) was rare (Table 2).

Table (2): Key Ultrasound/Doppler Findings

Finding	Frequency	Percentage (%)
Compressed left renal vein (Nut cracker syndrome)	15	36.6%
Dilated gonadal (ovarian/testicular) vein	17	41.5%
Dilated internal iliac vein	8	19.5%
Venous reflux	39	95.1%
Reversed flow	16	39%
May-Thurner syndrome	6	14.6%
Sciatic plexus dilation	2	4.9%

"A columns chart showing 11 patients with gonadal insufficiency, with 63.6% moderate severity (7 patients) and 36.4% severe (4 patients), while the remaining 73% of the cohort (30/41) have no gonadal insufficiency" (Chart 1).

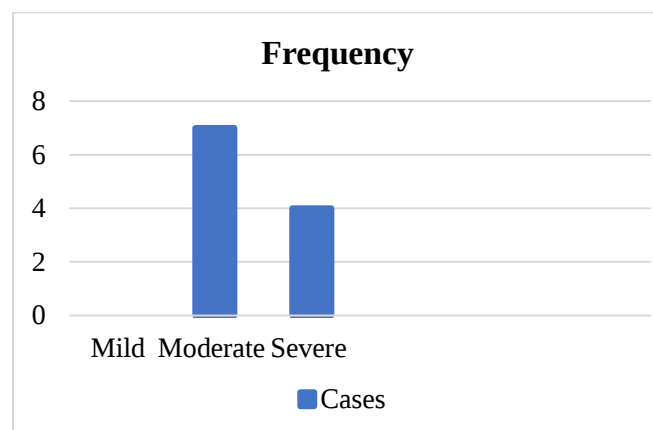


Chart (1): Gonadal Insufficiency Severity.

Gonadal insufficiency can be graded by correlating symptoms, imaging, and complications. Clinically, patients may present with pelvic or abdominal pain, dyspareunia, or swelling. Ultrasound and Doppler findings ranged from gonadal volume reduction and parenchymal heterogeneity to altered vascularity with venous reflux. Complications included gonadal dysfunction, pelvic venous insufficiency and secondary lower limb varicose veins (Table 3).

Table (3): Gonadal insufficiency grading according to symptoms, ultrasound & Doppler findings and complications

Symptoms Score	Ultrasound Score	Complications Score	Total Grade	Severity
2 (Flank/pelvic pain)	3 (Reversed flow in gonadal vein)	1 (Lower limb VV)	2.0	Moderate
2 (Abdominal/flank pain)	3 (Ovarian vein reflux)	2 (Ovarian insufficiency)	2	Moderate
2 (Abdominal pain, hematuria)	2 (Enlarged ovarian veins, reflux)	1 (Lower limb VV)	1.7	Moderate
2 (Pelvic pain, heaviness)	3 (Bilateral ovarian dilation)	2 (Ovarian insufficiency)	2	Moderate
3 (Chronic pelvic pain, dyspareunia)	3 (Reversed flow in ovarian veins)	1 (Lower limb VV)	2.3	Severe
3 (Pelvic pain, dyspareunia)	3 (Bilateral ovarian dilation, reflux)	2 (Ovarian insufficiency)	2.7	Severe
1 (Pelvic discomfort, leg pain)	2 (Both ovarian veins dilated)	1 (Lower limb VV)	1.3	Moderate
2 (Testicular pain, scrotal swelling)	3 (Reversed flow in gonadal vein)	2 (Varicocele)	2.3	Severe
2 (Scrotal pain, heaviness)	3 (Reversed flow in testicular vein)	2 (Varicocele)	2.3	Severe
2 (Pelvic pain, leg heaviness)	3 (Reversed flow in ovarian vein)	1 (Lower limb VV)	2.0	Moderate
1 (Abdominal pain, leg swelling)	3 (Reversed flow in gonadal vein)	1 (Lower limb VV)	1.7	Moderate
0–1 (variable)	0–2 (variable)	0–1 (variable)	0–1.7	Mild–Moderate

Hypertension (50%) and smoking/obesity (33.3% each) were notable risk factors among MTS patients, though family history was absent. This suggests mechanical compression as the primary etiology, with risk factors exacerbating severity (Table 4).

Table (4): Risk factors in May-Thurner Syndrome (MTS) cases

Patient ID	Smoking	Obesity	Diabetes	Hypertension	Family History
34	Yes	No	No	Yes	No
35	No	No	No	No	No
36	No	Yes	Yes	Yes	No
37	No	No	No	No	No
38	Yes	Yes	No	Yes	No
39	No	No	No	No	No
Prevalence	2 (33.3%)	2 (33.3%)	1 (16.7%)	3 (50.0%)	0 (0%)

May–Thurner Syndrome can be graded according to the degree of left common iliac vein compression and its hemodynamic impact (Table 5).

Table (5): Grading of the May Turner Syndrome

Grade	Symptoms	Ultrasound Findings	Complications
0	None	No compression or reflux	None
1	Mild (e.g., leg heaviness)	Mild compression (<50% narrowing, mild reflux)	Mild varicose veins
2	Moderate (e.g., pelvic pain)	Moderate compression (50–75% narrowing, increased reflux)	Varicose veins or varicocele
3	Severe (e.g., chronic swelling)	Severe compression (>75% narrowing or reversed flow)	Extensive varicosities or thromboembolism

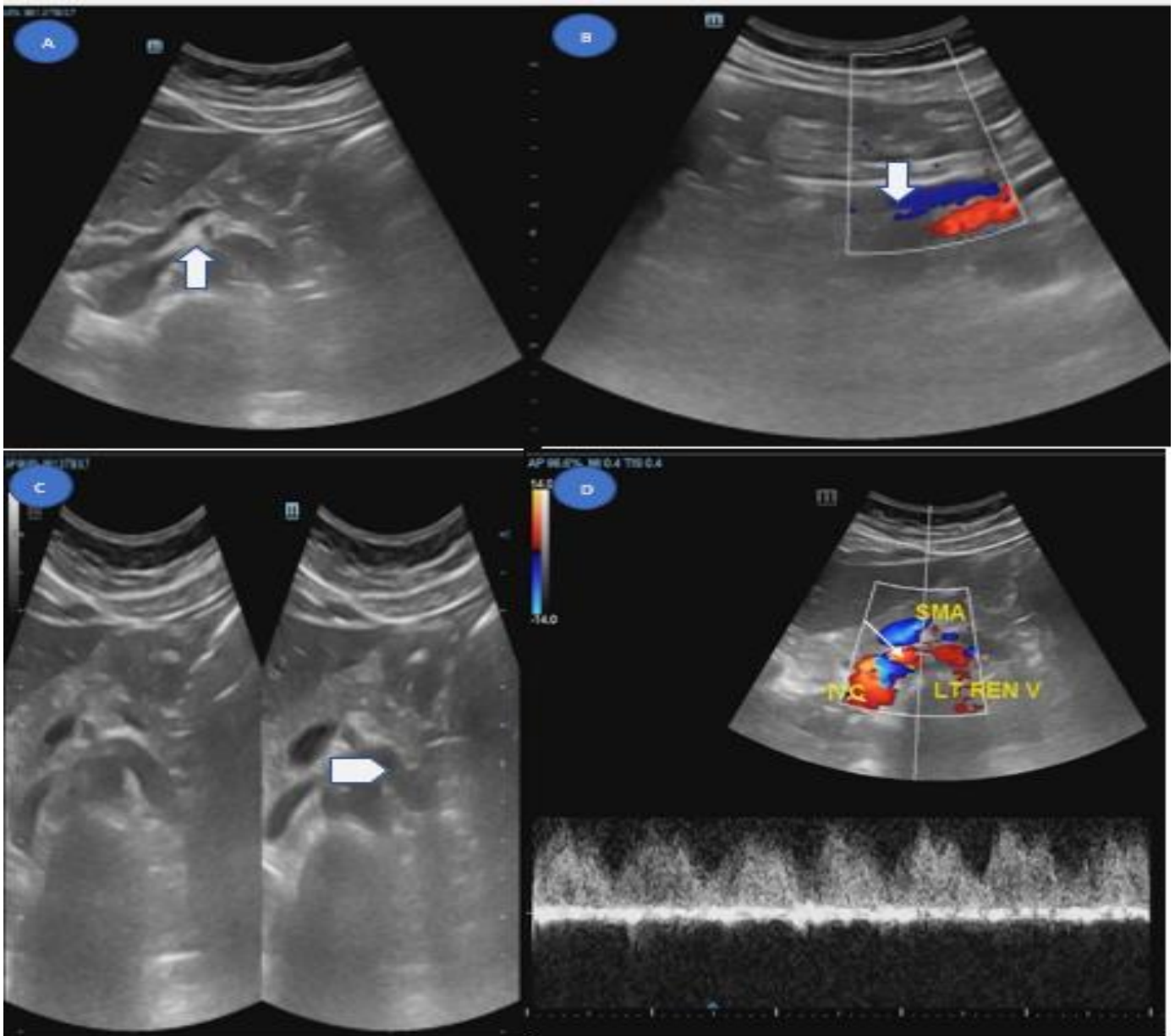


Figure 1. (A) Axial ultrasound image of the midline abdomen in a 34-year-old female demonstrating compression of the left renal vein between the aorta and the superior mesenteric artery with attenuated caliber (arrow up). (B) Sagittal image showing post-stenotic dilatation of the left ovarian vein (arrow down). (C) Axial section depicting the dilated segment of the left renal vein proximal to the compression site (arrow head). (D) Color Doppler image of the compressed segment showing aliasing and increased flow velocities exceeding 50 cm/sec (arrow).

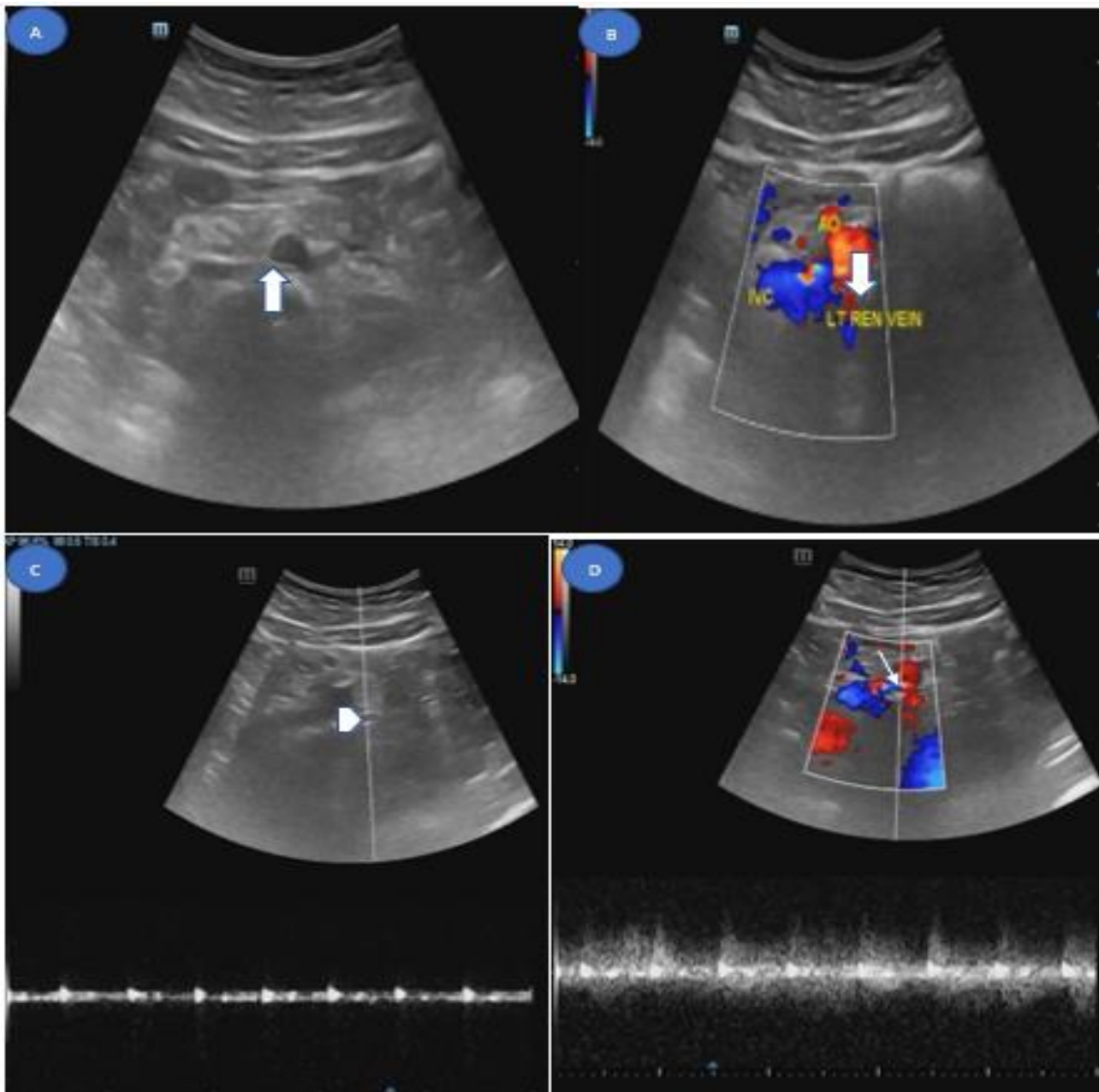


Figure 2. (A) Axial ultrasound image of the midline abdomen in a 41-year-old male demonstrating compression of the retro-aortic left renal vein between the aorta and the spine (arrow up). (B) Axial image with applied color box showing the course of the renal vein (arrow down). (C) Axial section depicting the normal velocity of the left renal vein (10-20 cm/sec) proximal to the compression site (arrow head). (D) Color Doppler image of the compressed segment showing aliasing and doubling of velocities exceeding 45 cm/sec (arrow).

DISCUSSION

The significant gender difference in smoking prevalence (70% males vs. 16.1% females, $p=0.003$) reflects broader epidemiological patterns, with smoking-induced endothelial dysfunction potentially contributing to venous reflux, particularly in male patients⁽¹⁰⁾. Conversely, the higher family history prevalence in females (35.5% vs. 10% in males) suggests genetic components in female-predominant pelvic venous insufficiency⁽¹⁰⁾.

The predominance of pelvic pain (43.9%) and leg swelling/heaviness (41.5%) demonstrated the symptomatic continuum between abdominal/pelvic

venous pathology and lower extremity manifestations. This validates the "pelvic escape points" concept described by **Leal Monedero et al.**⁽¹¹⁾ where insufficient pelvic veins communicate with lower extremity superficial veins. **Zolotukhin et al.**⁽¹²⁾ reported venous symptoms in 14.8-36.3% of the general population, while chronic pelvic pain constitutes 10-40% of gynecology presentations^(13, 14). Venous reflux was nearly universal (95.1%), which is aligning with **Gültasli et al.**⁽¹⁵⁾ who reported venous insufficiency in 70% of patients with pelvic veins > 5 mm. This widespread presence supports the link between pelvic venous pathology and lower limb

varicosities. In a large study of 985 women, 76.8% had lower-limb varicose veins caused by pelvic escape points, with symptomatic improvement following treatment ⁽¹⁶⁾.

Dilated gonadal veins were observed in 41.5% of patients, which is consistent with **Baz** ⁽¹⁷⁾ and **Yoo et al.** ⁽¹⁸⁾ who found pelvic-origin varicosities in 65.8% of patients with unusual varices. **Barros et al.** ⁽¹⁹⁾ demonstrated that 86% of patients with pelvic escape points had pelvic varicose veins with significantly larger left gonadal vein diameters. Our grading system for gonadal vein insufficiency (moderate: 5-8 mm, severe: > 8 mm) provides a refined framework compared to the ≥ 4 mm threshold used by **Steenbeek et al.** ⁽²⁰⁾. Reversed flow in gonadal veins occurred in 39% of patients, which is corroborating **Marcelin et al.** ⁽²¹⁾ and **Emeka and Lil** ⁽²²⁾ who identified flow reversal during Valsalva maneuver as pathognomonic for pelvic congestion syndrome. **Park et al.** ⁽¹⁴⁾ similarly observed reversed flow in all PCS patients.

Compressed left renal vein was found in 36.6% of patients, with only 4.9% meeting full Nutcracker syndrome criteria. This is closer to the 14.4% reported by **Szaflarski et al.** ⁽²³⁾ than the 82% by **Baz** ⁽¹⁷⁾ suggesting diagnostic criteria variability. **Kurklinsky and Rooke** ⁽²⁴⁾ explained the common occurrence of subclinical compression. Full Nutcracker syndrome cases presented with notable symptoms including ovarian insufficiency and flank pain, which is consistent with **Matei et al.** ⁽²⁵⁾'s cascade of venous hypertension.

Internal iliac vein reflux occurred in 19.5% of patients, mostly severe cases, which is consistent with **Whiteley et al.** ⁽²⁶⁾ who noted 25.6% prevalence in recurrent varicose veins. Importantly, 75% of these patients experienced pelvic pain, supporting **Rozenblit et al.** ⁽²⁷⁾'s pathophysiologic model of valvular incompetence in pelvic congestion development.

May-Thurner syndrome prevalence was 14.6%, which is lower than the 18-49% reported by **Kasirajan et al.** ⁽²⁸⁾. Notably, 83.3% had left-sided symptoms, typical for anatomical left iliac vein compression. Bilateral symptomatology corresponds with **Chen et al.** ⁽²⁹⁾'s findings of collateral circulation effects. Higher hypertension prevalence (50%) in May-Thurner patients supports **Martinez-Quinones et al.** ⁽³⁰⁾'s proposal that arterial dilatation exacerbates venous compression.

Sciatic plexus dilation occurred in 4.9% of patients, which is similar to **Leal Monedero et al.** ⁽¹¹⁾'s 3% prevalence, presenting with atypical sciatica-like symptoms, highlighting the importance of considering venous etiologies in neuropathic pain differential diagnosis.

Moderate gonadal vein insufficiency was found in 63.6% and severe in 36.4% of affected patients (26.8% total population), with frequent pelvic pain (72.7%) and universal venous reflux (100%), supporting a spectrum

of pelvic venous disorders as advocated by **Barros et al.** ⁽¹⁹⁾.

The connection between pelvic venous insufficiency and lower limb varicosities is well-established. **Hobbs** ⁽³¹⁾ and **Whiteley et al.** ⁽²⁶⁾ demonstrated pelvic reflux contributed to recurrent varicose veins in up to 33.3% of parous women, while **Labropoulos et al.** ⁽³²⁾ indicated that 34% of non-saphenous-origin varicose veins were pelvic in origin. The presence of lower limb varicose veins in all patients with Nutcracker syndrome or internal iliac vein reflux emphasizes the mechanistic connection, supporting comprehensive venous evaluation as advocated by **Jaworucka-Kaczorowska et al.** ⁽³³⁾.

Barros et al. ⁽³⁴⁾ provided additional validation showing that 12.2% of women had pelvic-origin reflux with 41.2% experiencing recurrent lower limb varicose veins, reporting high diagnostic accuracy for transvaginal ultrasound (sensitivity 96.2% & specificity 100%), supporting our use of Doppler ultrasound as a reliable diagnostic modality. Our diagnostic criteria align with established standards including cutoff values consistent with **Basile et al.** ⁽³⁵⁾ and **Garcia-Jimenez et al.** ⁽³⁶⁾, confirming the relevance of our measurements.

CONCLUSION

This study demonstrated abdomino-pelvic venous disorders as a significant, often overlooked cause of lower limb varicosities, with notable prevalence of gonadal vein insufficiency, left renal vein compression, internal iliac reflux, and May-Thurner syndrome. The proposed grading systems offer structured tools for severity assessment and treatment planning, while marked gender differences and frequent syndrome overlap support a continuum-based rather than isolated view of venous disease. Doppler ultrasound offers an effective, non-invasive diagnostic method, and integrating systematic pelvic venous evaluation into clinical practice may enhance diagnostic accuracy and optimize outcomes in patients with atypical or recurrent varicose veins.

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