Varicocele Embolization: Patient Selection: Preprocedure Workup, and Technical Considerations

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Abstract

Varicocele refers to an abnormally dilated and tortuous pampiniform venous plexus within the spermatic cord. The prevalence of varicocele is reported to be approximately 15% in the general male population. Its incidence increases with age and has a higher incidence in infertile men. Varicocele treatment (surgical or interventional) is considered one of the most common therapies of reversible infertility in men. Percutaneous embolization offers nonsurgical, minimally invasive option for the treatment of varicoceles, requiring only minimal sedation. In this article, the authors review the clinical and technical details of percutaneous varicocele embolization with a summary of currently available evidence.

Keywords
- varicocele
- embolization
- infertility
- interventional radiology

Varicocele refers to an abnormally dilated and tortuous pampiniform venous plexus within the spermatic cord. The prevalence of varicocele is reported to be approximately 15% in the general male population. Its incidence increases with age and can be as high as 35% in men with primary infertility.[1] Varicocele is considered one of the most common causes of reversible infertility in men. Varicocelectomy and percutaneous embolization of the gonadal vein are considered major therapeutic options for men with varicocele. Percutaneous embolization offers nonsurgical, minimally invasive option for the treatment of varicoceles, requiring only minimal sedation. In addition, diagnostic venography during the procedure enables identification of the gonadal vein and collateral venous supply.

Clinical and Radiological Diagnosis

The most common clinical presentation of varicoceles in adults is infertility. Other presenting symptoms include scrotal pain and/or discomfort which can be exacerbated by long periods of standing. Varicoceles are commonly classified per the clinical criteria published by Dubin and Amelar[2,3] (►**Table 1**).

Scrotal ultrasound with color Doppler is the most widely used modality in radiology to evaluate varicoceles. Classic findings on ultrasound are dilated pampiniform plexus, with venous flow at rest and reversal of flow on Valsalva (►**Fig. 1**). Sonographically, varicoceles are classified into grades shown in ►**Table 2**. The additional value of ultrasound is in ruling out abdominal/testicular masses. Diagnostic venography is not routinely indicated for the diagnosis of varicocele and its use is primarily in conjunction with intervention and embolization.

Indications and Patient Selection for Interventional Management

The major indications for interventional treatment of varicocele are pain, infertility, and recurrence after surgical ligation. Failed surgical ligation typically is secondary to collateral veins, which are not seen at the time of surgery but can be identified on venography. Preprocedural evaluation of the patient includes a focused history and physical examination. Obtaining imaging is optional if the diagnosis can be reliably made clinically. Cross-sectional imaging of the abdomen and pelvis should be obtained when a patient

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Table 1 Clinical grading system of varicocele described by Dubin and Amelar[2,3]

Grade	Description
0	Not palpable
1	Palpable with patient standing and performing Valsalva maneuver
2	Palpable with patient standing, without Valsalva maneuver
3	Visible through the scrotal skin

Table 2 Sonographic grading system described by Sartechi et al

Grade	Description
1	The absence of varicose veins, but venous reflux with Valsalva
2	The presence of varicose veins >3 mm in diameter with the presence of venous reflux during a Valsalva maneuver
3	The presence of varicose veins >3 mm with the presence of venous reflux without Valsalva maneuver

presents with an isolated right-sided varicocele, given the possibility of venous compression due to malignancy.

Technical Considerations

Relevant Anatomy

The gonadal veins are formed by the confluence of the pampiniform plexus near the femoral head. The left gonadal vein drains into the left renal vein, whereas the right gonadal vein drains directly into the inferior vena cava (IVC) just below the right renal vein along its anterolateral wall. The angle formed at the confluence left gonadal vein and left renal vein leads to higher hydrostatic pressure and therefore, a higher incidence of left-sided varicocele.[4] However, variations exist in the pattern of left gonadal vein anatomy, including duplicated gonadal vein, single gonadal vein with collateral communications with retroperitoneal, paravertebral, and left renal veins; and duplicated left renal vein (►**Fig. 2**).[5] Varicocele embolization involves selective catheterization of the left renal vein, followed by subselective catheterization and embolization of the left gonadal vein and the pampiniform plexus (►**Figs. 3–5**).

Sedation

The procedure is typically performed on an outpatient basis under moderate sedation. The patient should be kept under light sedation after initial access, as patient cooperation during the procedure may be required to perform venography with Valsalva.

Access, Wires, and Catheters

The most common access sites are right common femoral vein or internal jugular vein (IJV), which are accessed with sonographic guidance. Right-side access is technically easier for the operator, and also provides favorable angle to access the left renal and gonadal veins. The right-sided gonadal vein can be difficult to access through femoral approach; thus, an IJV approach is preferred. The embolization procedure can be performed using a low profile 5- or 6-Fr system. A guiding

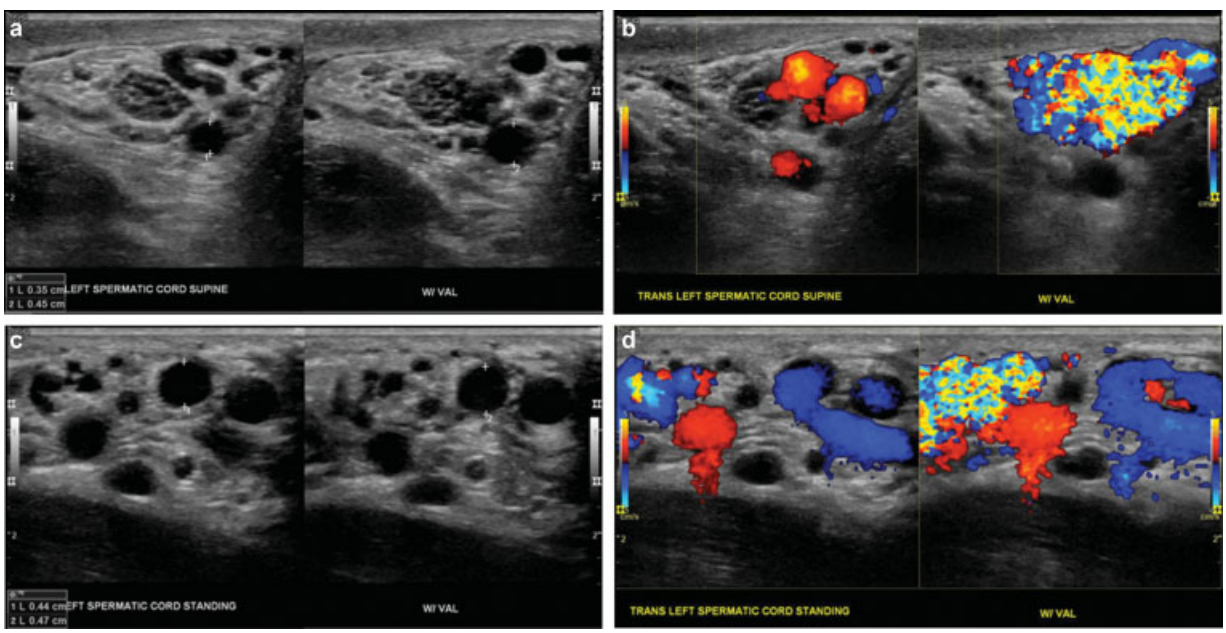

Fig. 1 Diagnostic ultrasound of the left spermatic cord in a 30-year-old man with scrotal discomfort. Supine sonographic images (**a**) show dilatation of the pampiniform plexus, exacerbated by Valsalva maneuver. Supine color Doppler sonographic image (**b**) showing hypervascularity of the pampiniform plexus, with increased flow upon Valsalva (note Aliasing on color Doppler indicative of high flow). (**c, d**) Sonographic images obtained with patient standing shows increased dilatation of the venous plexus compared with supine positioning, exacerbated with Valsalva.

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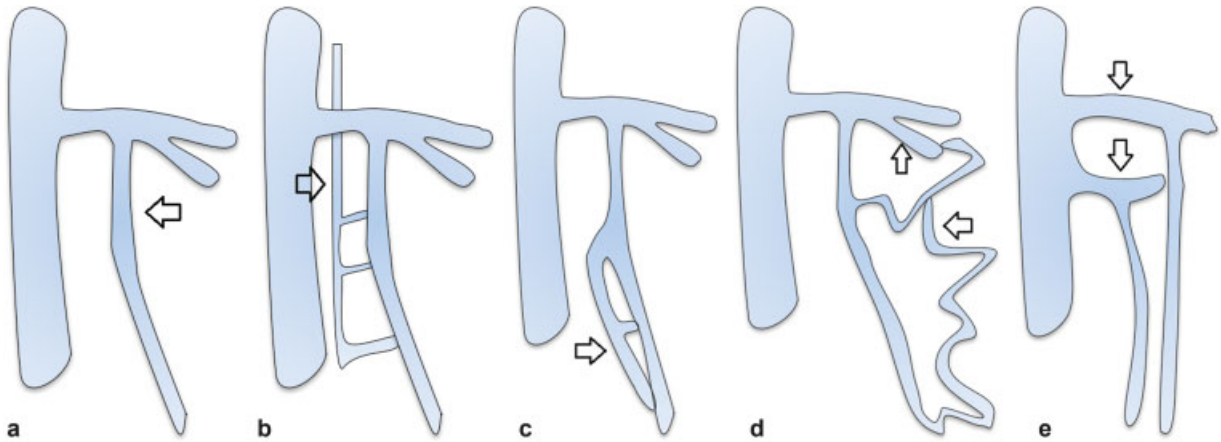

Fig. 2 Illustrated varicocele classification. (**a**) Single gonadal vein (GV; arrow). (**b**) GV with accessory communicating veins to the paravertebral venous plexus (arrow). (**c**) Duplicated GV (arrow), which can be further classified into high, mid, low, and multiple GVs. (**d**) Single GV with multiple collaterals (arrows) to the left renal vein. (**e**) Single or double GV with duplicated left renal vein (arrows). (Adapted from Jargiello et al.[1])

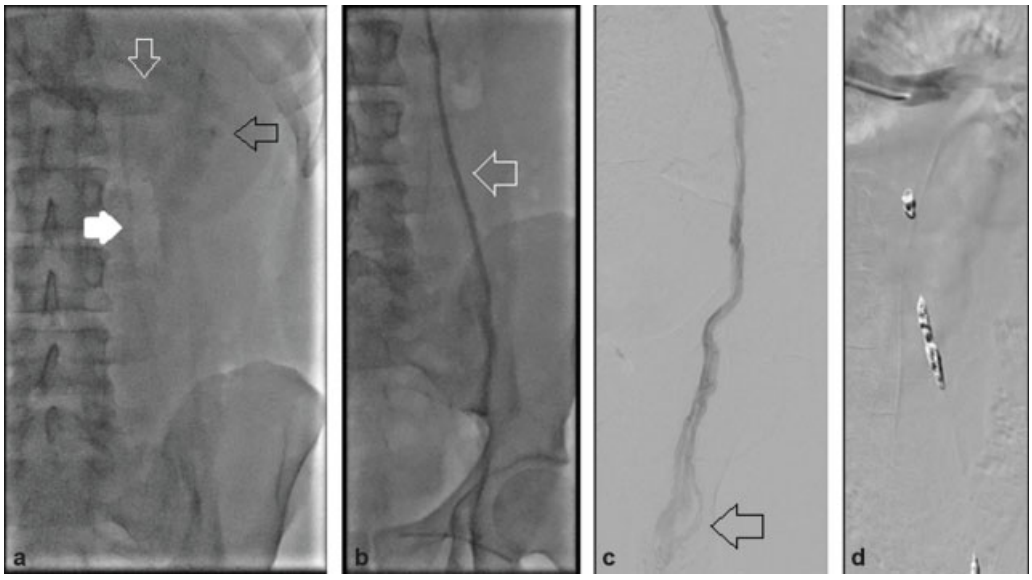

Fig. 3 A 24-year-old man presenting with left-sided testicular pain and heaviness. Left varicocele was diagnosed on clinical evaluation and referred for embolization. Fluoroscopic contrast injection with catheter in the left renal vein (open white arrow) (**a**) shows reflux of contrast into left gonadal vein (solid white arrow). Open black arrow = renal collecting system. The gonadal vein was selected using glide wire and selective injection (**b**) showed the course of gonadal vein (arrow) into pelvis. (**c**) Digital subtraction venogram shows single gonadal vein with reflux of contrast into scrotum (arrow) without evidence of retroperitoneal collaterals. (**d**) Successful embolization using sandwich technique (coils–STS–coils–STS–coils), with cessation of flow within gonadal vein. STS, sodium tetradecyl sulfate.

sheath (eg. Flexor Ansel, Cook Medical, Bloomington, IN) is placed in the IVC over the initial access wire. Hydrophilic wires and catheters (eg. Glidewire and Glidecath; Terumo, Shibuya City, Tokyo, Japan) are typically used to cannulate the left renal vein. A flush cavogram may be performed at the L1–L2 level to identify the renal veins if these are difficult to cannulate. The guiding sheath is then advanced into the renal vein to provide stability for distal catheterization and embolization.

Venography

Fluoroscopic contrast injection is performed to identify the ostium of the left gonadal vein. A microwire and a microcatheter are then used to select the gonadal vein. Once the catheter is placed within the gonadal vein, digital subtraction venography is performed by either placing the patient in reverse Trendelenburg position or with the patient performing Valsalva. Venograms are usually performed at multiple levels extending from the ostium of gonadal vein to the pubic symphysis. Venography provides confirmation of the diagnosis and also identifies the venous collaterals, which must be selectively embolized, as they may contribute to treatment failure. The most common collateral pathways include duplication of the gonadal vein, lumbar, renal capsular, iliac, and circumaortic renal veins.

Embolization and Embolic Agents

The microcatheter and microwire are placed as distal as possible within the gonadal vein. The superior aspect of

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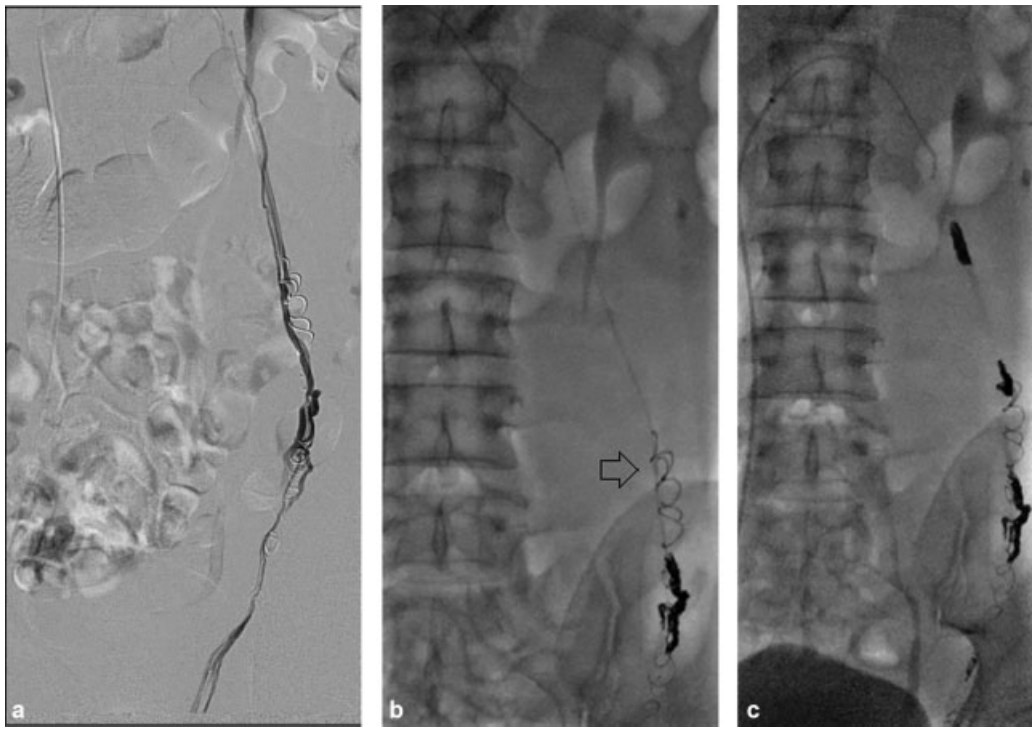

Fig. 4 A 31-year-old man with history of prior embolization 8 years previously presented with recurrence. (**a**) Digital subtraction angiography (DSA) through the left gonadal vein showing contrast opacification up to the inguinal canal. (**b**) Loosely packed coils from prior embolization can be seen in the mid-left gonadal vein (arrow). (**c**) Embolization performed using sandwich technique, using interrupted coils and sodium tetradecyl sulfate foam. Final DSA (not shown) showed complete embolization of the gonadal vein without reflux.

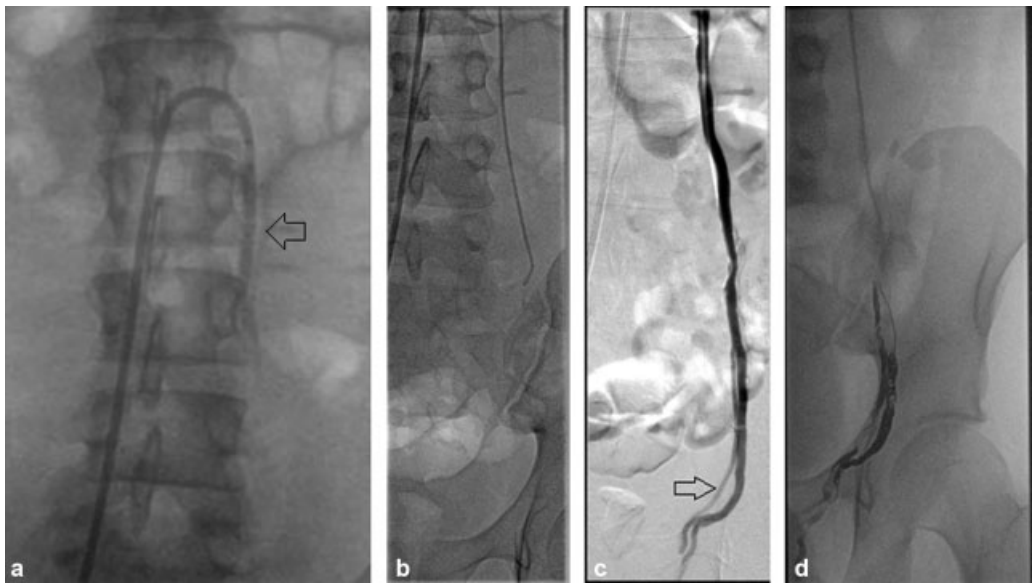

Fig. 5 A 22-year-old man with left-sided varicocele. (**a**) Left gonadal vein selected using 6.5-Fr Oscar sheath from left femoral vein approach, and gonadal vein (arrow) was catheterized using angled catheter (**b**). Contrast injection shows reflux of contrast within gonadal vein, with low duplicated gonadal vein (arrow) (**c**). Both tributaries of gonadal vein were embolized with coils and sodium tetradecyl sulfate (**d**).

femoral head/acetabulum is a reliable fluoroscopic marker for the deep inguinal ring, and the embolization is typically started at this level.

A multitude of embolic agents are available to perform varicocele embolization, including sodium tetradecyl sulfate (STS) foam, coils, plugs, and glue. The choice of embolic is largely based on operator preference and experience. Regardless of the embolic chosen, care must be taken to ensure cessation of flow within all visible collaterals, and prevent embolic migration.

Coils are commonly used embolic for varicocele, and both detachable and pushable coils can be used for embolization. Detachable coils provide more precise deployment and can be removed if the coil is inadequately sized for the vein. Fibered coils induce thrombosis within the vein and hydrogel-coated coils provide mechanical occlusion of the vessel

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by expanding in size after coming in contact with blood. The first coil must be placed below the most inferior collateral branch of gonadal vein or at the level of the pubic symphysis, whichever is lower. Additional coil nests are placed more proximally to exclude all potential collateral pathways. A tight coil pack is imperative for complete occlusion of the gonadal vein. In addition to coils, vascular plugs (eg. Amplatzer; Abbott Laboratories, Chicago, IL) also provide fast and efficient method for occlusion of proximal gonadal vein, with high technical success.

STS is a commonly used sclerosant available in 1 and 3% concentrations. It is usually mixed with contrast and air in variable proportions agitated in syringes using a three-way stop cock to form a smooth foam. This is important to ensure adequate coating of the venous walls and lumen which leads to endothelial inflammation and promotes adherence of venous walls. Sclerotherapy is associated with pain during injection, and care must be taken to ensure the sclerosant does not get washed away into the left renal vein and IVC.

Coils and sclerosants can be used together in the so-called sandwich technique. The first nest of coils is placed at the level of pubic symphysis, and sclerosant is injected proximally. This prevents reflux of sclerosant into the pampiniform plexus of veins, and preferentially allows the sclerosis of small collateral channels which are too small to catheterize. The second coil nest is placed proximally to the sclerosants, completing the "sandwich," which prevents washout of sclerosant into the renal vein and systemic venous circulation.

Glue (n-butyl-2-cyanoacrylate, n-BCA) is a liquid embolic which can be used for varicocele embolization. It is typically mixed with ethiodized oil (Lipiodol; Guerbet, Roissy—Charles de Gaulle, France) usually in a 1:1 ratio with 1 mL each. The proportion of oil can be increased to increase the viscosity and opacity of the mixture, but slows the polymerization time. The catheter is flushed with 5% dextrose solution to prevent glue polymerization in the catheter lumen, and the glue is injected immediately afterward.

Summary of Data

Alqahtani et al in 2002 published a single-center review of 41 patients who underwent embolization using either sclerosants or sclerosants with coils, with technical success in 95% (embolization performed) and therapeutic success in 89% (improvement in symptoms), without major complications.[6] Ali et al reported their experience using 3% polidocanol, with a technical success of 92%; however, their recurrence rate of 16% was higher than previously reported in surgical literature (0.8–15%).[7] Beutner et al reported a retrospective comparison of 356 patients who underwent laparoscopic varicocelectomy, antegrade sclerotherapy, or retrograde embolization over a 10-year period, and found that recurrence rates were higher with sclerosis and laparoscopic varicocelectomy was more effective in correcting varicoceles. However, the increase in efficacy came with an increase in complications with double the rate of hydroceles and incisional hernia.[8] Cantoro et al performed a prospective study comparing patients with subclinical varicocele who underwent percutaneous embolization (coils and polidocanol) versus observation, and found that there was significant improvement in mean sperm concentration and total motility with significantly higher pregnancy rates in patients who underwent embolization treatment.[9] Flacke et al in 2008 reported a retrospective review of 223 infertile men who underwent embolization with coils and polidocanol, with high technical (99%) and therapeutic success (93%), significant improvement in sperm count and motility, and pregnancy reported in 26% of patients.[10] Kim et al studied 28 patients with postsurgical recurrent varicoceles and reported a high technical (93%) and clinical success (80%) in these patients.[11] Finally, a meta-analysis by Kroese et al in 2012 suggested that treatment of varicocele in subfertile men may improve chances of pregnancy, but also concluded that there was very low quality of evidence and more research is needed in this area.[12]

Conclusion

To conclude, percutaneous varicocele embolization is a safe and effective alternative to surgery for the treatment of symptomatic varicoceles and male infertility; however, it carries a slightly higher risk of recurrence compared with surgery. Careful patient selection, preprocedural preparation, and technical prowess are essential for success.

Conflicts of Interest

T.McC. serves as consultant for Terumo, Johnson & Johnson, and GE Healthcare. All other authors do not have any conflicts of interest.

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