Chapter 11
Vesicovaginal Fistula: Minimally Invasive Surgery (MIS) Approaches

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Abbreviations

C-section	Cesarean section
CT	Computed tomography
JP	Jackson-Pratt
MIS	Minimally invasive surgery
MRI	Magnetic resonance imaging
VVF	Vesicovaginal fistula

Introduction

Vesicovaginal fistula (VVF) is defined as an abnormal communication between the bladder and the vaginal epithelium [1, 2].

In developing countries, there are around three million women with untreated VVF, with more than 100,000 new cases each year. About 98% of the cases occur after obstetric causes, where prolonged or obstructed labor leads to ischemic pressure on the vaginal wall and subsequent fistula formation [2–5]. The incidence of iatrogenic bladder injury during Cesarean section (C-section), resulting in VVF is 2.4% in developed countries compared to <1% in developing countries [2].

On the contrary, in developed countries, the incidence of VVF is around 0.3–2% [6]. The majority of the cases are seen after iatrogenic injuries to the bladder during

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R. Sotelo et al. (eds.), *Urinary Fistula*,
https://doi.org/10.1007/978-3-031-15317-4_11

hysterectomy (occurring in 1 of every 1000 procedures) [7]. It can also occur in the setting of pelvic radiation, neoplasia, pessaries, foreign bodies, trauma, or infections [8–10].

These geographic differences seen in the distribution and etiology of VVF are probably related to specific characteristics of developing countries such as inadequate access to obstetric healthcare, poor socio-economic status, malnourishment, and early childbearing age [11–13].

Classification

There are several ways to classify VVF. Clinically, we classify them based on complexity and the anatomical location.

Based on Complexity

Complex fistulae include:

- Fistula size equal to or greater than 2.5 cm
- Fistula associated to radiotherapy
- Fistulas located at the bladder trigone or near the ureteric orifices
- Multiple fistulous tracts
- Failed repair attempts
- Associated with ureteric strictures/injury, ureterovaginal or rectovaginal fistula

Simple fistulae are those that do not comply with the characteristics mentioned above.

Anatomically (Based on the Location on Cystoscopy)

- Supratrigonal
- Trigonal
- Infratrigonal

Supratrigonal and trigonal fistulas are commonly seen near the ureteric orifices.

Clinical Features, Diagnosis

VVF patients commonly present with continuous urinary incontinence, especially while standing, recurrent urinary tract and/or vaginal infections, resulting in emotional and psychological distress impacting patients' quality of life. Occasionally, postoperative VVF may not develop until 1–6 weeks after the causative event [1, 4, 5, 12].

Once a VVF is suspected, a thorough investigation and pelvic physical exam should be performed. Adjunctive testing such as methylene blue instillation into the bladder in a retrograde fashion and tampon placement in the vaginal vault may confirm the diagnosis by staining the tampon after ambulation.

Computed tomography (CT), CT cystogram, or magnetic resonance imaging (MRI) might aid with the diagnosis and assessment of location, size, fistula proximity to the ureteric orifices, presence of any associated fistulae, relationship to its surrounding structures, and presence of concomitant ureteral injury, which is reported in up to 12% of VVF cases [14–16]. Cystoscopy/vaginoscopy has the added benefit of providing crucial information about the vaginal anatomy and tissue characteristics, as well as allowing for fistula identification/characterization.

Additionally, in cases where pelvic malignancy is suspected a biopsy is warranted.

Treatment Approaches

Conservative Treatment

Conservative treatment should be considered as the first intervention in patients with VVF unless the fistula has clear indications of surgical repair. This approach is characterized by continuous bladder drainage up to 12 weeks by means of a Foley catheter or a suprapubic tube. Theoretically, this will promote a decrease in the inflammatory tissue and edema for a better opportunity for healing. During this time, prophylactic antibiotics might be needed [17, 18].

Success rate through this approach have been reported to be between 67%–100% in patients with simple VVF [7]. However, if no beneficial change has occurred within this timeframe, resolution through this approach is unlikely to occur due to epithelization of the fistulous tract. Therefore, if conservative treatment is unsuccessful, a surgical repair can be recommended [4, 19].

Surgical Treatment

We usually recommend a surgical repair in patients with complex VVF or simple VVF that failed conservative treatment. The surgical principles for the minimally invasive management of VVF must be present to ensure a successful surgical repair. These principles include broad exposure of the fistula and surrounding tissues, excision of fibrous tissue/fistula borders, adequate mobilization of structures, watertight tension-free tissue approximation, multi-layered closure with non-overlapping suture lines, appropriate tissue flap interposition, and maximal bladder drainage after surgery [20].

Traditionally, the surgical approaches for VVF repair are vaginal or abdominal. Many urologists are relatively unfamiliar with the vaginal anatomy. This, and the limited space that the transvaginal space provides makes the transvaginal approach challenging. Therefore, some urologist advocate for the abdominal approach. Also, the abdominal approach is particularly preferred in supra-trigonal, complex fistulae, or recurrent fistulae after failed transvaginal repair [21].

Nowadays, with continuous advances in minimally invasive surgery (MIS) approaches, surgeons are increasingly performing reconstructive procedures laparoscopically or robotically. The first laparoscopic VVF repair described in 1994 [20] enabled a minimal cystotomy compared with the morbid O'Connor bivalve technique [22]. This had the advantages of a minimally invasive procedure, including magnification during the procedure, decreased abdominal pain, shorter hospital stays with faster recovery, and better cosmesis when compared to open surgery. However, the laparoscopic approach was not widely adopted among surgeons due to challenges in pelvic access, a bidimensional visual field, fulcrum effect, and instrument rigidity [11].

More than a decade later, the first robotic-assisted laparoscopic repair was reported in 2005 [23]. Robotic surgery maintains the advantages of laparoscopic surgery with the added benefits of providing three-dimensional anatomic view, higher magnification, decreased tremor amplitude, more degrees of freedom, wrist articulation, and optimized ergonomics [2].

Different robotic surgical approaches are noted within the literature, based on the plane used to identify the fistulous tract for its repair. Despite the controversy among the different robotic surgical approaches, the technique chosen is often related to patient and surgeon preference.

Herein, we will describe the step-by-step robotic-assisted approach for the repair of VVF.

Step-By-Step Robotic Surgical Technique

Step 1: Patient Preparation

All patients had mechanical bowel preparation and a single dose of prophylactic antibiotics (2nd generation cephalosporin or ampicillin/sulbactam + aminoglycoside) before surgery [18].

Step 2: Cystoscopy and Catheterization of the Ureters and Fistula

After general, endotracheal anesthesia is administered, the patient is placed in lithotomy position. A cystoscopy is performed to catheterize both ureters using double-J stents. The fistulous tract is cannulated using a different colored ureteral catheter or a Foley catheter, which will be retrieved through the vaginal canal, allowing for ease of intraoperative identification and protection during fistula dissection (Fig. 11.1).

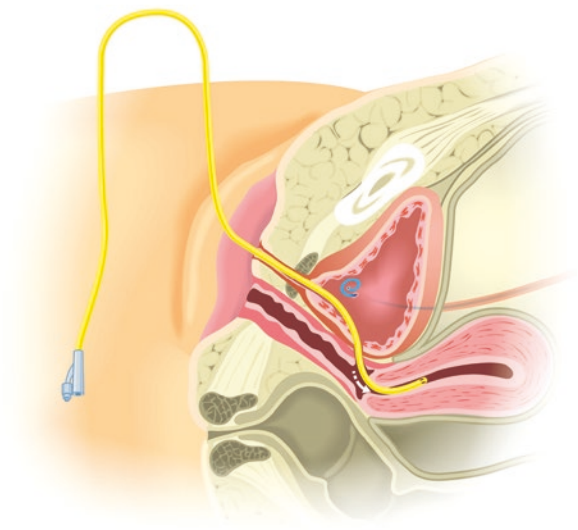

Fig. 11.1 Urethral catheter used to identify the vesicovaginal fistulous tract

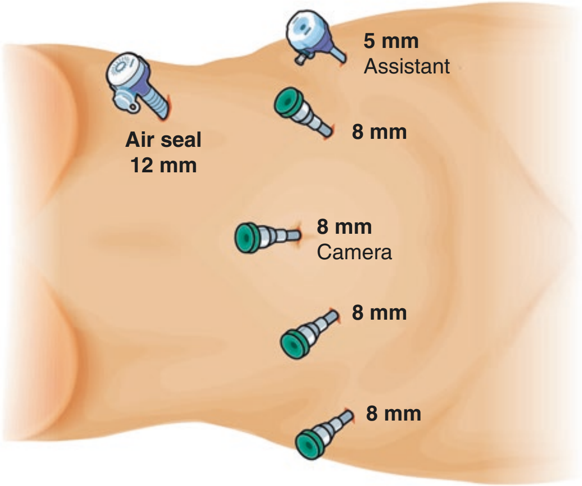

Fig. 11.2 Schematic drawing represents the robotic six-port transperitoneal configuration for VVF repair

Step 3: Port Placement

Access to the abdomen is achieved with the open Hasson technique [24]. Pneumoperitoneum up to 15 mmHg is established using high-flow carbon dioxide insufflation, an 8-mm camera port is placed at the umbilicus for cosmetic reasons. A 0-degree lens is used to assess for adhesions or bowel injuries that may have occurred during the initial access. Subsequent trocars are placed under direct visualization in a six-port transperitoneal configuration which include two 8-mm ports placed symmetrically on the left and right pararectal lines. A fourth port is placed cephalad to the iliac crest on the right side. A 5-mm assistant port is placed cephalad at the right or left side of the 8-mm port, which is used for suction-irrigation (Fig. 11.2).

Step 4: Creation of an Omental Flap

Once in the abdominal cavity, the first step is adhesiolysis. Next, omental flap harvesting based on the right gastroepiploic artery is performed following the open omentoplasty principles [25] with either standard laparoscopic instruments or robotic system in cephalic view with the patient placed in reverse Trendelenburg position. Cutting along the gastrocolic ligament between the greater gastric curvature and preserving the gastroepiploic artery should give enough length to reach the pelvis. However, if the flap is still not long enough, a larger omental flap can be done by performing a longitudinal incision parallel to the vessels running through the omentum. Once the omentum harvesting is completed the patient is placed in a steep Trendelenburg position for VVF repair. In cases where omentum is unavailable, vaginal flap, peritoneal flap, Martius fat pad, biologic flap tissue such as amniotic membranes or injectable materials (fibrin glue or cyanoacrylate injections), have been reported to be used safely and efficiently as interposition tissue/material [26–29].

Step 5: Docking of the Robot

After placing the patient in a steep Trendelenburg position, docking of the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) is carried out. The Si® system is docked between the patient's legs, while the Xi® system is docked from the patient's side (Fig. 11.3).

Fig. 11.3 Schematic drawing depicts patient placed in steep Trendelenburg position and Docking of the Xi® DaVinci Surgical System on the side of the patient

Step 6: Cystotomy and Fistulectomy

Adhesiolysis is performed using sharp and blunt dissection until the superior part of the bladder, Douglas pouch, and the surface of the uterus (if present) are anatomically identified. A minimal longitudinal cystotomy is carried out with monopolar scissors, in the direction of the fistulous tract identified either by pulling the previously placed catheter or by switching off the robotic camera light and focusing the cystoscope light on the fistula (Fig. 11.4a). At this time, the vagina has to be packed with a wet sponge to maintain pneumoperitoneum.

The longitudinal cystotomy is advanced distal to the fistulous defect until the posterior aspect of the catheter and vaginal sponge retractor are exposed (Fig. 11.4b) The walls of the bladder can be retracted laterally to assist with a wider exposure. Stiches are placed with a Keith needle or a Carter-Thomason device on either side of the cystotomy. Then, two-ends of stiches previously placed are anchored outside the anterior abdominal wall, providing adequate exposure of the fistula.

The resection margins of the fistulous tract are marked in “tennis racket” form by scoring the bladder mucosa with monopolar scissors. The fibrotic edges of the fistula are carefully excised with cold scissors (Fig. 11.4c).

Once the communication between the two organs becomes evident, the plane between the bladder and the vagina has to be completely separated for later interposition tissue anchoring (Fig. 11.4d).

Of note, this surgical step could be carried out through different approaches. A transvesical approach, which is considered an adaptation of the O’Connor procedure, where a minimal cystotomy is created towards the fistula, enabling a direct visualization of the fistula tract and ureteral orifices. However, a long cystotomy might lead to detrusor muscle dysfunction, decreased bladder capacity, and recurrent urinary tract infections [15, 23]. Nonetheless, Sotelo et al. [17] described this approach where the fistulous tract is reached without the need for additional vaginal incisions or extensive dissection of the vesicovaginal space, potentially decreasing the recurrence rate and irritative voiding symptoms (Fig. 11.5a).

Another alternative to access the fistulous tract can be through the retrovesical space. This approach was proposed as safer in terms of less bladder trauma. However, the dissection planes can be difficult to delineate and could lead to inadvertent injuries of ureters or cervix, especially when the uterus is present (Fig. 11.5b).

Lastly, the transabdominal-transvaginal approach involves opening the vagina towards the fistula. Useful in patients in which the vesicovaginal space is difficult to dissect. This approach seeks to overcome the challenges of transvesical and retrovesical approaches. Sotelo et al. [1] also described a transabdominal-transvaginal approach that minimizes bladder incision and, thus, provides excellent results in terms of lower patient morbidity, blood loss, and postoperative bladder irritability (Fig. 11.5c).

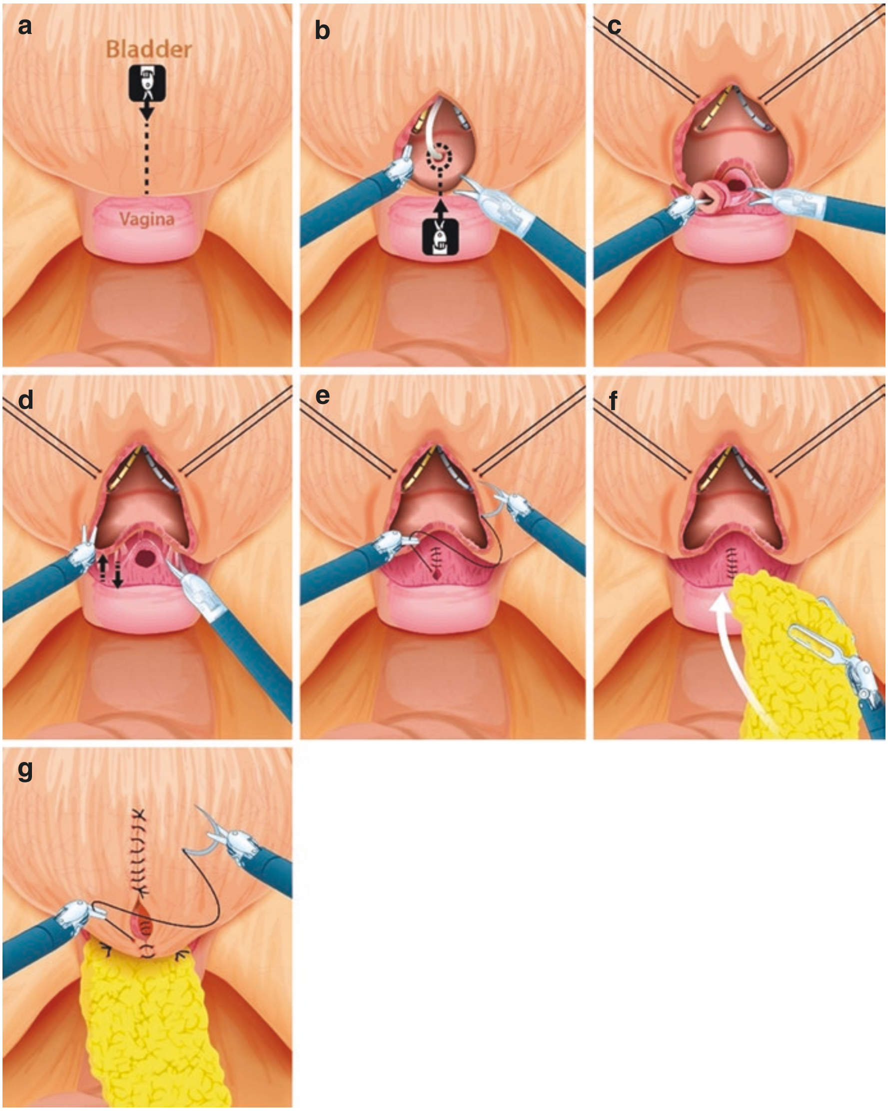

Fig. 11.4 Step-by-Step robotic VVF surgical repair. (**a**) A posterior longitudinal cystotomy performed with monopolar scissors in a downward fashion. (**b**) Schematic drawing represents vesicovaginal fistulous tract catheter, and dissection margins. (**c**) Fistulectomy performed with a combination of hook cautery and monopolar scissors. (**d**) Vesicovaginal wall space dissection. (**e**) Vaginal closure with 2-0 barbed suture in a running fashion. (**f**) Omentum interposition between the anterior vaginal wall and the posterior bladder wall. (**g**) A cystorrhaphy is performed with 2-0 barbed suture in a running fashion

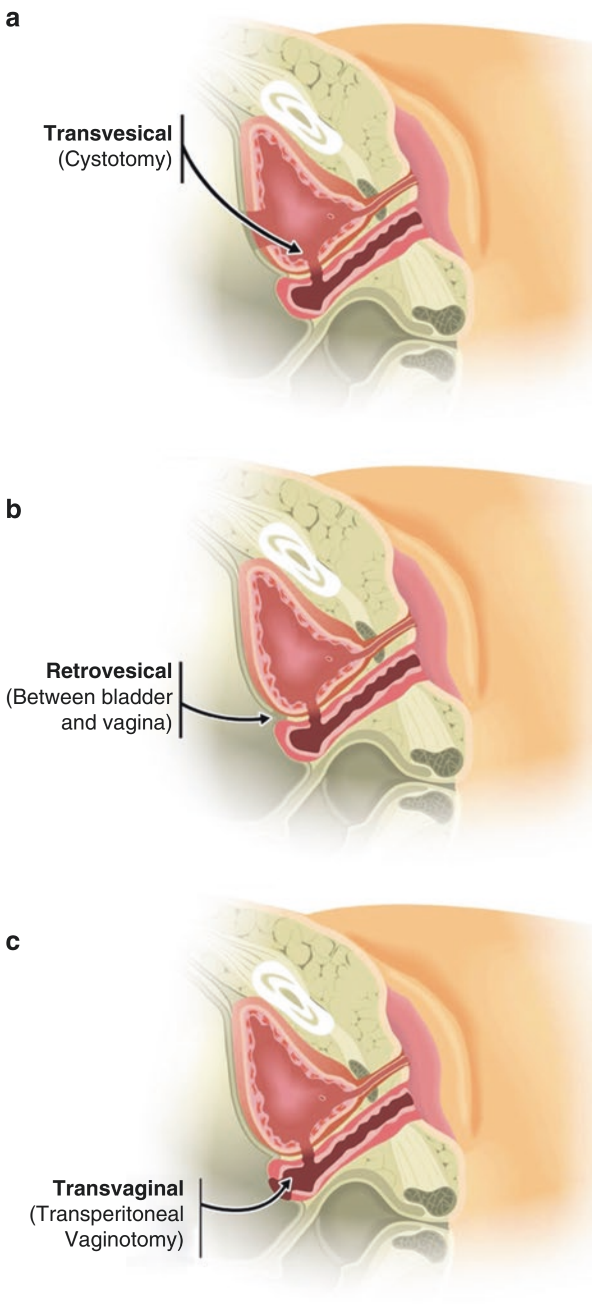

Fig. 11.5 Robotic surgical approaches for VVF surgical repair. (**a**) Transvesical: longitudinal cystotomy towards the fistula. (**b**) Retrovesical approach: extravesical access to the fistulous tract. (**c**) Transabdominal-transvaginal: opening the vagina towards the fistula

Step 7: Vaginal Closure

Vaginal closure is done in a transverse running locking fashion using 2-0 Monocryl or barbed suture on a CT-1 needle (Fig. 11.4e). It is important that both suture lines are aligned perpendicular to each other, which reduces the risk of fistula recurrence. In cases where the uterus is present imposing considerable tension on the suturing, the vaginal wall is closed longitudinally.

Step 8: Tissue Interposition

The operating table patient is placed back in a horizontal position, and the previously harvested omentum is placed down in the pelvic cavity and anchored in the vesicovaginal space distal to the repair to prevent future contact between suture lines (Fig. 11.4f). If omentum is not available, peritoneal, or vaginal flap can be used instead.

Step 9: Bladder Closure

Next, cystorrhaphy is performed vertically starting at the distal apex of the cystotomy using 2-0 Monocryl or barbed suture on a CT-1 needle in a running fashion. Then, the inferior portion is closed until the two sutures are encountered and knotted in the midline (Fig. 11.4g).

Step 10: Catheter Placement, Trocar Removal and Skin Closure

The ureteral catheters can be removed or remain in place if the excision and repair was close to the ureteral orifices. A 20 Fr Foley catheter is inserted to maintain bladder drainage. Watertight closure is assessed by instilling 180 cc of diluted methylene blue. In case of leakage, an additional interrupted suture can be placed.

Finally, a Jackson-Pratt (JP) drain is placed in the cul-de-sac. Hemostasis is ensured, trocars removed, and the fascia and skin are closed.

Of note, this surgical repair is often performed after a hysterectomy. VVF in the presence of a uterus is rare and usually occurs after a C-section. The surgical repair principles are the same; however, it is imperative to open the bladder first, without attempting to find the plane between the bladder and the uterus, due to the high risk of inadvertently opening the cervix canal. Moreover, it is crucial to properly mobilize the bladder and vagina to allow a tension-free anastomosis. In the presence of uterus, the vaginal closure will be performed longitudinally instead of transverse.

Postoperative Management

The JP drain previously placed is removed 3 days after surgery if the output is <50 cc in 24 h and after testing fluid creatinine. The Foley catheter should be maintained for at least 10 days and irrigated as needed to maintain patency. The Foley catheter could be maintained for longer if the tissue quality was deemed deficient during reconstruction. A retrograde cystogram can be done to confirm that there is no contrast extravasation prior to catheter removal. If left in place, double J stents are removed under cystoscopy guidance after 3 weeks.

Prophylactic antibiotics are given and maintained until all catheters are removed. Urine cultures are ordered at the time of removal and 2 weeks after. Sexual intercourse, douching, and tampons usage are prohibited for up to 2 months postoperatively.

A postoperative cystoscopy is performed as a standard follow-up every 3 months until 12 months after surgical repair or can be performed any time if symptoms of recurrence are present.

Conclusion

A standardized surgical approach for VVF repair is still debated. The repair should be individualized among patients and surgeon's experience and expertise. Although the use of robotic-assisted surgical repair of VVF its still in constant improvement, these techniques are rising in popularity among surgeons. Thus far, it has yielded promising results as a safe and feasible treatment approach in terms of improved visibility, dissection precision, dexterity, and shorter convalescence. However, further prospective, and randomized controlled studies are needed to standardize the role of MIS approaches in the repair of VVF.

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