Urinary Fistula

René Sotelo
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Enanyeli Rangel, Laura C. Perez, and Charles F. Polotti

Abbreviations

CT	Computed tomography
EBRT	External Beam Radiation Therapy
MIS	Minimally invasive surgery
MRI	Magnetic resonance imaging

Introduction

Fistulae are defined as abnormal epithelized connections between two or more surfaces [1].

Urological fistulae have low incidence but can cause significant physical, social, and psychological morbidity [2]. Approximately 30,000–130,000 new cases occur every year, and more than 95% of these cases occur in developing countries [3].

There are many different types of urinary fistulae. These include vesicovaginal, urethrovaginal, ureterovaginal, vesicouterine, rectovesical, and rectourethral. Hilton reported his experience over 25 years. In his publication 74% of the fistulae were

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vesicovaginal, 11% were urethrovaginal, and 6% were ureterovaginal, 3% were vesicouterine, and 1.4% were rectovesical [4].

Several risk factors can contribute to fistula formation, including infections, malnutrition, diabetes, cancer, previous surgeries, and energy treatments. Energy treatments can generate progressive endarteritis of the vasa vasorum, causing a state of hypoxia. Creating potentially necrosis [5].

In developing countries, urological fistulae are typically urogynecological and commonly resulting from prolonged labor. In contrast, in developed countries, they are relatively infrequent and usually result from non-obstetric and iatrogenic causes, leading to significant cause of medico-legal claims [2]. In the male population, fistulae are commonly iatrogenic following prostate treatments. 1% occur after external beam radiation therapy, 1–6% with radical prostatectomy, and 5–9% with brachytherapy or cryotherapy develop a fistula [6].

Despite fistulae being present for centuries, no official protocols or guidelines have yet been established to handle such problems [7]. Most fistula repairs are performed by relatively few expert surgeons in high prevalence areas. Consequently, there is wide variation in fistula location and little standardization of management protocols and outcome measurement [8].

This chapter aims to summarize the most important aspects of urinary fistulae.

Classification

Regardless of the location and the organs involved, most authors agree in classifying fistulae as simple or complex [9].

Simple Fistula

- Unique tract
- Size less than 2.5 cm
- Not associated with previous repair attempts
- Not associated with energy treatment

Complex Fistula

- Multiple tracts
- Size equal to or greater than 2.5 cm
- Associated with failed repair attempts
- Associated with energy treatment

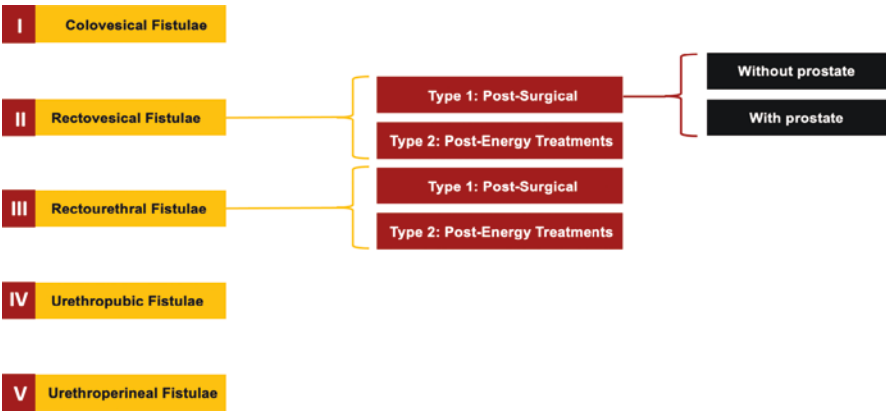

Fig. 1.1 Urological fistula classification according to etiology

We also classify urinary fistulae according to etiology. The etiology is vital in the decision-making process when designing the surgical plan (Fig. 1.1).

Diagnosis

Regardless of the type of fistula, the primary goals at the time of diagnosis are [10, 11]:

1. Fistula identification
2. Fistula size determination
3. Establishment of anatomical relationships
4. Determination of viability of the tissues surrounding the fistulous tract
5. Identification of concomitant pathologies

Detailed medical history and physical examination are mandatory. In addition, determining comorbidities that may affect the quality of tissues and their healing ability is critical [12].

In the case of urogynecology fistulae, a bimanual pelvic examination, digital vaginal examination, and the use of speculum can provide invaluable information about vaginal anatomy and tissue characteristics while enabling fistula identification. Methylene blue instillation into the bladder and tampon placement in the vagina may confirm the diagnosis of vesicovaginal fistula by staining the tampon after ambulation [10]. On the other hand, in the case of uroenteric fistulae, evaluation of the anterior wall of the rectum and the fistulous tract can be done through digital rectal examination. However, its sensitivity is low [13].

In general, endoscopic procedures are the gold standard, including cystoscopy, vaginoscopy, proctoscopy, or sigmoidoscopy. In addition, voiding cystourethrogram and retrograde urethrography aid in fistulous tract and defect size measurement [10, 14].

Computed tomography (CT) or magnetic resonance imaging (MRI) should be routine in evaluating any urinary fistula. They can aid in the detection of concomitant lesions and help determine the presence of multiple fistulous tracts. With contrast, CT sensitivity and specificity can increase to 90 or even 100%. MRI has a sensitivity and specificity of 100% due to its excellent resolution in soft tissues. Biopsies of the fistulous tract are essential in cases associated with malignancy [11, 15, 16].

Treatment

The success in the management of urinary fistulae will depend on several factors, including their type, location, time from diagnosis to treatment, quality of the adjacent tissues, comorbidities, etcetera [17]. In addition, the best chance of success is with the first repair, with success rates decreasing with subsequent repairs [18]. Cromwell et al. reported success rates of 88.1% of vesicovaginal fistulae after an index repair and 68.9% after a second operation [2].

Conservative Treatment

Conservative treatment should be used as the first intervention unless the fistula has clear indications of surgical repair. The primary role of conservative management is to divert urine and feces from the fistulous tract, reduce inflammation, prevent infections, and allow fistula closure without direct intervention on the fistulous tract [13, 19].

Surgeons debate conservative treatment due to its low success rates (7–16.2%) [20]. Conservative strategies include urethral catheterization, suprapubic cystostomy, percutaneous nephrostomy, and diverting ileostomy or colostomy. Some authors recommend urinary and fecal diversions simultaneously to maximize the chances of success [21]. Others do not recommend performing colostomies in those cases presenting with simple fistulae [22, 23].

Of note, if no beneficial change has occurred within the first 12 weeks using a conservative management, resolution is unlikely to occur due to epithelization of the fistulous tract [18].

Timing of Surgical Repair

The ideal time for fistula repair is still unclear [24]. If the fistulae is recognized within the first 72 hours, prompt surgical repair is recommended, with success rates of up to 95.2% [25]. In some cases, authors prefer to perform the surgical repair at least 3–6 months after the initial diagnosis to allow the inflamation to decrease, granting the possibility that the fistula will close spontaneously [24].

Of note, when spontaneous closure of the fistula is ruled out and the decision is made to proceed with surgical treatment, all drainage catheters should be removed weeks before the surgery to minimize inflammatory edema of the bladder mucosa. Patients should use continent pads and impermeable barrier creams, such as zinc oxide, to minimize irritative effects of incontinence on surrounding perineal and vulvar skin [8].

Surgical Treatment

There is still controversy surrounding surgical management, and there is no consensus on the best surgical approach. The approach selection is based on the fistula location, complexity, and the surgeon's preference. Table 1.1 summarizes the fundamental principles that must be present to ensure a successful surgical repair [26].

Regardless of the planned intervention timing, every surgeon should make sure there is no excessive inflammation or active infection and should optimize the nutritional and functional status of the patient before proceeding. Before surgical repairs, comorbidities such as diabetes mellitus and hypertension should be well controlled [5, 14].

Laparoscopic Management

Laparoscopic management to repair urinary fistulae were initially proposed to decrease the morbidity associated with open surgical approaches, with similar success rates, minimal surgical trauma, and lesser complications, thus allowing a quick return to work activities and a better cosmetic result [18].

Laparoscopy requires a longer learning curve due to suturing and intracorporeal knot tying [27]. Other disadvantages include a two-dimensional visualization, fulcrum effect, and a limited range of instrument movement in the pelvic area [18].

Robotic-Assisted Management

Robotic assistance in complex procedures has overcome the technical difficulties of the laparoscopic approach, even in challenging cases of fistula recurrence [28]. Benefits of robotic surgery include:

- Shorter learning curve
- Visualization improvement through use of three-dimensional vision with better depth perception

Table 1.1 Principles of urologic fistula repair

1 Adequate exposure of the fistula tract
2 Excision of non-viable tissue from fistulae edges
3 Careful mobilization of vascularized tissues
4 Well-vascularized, healthy tissue for repair
5 Watertight closure of each layer
6 Interposition of well-vascularized tissue between the organs
7 Tension-free, non-overlapping suture lines
8 Adequate urinary and fecal drainage after repair
9 Prevention of infection (use of pre, post, and intraoperative antibiotics)
10 Beware of malignant etiology of fistula
11 Follow-up esdoscopic procedures
12 Nutritional optimization

- Implementation of new instruments (EndoWrist) and platforms that increase the precision in the surgeon's technique with increased degrees of freedom and dexterity
- Tremor filtration
- Higher magnification
- Surgeon's ergonomic position
- Ability to use fluorescence imaging (Firefly Technology, Winchester, UK) with ICG (Akorn, Lake Forest, IL, USA), allowing intraoperative tissue blood supply evaluation.

These advantages permit better identification of anatomical structures during reconstruction, favoring the reduction of intraoperative and postoperative complications. However, its high cost and prolonged surgical times are notable disadvantages [29, 30].

Interposition Tissues

The use of interposition tissue is still controversial. Some authors promote its routine use to increase the first repair success rate [18]. Others consider its use only for the management of complex fistulae [14]. Currently, there is a lack of randomized clinical trials or large data series on the utility of biological tissues in urinary fistula repairs, and future studies are needed to prove its effectiveness.

The function of interposition tissues is to provide a healthy barrier, which prevents overlapping suture lines, promotes replacing necrotic tissue by healthy tissue, increasing healthy blood supply, and metabolic and immune activity. Therefore, this may decrease fistula recurrence rates [9].

There are two types of interposition tissues, flaps, and grafts. Flaps involve the transfer of tissue while maintaining its original blood supply. The main limitation of the flap lies in bringing it to the affected area without tension. On the other hand, grafts involve transferring tissue from its original location to a remote one; without preserving its original blood supply. Therefore, graft survival depends on local factors [11].

While using abdominal approaches, omental flaps are easy to access and mobilize, reducing operative time, infections, and overall perioperative morbidity. In addition, the omentum has angiogenic properties, abundant blood vessels, and lymphatics. The blood supply of this tissue comes from branches derived from the gastroepiploic arteries [9, 11]. However, its main disadvantage is the need for a transabdominal approach [18].

Of note, the anterior rectus muscle and peritoneal flaps can be a solution when the omentum is unavailable or cannot be mobilized due to adhesions from previous surgeries. However, in some cases, identification and anatomical access can be challenging due to inflammation of surrounding tissue [11].

For the transvaginal approach the Martius flap or bulbocavernosus muscle flap are good options [18], with success rates up to 90% [18, 31]. However, labia majora asymmetry is one of its disadvantages.

In large and complicated fistulae, the gracilis muscle graft can be used with a 91% success rate. It has been indicated as one of the most used among surgeons, 75% of cases. It can be widely used in abdominal, transvaginal, or transperineal repairs and requires little mobilization due to easy availability regardless of the patient's age [21].

Amniotic membranes can also be used as interposition grafts. Possibly enhance repairs via an immunomodulatory effect on angiogenesis and inflammation [32, 33]. Cyanoacrylate injection can be used as interposition material. This substance polymerizes after contact with tissue or water and promotes overlying epithelization [34].

Alternative Treatments

Sealing glues or glues with fibrin represent hemostatic agents that allow the stimulation of fibroblast migration and proliferation, passively promoting the occlusion of the defect through fibrin deposition and scar formation.

The advantages include low cost, a favorable safety profile, and ease of use under local anesthesia. Success reports of using these glues have been estimated between 30 to 80% [35, 36]. Interestingly, some studies have reported the highest success rates in larger size fistulae, showing 10% and 26% recurrence rates in patients with fistulae larger and smaller than 3.5 cm, respectively [37]. However, more studies are necessary to validate its benefits.

Inoperable Fistulae

The management of inoperable fistulae poses a challenge. These fistulae generally have a history of multiple repairs, destruction of continence mechanisms, large defect size, and surrounding tissues that make anatomical closure impossible. However, there are no standardized parameters to determine which patients would benefit from management with definitive urinary diversions. There is also no limit to the number of surgical repairs that can be offered to the patient before providing a urinary diversion [38]. Despite this, any surgical decision must be made based on an extensive pre- and postoperative investigation, considering the future repercussions and long-term care [39].

Postoperative Management

Deep venous thrombosis (DVT) prophylaxis should be continued post-operatively with low-molecular-weight heparin (LMWH), in addition to encouraging early ambulation. The Jackson-Pratt drain is removed after 2–3 days if the output is <50 ml in 24 h and if fluid creatinine measurements are normal. Continuous drainage of the bladder must be ensured. The Foley catheter should be maintained for 10 days and irrigated as needed [40]. Some authors recommend leaving the catheter for 14 days to ensure complete closure and prevent future recurrence [41]. However, the Foley catheter could be maintained longer if the tissue quality is poor during reconstruction. Generally, when fistulae develop after energy treatments, the catheter can be left up to 1 month, and concomitant hyperbaric oxygen therapy can be an option to improve healing.

Before the catheter removal, a retrograde cystogram should be done to confirm the absence of leakage or contrast passage to the other structures. In some cases, a voiding cystourethrogram can be performed. Appropriate prophylactic antibiotics are generally given before and after all catheters are removed. Urine cultures are ordered at the time of the catheter removal and 2 weeks afterwards [42]. If double J stents were left in place, they are removed under cystoscopic guidance after 21 days. Sexual intercourse, tampon usage, and douching are prohibited for up to 2 months postoperatively.

Postoperative cystoscopy can be performed if the patient has symptoms of recurrence, with the failure to cure most prevalent within the first 3 months after surgical repair. Long-term follow-up after the fistula repair is highly recommended, since some of the data suggest that recurrences can occur as late as 2 years after repair [43].

Conclusion

The first step for successful urinary fistula management is an adequate diagnosis supported by an extensive clinical exam and imaging evaluation. Proper timing selection is essential as the best chance of success is with the first repair. Standardized management for urinary fistulae repair is still controversial. Therefore, the approach should be individualized among patients and according to the surgeon's expertise.

Further prospective and randomized controlled studies are needed to standardize the role of conservative and surgical management.

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Chapter 2
Treatment Decision

Preston K. Kerr and Steven B. Brandes

Introduction

The management and reconstruction of complex fistulas are some of the most difficult problems to treat in urology. To decide on the proper management, a detailed knowledge of the fistula etiology, integrity of the anal and external urethral sphincters, functional status of the bladder, extent of radiation (or other energy source) damage, size and location of the urinary fistula, and the overall performance and nutritional status of the patient are needed. Few surgeons have had a large experience with such fistulas, and this explains why there is often times no clear standard surgical approach. Treatment needs to be tailored to the specifics of the fistula, the etiology, and most importantly, the patient.

Definition of Urinary Fistula

The term fistula is derived from the latin word for pipe [1]. It is an extra-anatomic, epithelialized channel between two hollow organs or a hollow organ and the body surface. It can be further classified by its anatomic location [2].

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Temporizing Management of Incontinence and Improving Quality of Life

In most, if not all cases, the first course of management should be improving quality of life by controlling or minimizing urinary or fecal leak. Nonsurgical (conservative) management can occasionally work for patients with a very small, non-endothelialized, uncomplicated fistula [fistula not secondary to an energy source (radiation), not TB, etc.] [3]. Once a fistula is endothelialized, attempts to de-epithelize [i.e., curettage, silver nitrate, etc.], followed by prolonged catheter drainage almost always fails.

Additionally, in some cases, the patient may be a poor candidate for surgery or does not want to pursue definitive management. In these cases, conservative management may be the only option. Regardless, prior to surgery, quality of life, as well as the local tissue, can be improved by controlling the incontinence.

Depending on the location of the fistula, urinary diversion can be via a foley, suprapubic tube, ureteral stents, or nephrostomy tubes. If the fistula is intraperitoneal, JP tubes or percutaneous drainage may be necessary. If a large cavity is associated with the fistula, a wound vac may be helpful in getting the bed ready for a definitive repair. The effects of negative pressure wound therapy (NPWT) has revolutionized wound healing and can result in an optimized wound environment for healing [4]. NPTW for fistula closure however, has very mixed success [5–8]. Diverting the urine allows for good skin care and helps minimize rashes and skin breakdown. Adjunctive measures for avoiding skin breakdown include barrier creams, regular diaper changes, and good overall hygiene.

Patient Selection for Surgery

To determine candidacy for surgery, an accurate picture of the fistula and patient is needed and a full assessment is needed.

Assessment of Urinary Fistulas

Examination Under Anesthesia

The most important step to a successful repair is to determine whether a repair is feasible or wise while taking into account patient comorbidities. To decide if a urinary fistula can be effectively and durably repaired, it is important to properly assess the size, location, and etiology of the fistula. Examination of a fistula under anesthesia, or at least some kind of sedation enables the urologist to properly assess the fistula, the quality of the tissue, and prevents the patient from suffering. Trying to evaluate a urinary fistula in the office without sedation usually results in a suboptimal assessment, as the patient may not tolerate the pain of proper imaging or endoscopy. For this reason, on meeting a new patient in the office with a urinary fistula, I usually book them in the operating room and do not attempt an office assessment. In this way, the entire armamentarium of fluoroscopy, cystoscopy, ureteroscopy, colonoscopy, as well as operative retractors can be used without difficulty.

Examination of The Rectum and Pelvis

For a proper examination under anesthesia, it is important to focus on and assess for the following:

1. Assess if the prostate (vagina in female patients) and bladder are mobile or fixed?
   A fixed or frozen pelvis is a relative contraindication to a fistula or reconstructive surgical repair. Such patients are typically more reliably managed definitively with a supra-vesical urinary diversion.
2. For patients with a urinary-rectal fistula, be sure to palpate the rectal ulcer and measure its size and note its location by proctoscopy/sigmoidoscopy. Assess the mucosa for pallor and radiation changes.
3. For each urinary-rectal fistulas, determine the fistula distance from anal verge. Fistulas <6 cm from the anal verge can often be repaired transanal. Fistulas >6 cm from the anal verge often require a tranabdominal laparoscopic or robot-assisted repair, a transsacral, or a transabdominal open approach.
4. Perform a complete general physical exam with particular attention to the abdomen, inner thigh, and perineum. A general exam involving the region surrounding the fistula can provide much information. Assess the quality of local tissues and skin. Is there loss of hair? Are there other stigmata of radiation changes? Is the tissue compliant and flexible or is it fixed and rigid?
5. Cystoscopy and Imaging Under Fluoroscopy include a retrograde urethrogram, voiding cystourethrogram, cystograms, and retrograde/anterograde nephrostograms. During cystoscopy, assess all bladder or bladder wall fistula for proximity to the ureteral orifices and trigonal ridge. Look for any radiation cystitis changes and attempt to determine bladder capacity. Assess if the capacity is normal, or is reduced by a small contracted bladder. Remember that bladder capacity under general anesthesia is usually twice the awake patient. So under general anesthesia a normal capacity is 600–1000 mL, typically.

Also use a low index of suspicion for shooting retrograde pyelograms and/or ureteroscopy, to assess for an associated ureteral fistula or stricture.

Fistula and Cavity Characteristics

Cavity

Most urinary fistulas resulting from radiation or other energy sources are not just a fistula connecting two cavities. Typically, the fistula is from the urologic organ to a cavity, and then from the cavity to another fistula that connects to the skin or another organ. Thus, it is also essential to evaluate the cavity size and location. Fixing a fistula without filling the cavity with tissue transfer of muscle, skin, or omentum, is a set up for failure. Typical tissues transferred to fill pelvic cavities include the omentum, gracilis muscle, myo-cutaneous gracilis flap, rectum abdominus, myo-cutaneous rectal flap and gluteal muscle.

Fistula

As to the fistula itself, it is essential to determine the location of the fistula and how it connects the 2 strictures together. Assess the width of the fistula opening on both sides. The length of the fistula tract should also be determined and if the tract is tangential or perpendicular (directly connecting the 2 strictures). It is also important to note if the fistula and surrounding tissues are inflamed or infected. Such tissues are very friable and tend to bleed easily. Trying to repair a fistula with such tissues is unlikely to succeed because sutures often pull through, the tissues are not very pliable, and they are hyper vascular—so they bleed easily. If the urinary fistula developed after resection for a diagnosis of cancer, it is essential to confirm that the patient is without any evidence of recurrence on sectional imaging. If there is any question, perform a fistula biopsy. This holds especially true if the pathology report of the cancer resection had included positive margins or advanced tumor stages. Fistula surgery will always fail in the face of active cancer at the site.

Selection is the Silent Partner of the Surgeon

Knowing who not to operate on is often more important than knowing who to operate on. In other words, an unhealthy patient with poor protoplasm is a set up for failure, regardless of the surgical technique and skills of the surgeon. It is magical thinking to think that inflamed, infected, and/or radiated tissue in an unhealthy patient will heal properly. A healthy patient with healthy tissue make for a successful surgery. As my mentor Dr. Jack McAninch used to say, “you can’t make a silk purse out of a sow’s ear”.

Patient Preparation for Surgery

Timing of surgery is key to maximizing surgical success.

1. *The best chance for a successful repair is the first chance.*

   Before tackling a repair, maximize the patient's health, resuscitation, and the surgical conditions (proper surgical equipment/retractors, a proper scrub tech and first assist). Come prepared for the surgery and don't be hesitant to call for help if needed.

2. *Optimize the overall physical conditioning of the patient and assess patient physiologic reserve.*

   So your patient has poor physiologic reserve or isn't quite optimized…what can you do?

   The first thing to do is to not rush to perform surgery. Delay surgery weeks to months and maximize physical conditioning and comorbidities first. Just as important as the surgical techniques and expertise of the surgeon is the patient's overall condition. To optimize the patient, start with assessing the physical condition/reserve of your surgical candidate.

   A thorough assessment can include the use of surgical risk calculators such as the ACS/NSQIP risk calculator (riskcalculator.facs.org), Revised Cardiac Risk Index for Pre-Operative Risk (RCRI, www.MDalc.com), or the Surgical Outcome Risk Tool (SORT, www.sortsurgery.com). Such calculators are validated regularly and are the best studied and most [9, 10].

   The ACS/NQIP risk calculator estimates the chance of 13 unfavorable outcomes or complications after surgery and attempts to predict the length of hospital stay. Be warned that the data set is not validated in all surgical procedures, but this calculator remains one of the best validated tools in our armamentarium [11]. The RCRI requires only 6 variables, and estimates the risk of cardiac complications (30-risk of death, MI, or cardiac arrest) after noncardiac surgeries [12]. The SORT is a simpler and faster risk calculator that attempts to predict 30-day mortality after non-cardiac surgery in adults [13]. These surgical risk calculators can provide an initial preoperative assessment and can be very useful in surgical counseling and shared decision making.

   Assessing the activities of daily living (ADL) such as eating, toileting, bathing, and other activities required to independently care for oneself is easily performed via the use of a number of validated indices, such as the Barthel index, Katz Index, and the Lawton IADL. In an elderly or frail looking adult, these instruments give you an assessment of a patient's functional status and ability for self-care. Low survey scores are associated with poor surgical outcomes and increased caregiver needs post-operatively [14–17]. The Barthel Index, previously known as the Maryland Disability Index, is the most familiar of the instruments used (https://www.mdcalc.com/barthel-index-activities-daily-living-adl) [18].

The physical performance test assesses multiple domains through a series of simulated tasks from writing a sentence to eating, to climbing a flight of stairs. Used more often in the geriatric population, this instrument has validated specifically in transplant and orthopedic settings and found to be associated with patient outcomes [19–21]. While its use is not validated for urological reconstructive surgery. The test evaluates a patient's global fitness and helps guide the shared decision-making process. Other methods for predicting surgical outcomes are sarcopenia by assessing psoas muscle atrophy on CT imaging**,** as well as the frailty index [22, 23]. The frailty can predict post-operative mortality across a number of non-cardiac surgeries independent, of operative stress [24]. However, data is limited. Optimizing patient physiologic reserve to better tolerate surgery and enhance surgical outcomes is termed prehabilitation [25].

3. *Maximize the overall nutritional state of the patient*

Recent literature supports that the concept of prehabilitation with or without exercise may be associated with decreased hospital stay and accelerated return to presurgical functioning [26]. The first step is the use of a screening tool such as the Nutritional Risk Screening 2002 (NRS-2002, https://www.mdcalc.com/nutrition-risk-screening-2002-nrs-2002) and serum albumin, prealbumin, and transferrin levels testing [27]. A Serum albumin of <30 g/L is associated with post-operative morbidity and mortality in urologic oncology patients [28–30]. Meal planning and optimization should occur at least 1 month (some advocate 12 weeks) prior to surgery, and should involve a nutritionist if moderate to severe [27]. Ideally this is done in conjunction with a physical conditioning program [27, 31]. Oral carbohydrates loading just prior to surgery has shown a mixed decrease in hospital length stay, reduced insulin resistance and improved perioperative discomfort for major abdominal surgeries [30, 32].

Appetite stimulants and protein shakes, and for patients with swallowing difficulties or short gut—tube feeds or total parenteral nutrition for a few weeks prior to a fistula repair are often important for maximizing surgical success [27].

4. *Smoking cessation and drug abstinence*

When using flaps or grafts, all reconstructive surgeons understand the importance of maintaining proper arterial inflow and venous outflow is essential to graft take or flap survival. Cigarettes cause vasoconstriction and creates an environment of tissue hypoxia. The damage is multi-faceted. Of the thousands of chemical within cigarettes, nicotine, carbon monoxide, and hydrogen cyanide in cigarette smoke, all contribute to poor healing through decreased oxygen delivery and utilization, as well as deranged collagen deposition [33]. Smoking itself has been shown to predict major postoperative complications and increased hospital length of stay. In high-level smokers (>1 pack a day), flap or graft death is three times more likely than non-smokers. And after tissue necrosis develops in a flap or graft, the percent that necroses is three-fold greater. Therefore, most elective fistula surgery should be delayed until the patient ceases smoking for at least 1 month prior to surgery. This alone will improve healing and portend to better outcomes [34–36].

5. *Optimize the local tissue*

   For a successful surgery, one needs to optimize the local tissue and environment. Any infections need to be adequately treated with antibiotics prior to definitive surgery. In some cases, this may mean a PICC line for prolonged antibiotics. Diverting and controlling any urinary or fecal leakage will minimize the local inflammation and allow the tissues to heal.

   Hyperbaric oxygen (HO) has been in use for many years, especially for radiation cystitis, burn victims, and for wound healing, but less so for urinary fistulas [37–39]. HO simulates leukocyte microbial killing, enhances fibroblast replication, and increased collagen formation and neovascularization of ischemic tissue. These effects are especially useful in radiated tissues [40]. Its use in the pre-operative and post-operative setting is promising, as to flaps, grafts, and poorly healing radiated tissue after surgery [41–43]. HO can permanently raise tissue oxygen tension to roughly 80% of normal, and after 20–30 hyperbaric treatments, ischemic radiated tissue can become amenable to accepting a split-thickness skin graft. Therefore, in irradiated patients, it is thought that 30 treatments prior to surgery, and 10 after, can optimize outcomes. Bowersox et al. In a series of 105 patients with ischemic skin flaps and grafts, utilized HO to salvage 89% of threatened flaps, and 91% of skin grafts [44]. In the case of a compromised flap or graft, early HO is administered twice daily for up to 10 days post-op depending on the flap or graft's clinical characteristics. For hypospadias cripple surgeries, a recent student reported 89% success with the use of preoperative HO with postoperative nitroglycerine paste. The surgical cohort was complex with a mean of 5.5 failed previous repairs. Robust, high-level evidence is still lacking, however HO is very promising and should be considered for urinary fistula repairs in radiated tissues, in the context of multiple failed procedures, or in the case of compromised postop flaps or graft.
6. *Pain Control*

   If the patient's main complaint is pain, such as from a rectal ulcer, nerve damage, or secondary to damage from an energy source (radiation or cryotherapy), the pain will often be severe, debilitating, and unrelenting. These patients are often desperate and thus not thinking clearly. They will often ask you to perform surgery immediately, as they are suffering. Diverting the urine and/or fecal stream away from an ulcer associated with the fistula will help to reduce the pain. However, if the pain is secondary to nerve pain, then performing exenerative surgery may not resolve the pain. Refer such patents to anesthesia pain management first. Once the pain is bearable and under control, the patient will be able to think more clearly and be able to weigh options rationally and make a well-informed choice (shared decision-making).
7. *Treat the whole patient*

   Oft neglected by the surgeon is the psychological state of the patient and the depth of his social support network. Treat each patient holistically as a human being rather than as a diseased organ with a urinary fistula. The typical patient who gets a urinary fistula is anxious/worried. Anxiety and stress can potentiate the perception of pain and increase the patients suffering. So, treating the patient's anxiety and stress will help ease his suffering. This holds true especially if definitive management needs to be delayed for weeks or months, while the conditions for repair are optimized. The level of "grit" that each patient possesses, and their ability to tolerate and successfully navigate stress varies greatly. The reason for this is patient irrational self-talks. So to help anxious patients calm down and better manage their stress, I provide a "what's the DIF" talk. Where D = duration, I = intensity, and F = frequency. The irrational self-talk patient thinks that his/her suffering will never end, the intensity will be a 10, and the frequency of pain will be constant. It is thus reasonable and understandable for a patient to become anxious and stressed—for they irrationally believe they will be in a constant state of suffering for the rest of their life. However, often all that is needed is a bit of cognitive therapy. I make sure that the patient understands that regardless of their pain intensity, the duration will not be forever, and the frequency will improve. More often than not, this simple exercise allows patients to see that there is a light at the end of the tunnel. Additionally, I find it is very important to reinforce to the patient that they are not alone. Also, I always express to the patient that "we will do this together". In cases where more is needed, I use a low threshold for referral to a psychologist, behavioral therapist, or psychiatrist (for pharmacotherapy). The first thing I ask every fistula patient at the start of an office visit, is if they are eating or sleeping properly. Patient suffering is exponentially worse if they are so anxious that they cannot eat or sleep well.

Developing a Surgical Plan for Repair

Shared decision making is key to a successful outcome. Repair of genitourinary (GU) fistulas are primarily a quality-of-life procedure and this always needs to be kept in the back of the mind of the surgeon. To properly formulate a surgical plan based on shared decision making and improve quality of life, discuss the following:

1. *What is the patient's #1 goal?*

   First and foremost, ask the patient directly what do they expect to achieve with surgery and what is most important? Is it to void normally out of native urethra? Is it to achieve good quality of life? Is it a procedure to relieve pain? Ask each patient if body image is important. Is a permanent urinary or fecal stoma acceptable? Is a catheterizable stoma acceptable? These are complex discussions that take time. Sometimes a consultation with a patient advocate can be very helpful.
2. *What bothers him/her the most?*

   What is most bothersome to the patient. Is it Incontinence (diurnal or nocturnal)? Is it pelvic pain? Or is it recurrent urinary tract infections or episodes of urosepsis requiring hospitalization?

3. *What are the patients expectations?*

   Set realistic patient expectations. Many patients have magical thinking and won't accept anything less then being "fixed." Often a new normal is achieved, and its not possible to get back to the way they were before.

A Plan in Motion

Once a treatment plan is set, do not be bullied by your patient to change your management because they are unable to accept what you are recommending. The treatment plan that you formulate is a recommendation, not an order. If the patient cannot accept or follow you recommendation, then I often suggest to the patient they seek a second or even third opinion. There have been many times I have allowed myself to be bullied by a patient to do a surgery that I did not think would be successful. I usually regretted it. In formulating your final plan, I once again remind you to take into consideration your patient's characteristics. Those with a hostile abdomen and/or complex intra-abdominal fistula from an energy source are difficult, and an aggressive approach can go very poorly. In these patients however, I find that a serious complication tends to end poorly for the patient. Heroic surgery for complex fistulas should never be taken lightly.

Urinary Supra-Vesical Diversion vs. Fistula Repair

Patient factors should weigh heavily when selecting the type of fistula repair or urinary diversion (see Table 2.1). Patients who have multiple comorbidities and are thus poor surgical candidates or with limited life expectancy, have limited options

Table 2.1 Contraindications to fistula repair

A. Relative contraindications
• Poor performance status
• Elderly and frail
• Multiple co-morbidities
– i.e. peripheral vascular disease, diabetes mellitus, coronary artery disease, smoking
• Patient preference for urinary diversion
• Frozen pelvis
• Large fistula with an energy source etiology that makes reconstruction prohibitive—i.e. a heroic surgery
B. Absolute contraindications
• Persistent local malignancy
• Actively on chemotherapy
• Actively receiving EBRT
• Poor life expectancy

for managing their urinary fistulas. If the internal urinary sphincter is intact, the first step for recto-urethral or urethral-perineal fistula is a suprapubic tube to divert the urine away. However, if the bladder neck is open, or the urinary fistula is in the bladder, then options become limited. At this junction, the only noninvasive method to proximally divert urine is placement of bilateral percutaneous nephrostomy tubes. In most cases this will divert urine. However, in some instances, significant amounts of urine may still travel down the ureters. An effective and durable method for managing such urinary fistulas and incontinence includes bilateral percutaneous nephrostomy tube placement, followed by trans-ureteric embolization of the distal ureters using a combination of Gianturco coils (steel coils) and Gelfoam (gelatin sponge) (see Figs. 2.1 and 2.2). Shindel et al. reported their 12-year experience with ureteric embolization for refractory urinary fistula in those unable to undergo a definitive surgical procedure due to comorbidities and/or limited life expectancy [45]. The authors noted in all 29 patients, ureteral embolization and bilateral nephrostomy tubes resulted in near complete dryness within 3 days. 3/29 patients ultimately underwent successful ileal conduit urinary diversion. Of the 80% who died, the mean time from embolization until death from comorbidities/cancer was only 8 months. They concluded that the best candidates for ureteral embolization were those with Poor performance status, limited life expectancy, or as a staged method to control urine leakage (for healthier patients), followed by a delayed supra-vesical reconstruction.

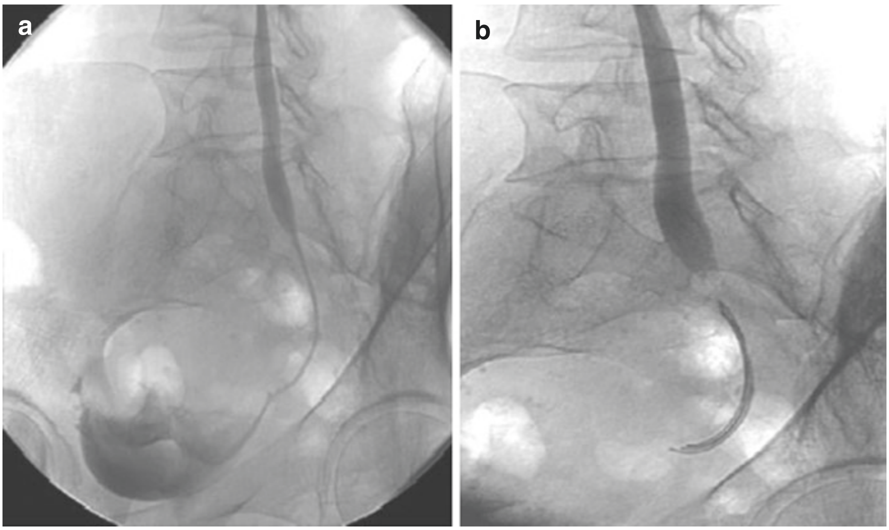

Fig. 2.1 (**a**) Coil deployment embolization of the left distal ureter. (**b**) Nephrostogram demonstrating ureteral occlusion. Note radioopaque coils in distal ureter

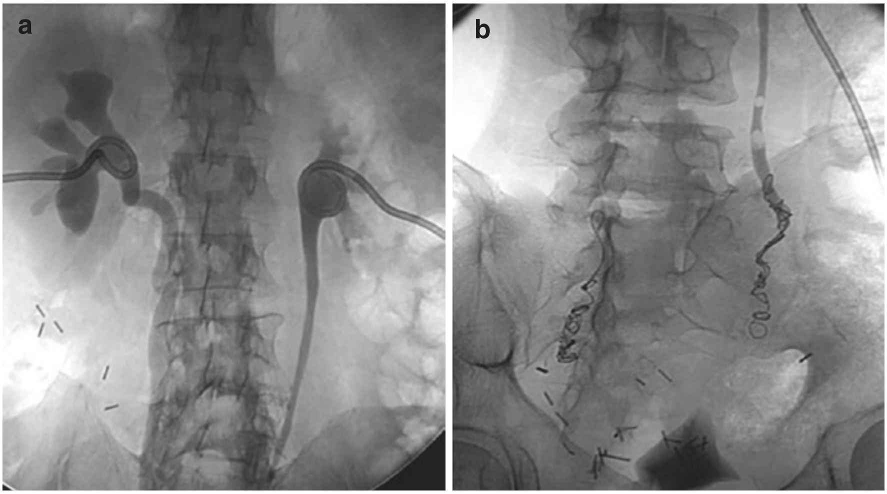

Fig. 2.2 Bilateral Ureteral coil embolization just distal to the iliac arteries. (**a**) Bilateral Nephrostogram. (**b**) Nephrostogram demonstrating bilateral ureteral occlusion

The Radiated Pelvis

A radiated urinary fistula, in a radiated pelvis, has a less-than-ideal success rate of repair [19]. Eswara and colleagues retrospectively reviewed a cohort of 86 patients who underwent treatment of enterourinary fistulae and urinary cutaneous fistulae. Of those that underwent radiation, 44 (72%) required permanent diversion, compared with only 3 of the 42 non-radiated patients (7%).

Raup et al. evaluated 27 patients who underwent a urinary fistula repair with a gracilis flap. The authors documented higher flap failure in those that were radiated (5/20) vs. non-radiated patients (3/7). Again, among those that underwent pelvic radiation, 90% (18/20) developed bladder outlet dysfunction as defined by a bladder neck contracture or stress urinary incontinence. This was in contrast to only 14% (1/7) who were not radiated. Additionally, radiation was associated with worse scores on the EPIC questionnaire suggesting a diminished post-repair quality of life [20].

In yet another retrospective review, Hanna and colleagues came to similar conclusions [21]. Over a 16 year period, 37 patients were treated for rectourethral fistula. Patients who had an irradiated fistula generally underwent more complex operative repairs including a higher rate of gracilis interposition flaps and pelvic exenteration. In radiated patients that underwent definitive repair, there was a higher rate of wound infections, higher length of stay post-op, a lower fistula closure rate, and a lower rate of fecal ostomy reversal as compared to the non-irradiated group.

It is not unreasonable then to consider urinary diversion as the initial and primary management in such patients. Those of us who are reconstructive urologists often look upon an ileal or colo-conduit as defeat. While the goal of reconstructive urology is to optimize the patient's urinary function, this does not always mean urination via the native urethra. As fistula surgery is a quality-of-life surgery, the end result is easing patient suffering and controlling urine leakage. For many urinary fistulas, a foley catheter, suprapubic tube, or nephrostomy tubes can keep a patient dry. There is no shame in a supra-vesical diversion as a permanent solution to a complex fistula—as long as the decision to do so comes from shared decision making with the patient. The whole patient, both physical as well as psychological health/illness needs to be considered.

Conclusions and Take-Home Messages

- Urinary fistula repair requires shared decision making with the patient. Clarify and set realistic patient expectations.
- Fistula surgery is complex and requires the whole surgical armamentarium. Come prepared.
- A complex urinary fistula repair, especially in a radiated field, may be a long and delayed process. It may make take months of staged surgeries and/or urinary drains to repair.
- Consider supra-vesical diversion. It is not a surgical defeat. As fistula surgery is QOL surgery, the end goal is an improved quality of life. Urinary diversion is clearly a better option than a daily diaper or having recurrent infections and/or pain.

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Part II
Fistulas in Both Genders

Chapter 3
Pyeloenteric Fistula

Laura Fernández Hernández, Juan Gómez Rivas, Jesús Blázquez Izquierdo, and Jesús Moreno Sierra

Abbreviations

CT	Computed tomography
ERCP	Endoscopic retrograde cholangiopancreatography
MRI	Magnetic resonance imaging

Introduction

The best definition of a fistula was formulated by Alexander-Williams and Irving [1], who defined it as an abnormal communication between two epitheliazed surfaces. The fistula can be congenital or acquired and can put two organs in communication with each other (internal fistula) or communication with the outside, specifically the skin (external fistula).

Despite its extraperitoneal location, the genitourinary tract has anatomical proximity to other organs, such as the gastrointestinal or gynaecological tracts, which conditions the possibility of establishing anomalous communications between them. In addition, the urologist also uses portions of the gastrointestinal tract to act as reservoirs or tubes for the transport of urine, and on occasions, this may lead to problems related to the surgical procedure itself.

Pyeloenteric fistula communicates the renal pelvis with the gastrointestinal tract. The aetiology can be urological, digestive or traumatic. This type of fistula is extremely rare and poses serious diagnosis and therapeutic problems. Therefore, a

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multidisciplinary approach between urologists and general surgeons is essential. Their topography is diverse, and the most frequent within their rarity is the renocolic fistula.

The first published case of pyeloenteric fistula corresponds to Hippocrates, who described a case of a renal abscess of lithiasic aetiology that drained spontaneously to the bowel and was diagnosed post-mortem [2].

In general, published series are scarce, and the most frequent is to find isolated clinical cases, published either by urologists or general surgeons. Therefore, it is difficult to find in the literature guidelines to follow in terms of diagnosis and treatment.

The following chapter aims to present an overview of the pyeloenteric fistula, including its diagnosis and management.

Definition, Specific Considerations, Classification

Pyeloenteric fistulas communicate the renal pelvis with the gastrointestinal tract (Fig. 3.1). These upper urodigestive fistulas are much infrequent than lower ones, with a 1:20 ratio and the aetiology is usually renal.

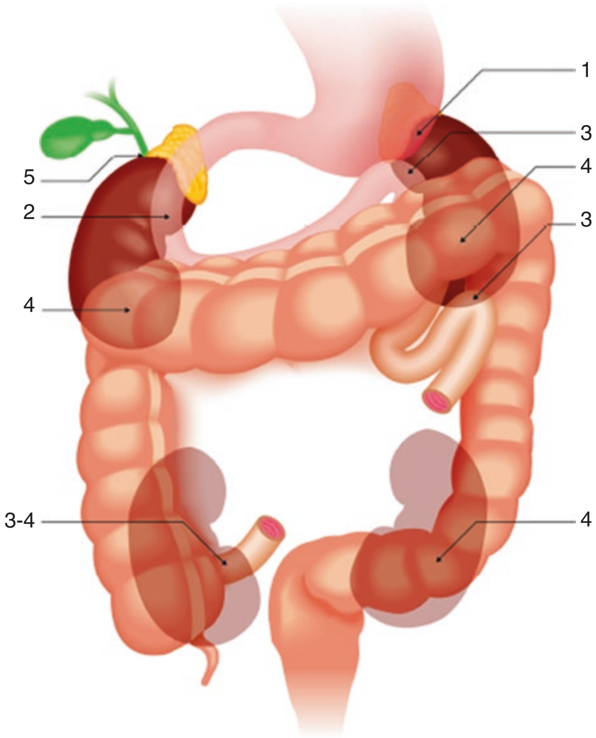


Fig. 3.1 Types of pyeloenteric fistulas. (1) Renogastric fistula. (2) Renoduodenal fistula. (3) Renojejunal and renoileal fistula. (4) Renocolic fistula. (5) Renohepatic and renobiliary fistula

These fistulas usually occur between 45 and 65 years of age and more frequently in men. They are often secondary to complications of inflammatory renal processes; abscesses or pyonephrosis, infectious, neoplasic or traumatic origin and generally with previous obstructive processes, such as lithiasis. This occurs due to the proximity of the kidney to the gastrointestinal tract, with the most frequent fistulas being those affecting the left or right colon or duodenum, with fistulas also having been described with the stomach, jejunum, ileum or liver [3].

Although infectious aetiology, particularly tuberculosis, has been the predominant aetiology in the past, thanks to the efficacy of antibiotherapy and early diagnosis, it has decreased considerably, with traumatic aetiology, mainly iatrogenic causes related to renal puncture and endourology, being nowadays the most frequent [4].

The causes leading to fistula are chronic infection, chronic mechanical obstruction, extravasation and abscess formation. The prognosis will depend on the functional damage and early resolution of the condition.

They can be classified according to their mechanism of production, their topography or their aetiology.

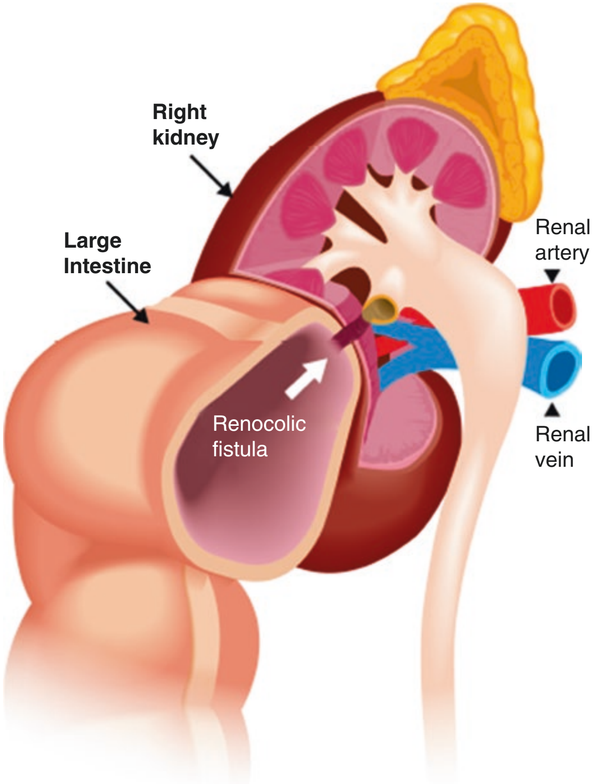
Depending on the mechanism of production, it can be:

- **Spontaneous fistulas:** produced as a consequence of existing pathology, either urological or digestive.
- **Provoked fistulas:** as a consequence of the traumatic action of an external agent, which in turn are divided into:
  - *Post-traumatic*: either by crushing or penetrating trauma. They may also be iatrogenic, after renal puncture techniques and percutaneous endourology, which have become standard of care nowadays and correspond to 0.5% of the complications of this technique, being located more frequently in the splenic angle of the colon [5]. Also, they can be a consequence of intestinal surgery or procedures that damage the wall of the bowel (needle punctures or biopsies) or after using the intestine in bladder augmentation, substitution or urinary diversion.
  - *Post-surgical*: usually unnoticed injuries due to the difficulty of the surgical field, for example, in the course of debridement of pyelonephritic abscesses or those produced by decubitus of drains maintained for long periods.
  - *Post-radiation*: the bowel is highly sensitive to the effects of radiation, in particular at the level of the mucosa and endothelium of the submucosal vessels. The mucosa of the bowel will develop cellular alterations that lead to necrosis and ulcerations. In addition, progressive endarteritis of the submucosal vessels will lead to obliteration, isquemia and fibrosis [6].

According to their topography, pyeloenteric fistulas are established between the renal pelvis and the gastrointestinal tract. The most frequent are renocolic, left or right, and renoduodenal, although some have also been described with other areas of the gastrointestinal tract.

- **Renocolic fistula** (Fig. 3.2): these fistulas are the most frequent given the anatomical relationship between the kidney and the colon; specifically, they are

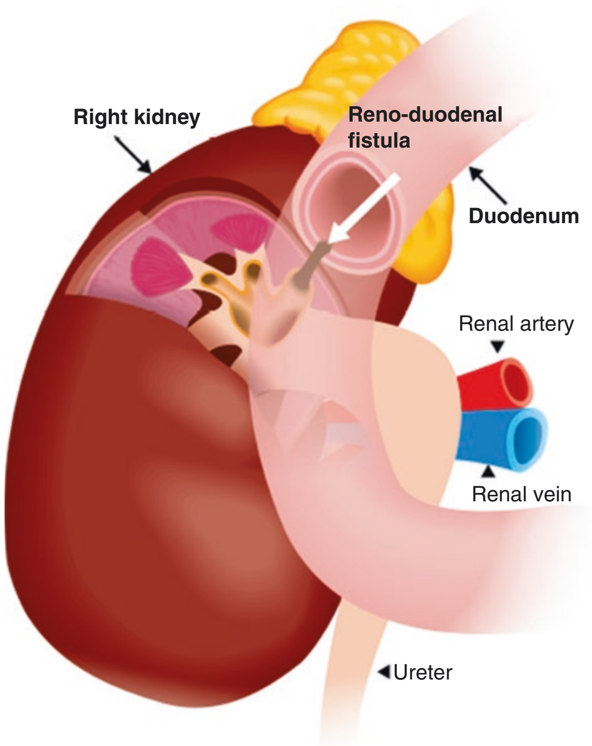
Fig. 3.2 Renocolic fistula



more frequent on the left side. The most common aetiology is infectious or lithiasis. Also, tumour or traumatic causes, among which the kidney's percutaneous puncture stands out, is the splenic angle of the colon the most affected location in this type of procedure.

- **Renoduodenal fistula** (Fig. 3.3): they are most frequently established with the right kidney, specifically with the infra-ampullary duodenal portion, but they can also be established with the left kidney, in this case with the duodeno-jejunal angle. The most frequent causes are inflammatory processes with pyelonephritis and perinephritic abscesses, either due to infectious causes or obstructive processes secondary to lithiasis, also due to intestinal causes, such as peptic ulcus or duodenal tumours [7].
- **Renogastric fistulas** (Fig. 3.4): they are always established with the left kidney due to their proximity. The most frequent aetiology is pyelonephritis, pyonephrosis, gastric ulcus or hydatid cyst. Few cases have been described, and they represent an essential diagnosis and therapeutic challenge.
- **Renojejunal and renoileal fistula:** the jejunum and ileum are intraperitoneal portions of the gastrointestinal tract; for this reason, these fistulas are exceptional. They occur secondary to trauma or congenital anomalies, such as ectopic kidneys.

Fig. 3.3 Renoduodenal fistula



- **Renohepatic and renobiliary fistula:** these are very exceptional fistulas, and very few cases have been described.

Depending on their aetiology, they may be urological or gastrointestinal.

- **Urological aetiology:** within pyeloenteric fistulas, the most frequent aetiology is urological. Pyonephrosis with perinephritis is the most frequent cause, described in some series as up to 80%, and lithiasis as an obstructive factor in the development of this type of fistulas, up to 65%, most commonly affecting the colon and duodenum, and to a lesser extent other parts of the gastrointestinal tract. The etiopathogenesis is related to an obstruction of the urinary tract, frequently of lithiasic cause, which provokes a hydropyonephrosis, which subsequently perforates, producing a perinephritic abscess. This abscess erodes the wall of the gastrointestinal tract and leads to the appearance of the fistula. Other less frequent causes are chronic infectious diseases such as tuberculosis, hydatidosis or actinomycosis. Congenital anomalies or renal cancer are less frequent causes; neoplasms can directly invade a neighbouring organ or provoke an obstructive process that leads to perforation with subsequent communication between two hollow organs [8].
- **Gastrointestinal aetiology:** these causes are less frequent. Cases of intestinal inflammatory processes such as diverticulitis, inflammatory bowel disease or

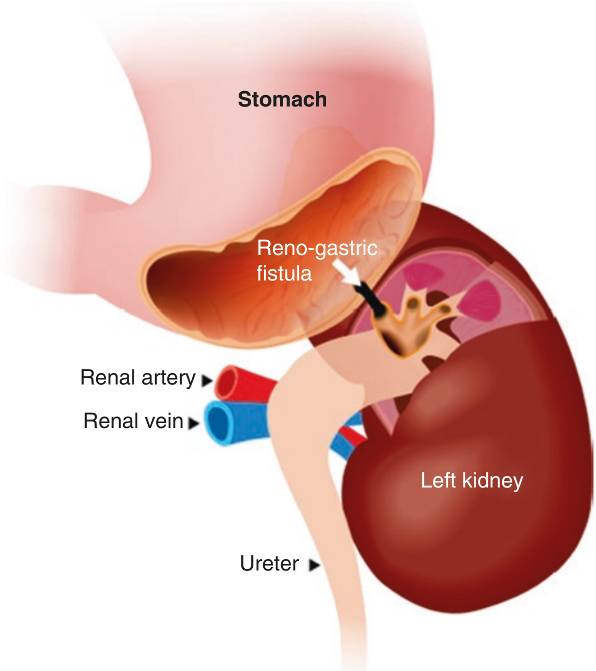


Fig. 3.4 Renogastric fistula

peptic ulcus have been described, as well as neoplasic processes or ingestion of foreign bodies.

- **Accidental etiology:** either post-traumatic, post-operative or post-irradiation.

Clinical Features, Diagnosis

There is no characteristic or specific clinical presentation for this type of fistula, which often delays diagnosis.

The clinical presentation will depend on different factors, such as the intestinal segment affected, the size of the fistula that allows the passage of urine to the gastrointestinal tract or the intestinal contents to the genitourinary tract, the existence of intraperitoneal or perirenal extravasation, the underlying renal pathology, the function of the affected kidney or presence of genitourinary tract obstruction, among others.

The evolution can be silent, or on the contrary, there can be cases of acute presentation with important symptomatology related to urosepsis.

These are usually patients with a weakened general condition as a consequence of prolonged urosepsis. The course of the disease usually annuls the functionality of the affected kidney. As a result, most of the time, the establishment of the fistula goes unnoticed.

They usually present weight loss, independently of the aetiology of the fistula.

They present signs of urosepsis, such as fever, dysuria or pyuria, together with pain in the corresponding flank. Morton’s triad may be present, consisting of lumbar pain, homolateral hip flexion and approximation of the thigh, as an antalgic posture due to irritation of the retroperitoneum [9]. They cause repeated urinary tract infections.

Once the fistula is established, the clinical features will change, with digestive symptoms predominating, depending on the intestinal area affected. Pneumaturia and fecaluria, so frequent and characteristic of vesico-intestinal fistulas, rarely appear in these fistulas since, in most cases, the affected kidney is usually non-functioning.

It is common for patients to present pain in the epigastrium, hypochondrium or flank. Nausea and vomiting, generally bilious. Hematemesis and melenas are exceptional. Watery diarrhoea with pus and urine in the stool, more frequently in renocolic fistulas. There may also be elimination of calculi from the rectum, which is very rare.

Therefore, the clinical background is very unspecific and very varied at the same time, which makes the diagnosis of these fistulas complicated on many occasions.

Regarding the diagnosis of these fistulas, it is essential to carry out a correct anamnesis since they are extremely rare situations. Therefore it will not be easy to reach the proper diagnosis and clinical suspicion is necessary. In addition, it is important to know the patient’s history, associated pathology, trauma or ingestion of foreign bodies. It is also essential to perform a physical examination to detect those signs that may be useful in the diagnosis.

It is helpful to carry out a blood test in which we can find normocytic anaemia or hypoproteinemia in the chronic course of the disease. We can also detect leukocytosis and elevation of acute-phase reactants in the case of acute urosepsis.

The appearance of hyperchloremic metabolic acidosis due to urine reabsorption is also striking. However, its appearance and intensity will depend on the functionality of the affected kidney.

A urinalysis is also valuable for detect pyuria or microscopic hematuria and a urine culture to detect the presence of enteric pathogens.

But the main tests for the diagnosis of pyeloenteric fistulas are radiological imaging.

Abdominal radiography allows us to detect the presence of radio-opaque lithiasis, but its usefulness is low for the diagnosis of the fistula. Kent’s sign, also known as pneumonephrosis, consists of air of intestinal origin outlining the renal silhouette. This is a classic radiological sign that is very rare and difficult to detect.

Intravenous urography is unused at present and has been replaced by Computed Tomography (CT). This test is of relative value since, in up to 80% of cases, the affected kidneys are non-functioning, and it does not reveal the fistulous tract.

CT is the most useful diagnostic study and should always be performed with contrast material administered intravenously. It can detect lithiasis, signs of pyelonephritis, renal abscesses, tumours or intestinal pathologies. However, on occasions in which the kidney is not functioning, it may not reveal the fistulous tract, and it is necessary to resort to another complementary test which is the anterograde or retrograde pyelography, to certify the fistulous tract, in addition to giving us important information on the location and distribution of the fistula [10]. This test is highly sensitive for detecting and defining the fistulous tract.

Other tests that can also be performed are the esophagi-gastro-duodenal transit and the barium enema, which allow us to detect fistulas and their trajectories. Endoscopic retrograde cholangiopancreatography (ERCP) is useful, particularly in biliary and pancreatic fistulas, to rule out obstruction distal to the fistula and as means of corroborating the diagnosis.

Abdominal ultrasound allows us to detect perirenal collections or abdominal masses and Magnetic Resonance Imaging (MRI), which allows us to better define the fistulous tracts due to its excellent intrinsic soft-tissue contrast and its ability to focus on any plane, are also tests used.

Treatment Approaches

The treatment is a real therapeutic challenge, as is the diagnosis. The final objective must be the resolution of the fistula and the reestablishment of the continuity of the urinary and gastrointestinal tract, which in most cases requires surgical management.

The prognostic factors depend on the underlying pathology and the treatment, almost always surgical and based on radical kidney surgery, resection of the fistula and closure of the affected gastrointestinal tract. Spontaneous closure of this type of fistula is rare. Post-surgical and post-traumatic fistulas can be considered an exception, in which an attempt must be made to close the communication and repair the affected organs, preserving their functionality [9]. In the case of iatrogenic fistulas in which the patient has good renal functionality, conservative management is used by placing a percutaneous nephrostomy or a ureteral stent, achieving closure of the fistula in up to 90% of cases [11].

Treatment is fundamentally based on three pillars: general treatment of the patient, treatment of the cause and treatment of the fistula.

The general treatment of the patient must be carried out in all situations since these are patients with systemic risk factors such as sepsis, anaemia, hypoproteinemia, renal insufficiency or presence of hydroelectrolyte disorders. All these factors influence the tissue healing process, and their resolution prior to surgery improves conditions and reduces morbidity and mortality [12].

Treatment of sepsis associated with broad-spectrum antibiotherapy is essential given the presence of digestive and urinary flora. In cases where there is an associated perirenal abscess, percutaneous drainage is sometimes used prior to definitive surgery. It is performed in stable patients and agreement with the radiology service to resolve the sepsis and improve the patient's condition for definitive treatment and successful resolution of the fistula.

On many occasions, urinary diversion by percutaneous nephrostomy is used initially to avoid maintaining the sepsis situation and to drain the infected urine to the outside.

Nutritional support, with parenteral nutrition or enteral nutrition distal to the fistula, is very useful in the management of pyeloenteric fistulas. It allows resting the gastrointestinal tract and improves the conditions prior to surgery.

It also corrects the hydroelectrolyte balances with the administration of fluid therapy. They are more frequent in upper urinary fistulas, specifically in pyeloduodenal fistulas, where hyperchloremic metabolic acidosis may be present.

Although surgical treatment is the most common treatment for this type of fistula, cases have been described in which intestinal rest, parenteral nutrition, and antibiotic therapy have been used to resolve the fistula conservatively [13].

If this is not the case, all these initial measures are fundamental for the patient to arrive in the best conditions for surgery and to reduce morbidity and mortality.

Surgical treatment is based on four fundamental pillars: excision of all fibrous-inflammatory tissue, obtaining margins of fresh friable tissue, closure of the orifices so that there is no tension between the sutures and interposition of well-vascularized tissue between the suture lines.

Treatment of the cause is necessary to solve the origin of the problem. In 90% of cases of pyeloenteric fistula, the cause is urological. Moreover, in a high percentage of patients, up to 80%, the kidney is non-functioning. This makes nephrectomy the treatment of choice in these cases.

In cases of gastrointestinal origin, such as diverticulitis, inflammatory bowel disease or colon cancer, the cause will be treated individually.

Regarding the treatment of the fistula, it will depend on its location.

In the case of renocolic fistula, the treatment of choice is nephrectomy in the case of a non-functioning kidney, in addition to excision of the fistulous tract and repair of the bowel. If the bowel is significantly affected, resection is sometimes necessary [14].

In the case of renoduodenal fistula, management is similar. Nephrectomy if the kidney is non-functioning, excision of the fistulous tract and repair of the duodenal lesion. In most cases, simple repair of the duodenal defect is sufficient. Still, on other occasions, it may be necessary to resort to more complex surgical techniques, such as using a defunctionalized bowel loop [15].

In renogastric fistula, nephrectomy and primary closure of the gastric defect is performed. In the renojejunal and renoileal fistulas, the intestinal defect is resolved either by primary suture, termino-terminal anastomosis or bowel resection. Renopancreatic fistulas require immediate urinary diversion since pancreatic enzymes are activated when they establish contact with urine and produce tissue autolysis.

Conclusions and Recommendations

Pyeloenteric fistulas are a rare entity of difficult diagnosis and treatment. Their aetiology is mainly urinary and less frequently digestive. Anatomically they involve the renal pelvis and the gastrointestinal tract. The most frequent are renocolic, followed by renoduodenal. The primary aetiology is infectious followed by iatrogenic given the increase in percutaneous procedures and post-traumatic. The clinical presentation is usually silent and sometimes associated with a septic picture or gastrointestinal symptoms. Therefore, it is essential to suspect it to establish a correct diagnosis as quickly as possible. The most useful complementary tests are CT and anterograde or retrograde pyelography. The initial treatment consists of stabilizing the patient through antibiotherapy, nutritional and hydroelectrolytic support and percutaneous nephrostomy when necessary. In most cases, the definitive treatment is surgical by nephrectomy, excision of the fistulous tract and repair of the affected gastrointestinal segment. Conservative management of iatrogenic fistulas can be considered by percutaneous nephrostomy with high success in most patients.

Dealing with pyeloenteric fistulas is an important diagnostic and therapeutic challenge for specialists that requires a multidisciplinary approach with urologists, general surgeons and radiologists, among others. It is essential to suspect it in order to diagnose it. In its management, it is essential to individualize cases according to the aetiology, the patient's baseline condition and the functionality of the kidney in order to carry out the best approach for each particular patient.

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Chapter 4
Nephropleural Fistula

Kian Asanad, Charles F. Polotti, and Gerhard Fuchs

Abbreviations

NPF	Nephropleural fistula
CT	Computed tomography

Definition, Specific Considerations, Classification

Nephropleural fistula (NPF) refers to an abnormal communication between the kidney and the thoracic cavity, specifically the renal parenchyma or collecting system and the pleural space. NPF may occur as a result of recurrent or severe kidney infections such as renal abscesses, xanthrogranulomatous pyelonephritis [1], tuberculosis [2], trauma, or kidney stone disease. NPF is uncommon; however, when it occurs it is generally seen as a rare iatrogenic complication of percutaneous renal access for stone disease, particularly in those with supracostal access.

There are few data on the incidence of NPF formation, although published estimates range between 0.08% and 1.4% among patients who underwent percutaneous nephrolithotomy with a supracostal approach [3–5]. Lallas et al. demonstrated in a retrospective review of 375 patients who underwent supracostal percutaneous renal surgery

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between 1993 and 2001, the overall incidence of NPF was 0.87% (4/462 percutaneous tracts), which increased to 3.3% (4/120 percutaneous tracts) when limiting to only those who underwent supracostal access [5]. Similarly, in a separate critical analysis of 300 supracostal access tracts, only 2 patients in this series developed a NPF [4].

Risk factors for pleural injury and subsequent NPF after percutaneous renal surgery include younger age (mean age <27 years) and lower body mass index likely due to a lack of significant perirenal fat. In a large prospective comparative study of 332 patients, patients who developed a pleural injury after percutaneous nephrolithotomy were younger (27.00 ± 11.18 vs. 37.06 ± 15.03, p = 0.03), had a lower body mass index (18.0 ± 1.90 vs. 21.12 ± 2.24, p = 0.002) and were right-sided renal surgeries [4.0% vs. 1.8%, p = 0.001) [6]. There was no association with stone surface area, hydronephrosis, or operative time. On multivariable analysis, only age and body mass index were significant predictors of pleural injury.

Clinical Features and Diagnosis

NPF may be classified as immediate or delayed. An immediate NPF is diagnosed intra-operatively with either direct visualization of pulmonary parenchyma during nephroscopy, urinary extravasation into the pleural space during antegrade nephrostography, or immediate post-operative plain-film radiography demonstrating a pleural effusion or hydrothorax. Delayed NPF may present as shortness of breath, tachypnea, cough, urine-like taste in the mouth, flank pain, or constitutional symptoms such as fevers and chills.

A delayed NPF should be suspected in any patient who presents with shortness of breath after percutaneous nephrolithotomy with plain films demonstrating a pleural effusion. Diagnosis can be made with contrast-enhanced computed tomography (CT) with delayed films demonstrating extravasation of urine into the pleural space and cystoscopy and retrograde and/or antegrade pyelography (Fig. 4.1), or diagnostic thoracentesis with examination of pleural fluid for creatinine.

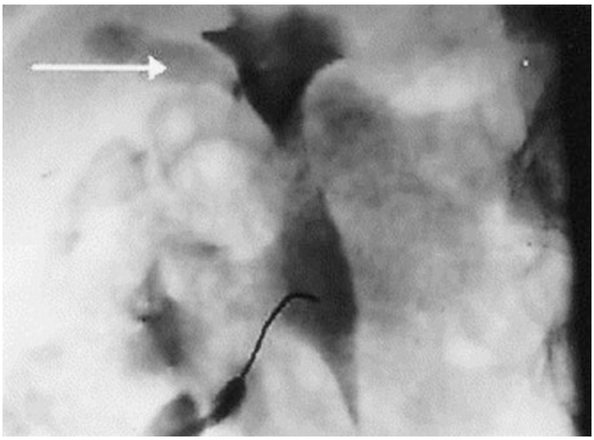

Fig. 4.1 Nephrostogram demonstrating fistulous communication between collecting system and pleura. White arrow indicates fistula. (Adapted from Lallas et al. Approved for use by Elsevier Copyright Clearance)

Treatment Approaches

Management of NPF can generally be accomplished non-operatively. Treatment of NPF typically involves thoracentesis with or without tube thoracostomy and urinary tract diversion with ureteral stenting and bladder catheter drainage. Thoracentesis should be considered as first-line treatment for urgent and symptomatic cases. Thoracic Surgery should be consulted for co-management of the pleural effusion. Mild pleural effusions may be managed with serial thoracenteses alone [7], while more severe cases with persistent effusions despite chest tube placement may require video-assisted thoracoscopy and decortication [5]. Antibiotics should be administered for concurrent urinary tract infections. It is imperative to evaluate for distal urinary obstruction and if present, this would be treated or bypassed. Urinary tract diversion should be accomplished with ureteral stenting and bladder catheter drainage. This method is preferred to percutaneous nephrostomy tube placement to prevent another possible cutaneous fistula from the urinary tract. Nutritional status of the patient should be optimized to promote wound healing and closure. Nephrectomy is indicated in cases of poor renal function as definitive management.

Prevention

Several strategies outlined here should be used to help prevent formation of NPF. Firstly, proper pre-operative imaging for anatomical evaluation, namely CT, especially for stones where the surgeon considers upper pole percutaneous renal access. Second, one should consider use of ultrasound-guidance in addition to fluoroscopy if there is any concern or evidence for aberrant anatomy due to prior renal surgery. In cases with complex upper pole stone burden, especially with prior history of percutaneous renal access, one should consider CT-guided renal access as well. Third, perioperative management of infection is critical. Fourth, adequate drainage of the collecting system at the time of nephrostomy tube removal is necessary to prevent delayed NPF such as in cases of a tiny or subclinical fistula secondary to pleural irritation after upper pole percutaneous renal access that would otherwise normally not be a concern.

Conclusions and Recommendations

NPF is rare and most often seen after supracostal percutaneous renal access. Diagnosis of NPF should be suspected in any patient presenting with respiratory symptoms after percutaneous nephrolithotomy and chest plain films demonstrating a pleural effusion. Management should include consultation with Thoracic Surgery. Most cases may be successfully managed with thoracentesis with or without tube thoracostomy and urinary tract diversion with ureteral stenting and bladder catheter drainage.Conflicts of InterestNone.

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Chapter 5
Ureterocolonic Fistula

Nicholas Serniak and Christine Hsieh

Abbreviations

CT	Computed tomography
NSQIP	National Surgical Quality Improvement Program
UCF	Ureterocolonic fistula

Introduction

Ureterocolonic fistula (UCF) is a rare entity that poses a diagnostic challenge, and is often recognized well after the inciting incident occurs. A UCF is formed when, by virtue of an iatrogenic insult, inflammatory process, malignancy, or a combination of such factors, the colon fuses to the ureteral tube causing communication between the two structures (Fig. 5.1). This most commonly results in bacterial contamination of the urinary tract. Due to its rarity, management is tailored to the patient's particular circumstances, using the few published case reports and fundamental surgical principles to guide therapy and intervention.

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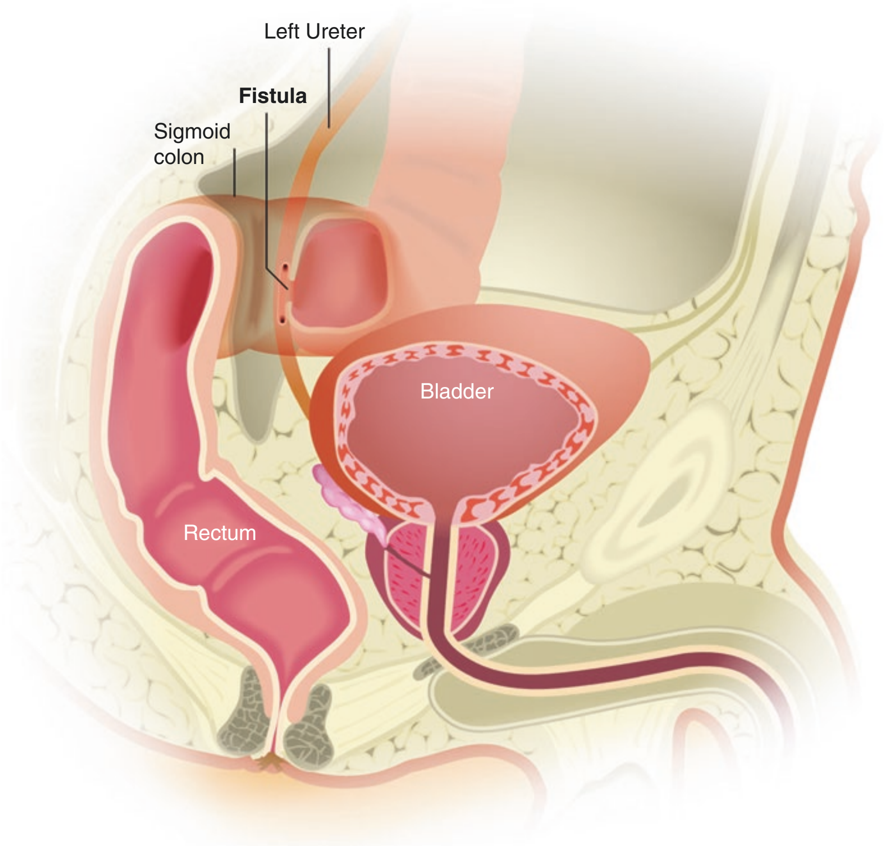

Fig. 5.1 Anatomic relationship of bladder, ureter, and sigmoid colon

Etiology

Iatrogenic injury to the ureter is commonly cited as the cause of eventual UCF formation. Ureteral injury is a dreaded complication of pelvic surgery, well-described in the colorectal, urologic, and gynecologic literature. Fortunately, this is a relatively rare occurrence. A review of laparoscopic gynecologic pelvic surgery showed an incidence of ureteral injury as less than 2% [1], with only 8.6% of those ureteral injuries were diagnosed at the time of the index surgery. In one review of the National Surgical Quality Improvement Program (NSQIP) data for laparoscopic colectomy, the authors found that intraoperative identification of ureteral injury occurred in only 0.6% of cases [2]. Most ureteral injuries are identified in the postoperative setting, ranging from 40% cited in colorectal literature to as high as 70% for laparoscopic gynecologic surgery. Of these injuries, few progress to or are eventually recognized as UCF.

In recent years, UCF is described with increasing frequency after procedures on the colon, urinary tract, and pelvic reproductive organs, concurrent with the rising popularity of minimally invasive pelvic surgery and ureteroscopic interventions [3, 4]. One explanation for delayed presentation and thus delayed diagnosis of ureteral injury is related to the mechanism of action, and this is thought to contribute to the subsequent development of UCF. Usage of energy devices in the vicinity of the ureter may cause a thermal injury which then evolves into full-thickness damage as coagulative necrosis progresses [3]. Devascularization and ischemia has also been postulated as a cause of UCF [4]. Because this process takes time, intraoperative imaging and investigations will not reliably identify the areas at risk. The resulting inflammatory or infectious process can then lead to development of a fistula.

Aside from iatrogenic insult, spontaneous UCF development is most commonly attributed to urinary calculus impaction causing pyelonephritis and obstruction [5] or as a secondary injury related to nearby inflammatory processes. Several case reports describe formation of UCF in patients with diverticulitis [3]. The formation of UCF is presumed to be related to inflammation of colonic diverticula directly overlying the retroperitoneum and left ureter [6]. As of 2019, there have been less than 20 case reports of UCF as a result of diverticulitis [3].

Other processes have been implicated in the formation of UCF. These include endometriosis, Crohn's disease, radiation injury, and malignancy [7]. Decades ago, tuberculosis was a commonly referenced etiology of UCF, but that drastically diminished with better control and treatment of the disease [8, 9]. Overall, these other etiologies remain rare occurrences compared to the increasingly described iatrogenic UCFs.

Diagnosis

Due to its rarity and oftentimes non-specific complaints, the diagnosis of a UCF can be delayed for weeks, months or even years. Signs and symptoms include frequent genitourinary infections, fecaluria or pneumaturia, or vague abdominopelvic or flank pain. A urinalysis may reveal pyuria or bacteriuria.

UCF can be identified on fluoroscopic imaging with radiopaque contrast material to highlight the relevant structures. Both contrast enema and retrograde cystourethrography have been described as effective diagnostic tools in the work-up of UCF. Instillation of contrast via the rectum under pressure may cause extravasation of the material into the fistulous tract, followed by opacification of the ureter [9] (Fig. 5.2). Similarly, retrograde cystourethrography may allow for delineation of a fistula tract and visualization of abnormal contrast filling [10, 11].

As UCFs are rarely considered at the top of a differential diagnosis for urinary complaints or vague abdominopelvic pain, it is not uncommon that cross-sectional imaging is obtained first in the form of a computed tomography (CT). Although the discrete tract may not be identifiable with CT, it does offer the benefit of tracing the path of the colon and examining it for potential involvement with the ureter. A

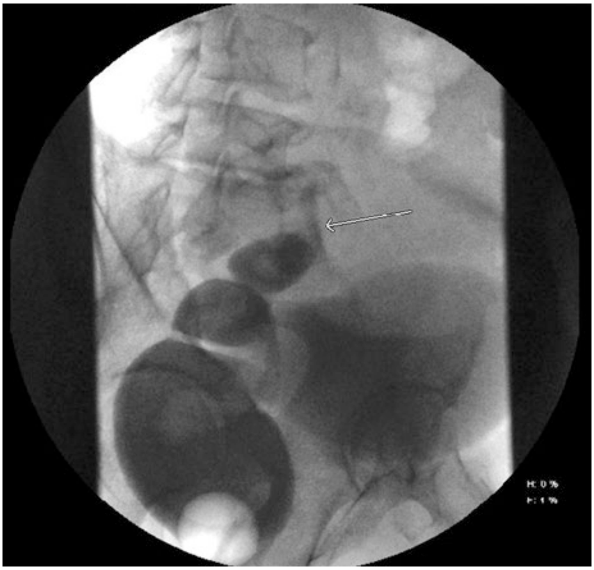

Fig. 5.2 Contrast enema showing opacification of the adjacent left ureter

finding of pneumo-ureter can lead to contrast-enhanced radiographic studies that will then better delineate the fistula anatomy [10]. A CT urogram is one such study where the protocol can be manipulated to achieve opacification of the ureters and search for extravasation into the colonic lumen [9]. Due to the rarity of UCF, there is no published literature directly comparing CT urogram to contrast enema.

Ultrasound has a limited role for the diagnosis of UCF. This modality has the potential to identify calculi or hydroureter; two entities associated with UCF than can further direct the workup in the appropriate clinical setting.

Management

Management of UCFs is largely surgical [12]. Although there has been a documented case of spontaneous fistula closure after fecal stream diversion [13], this is by far the exception to the rule. Definitive management should follow fundamental surgical principles, with excision of the affected colonic segment, and careful manipulation of the urinary system. If there is functional compromise or chronic infection of the ipsilateral kidney, concurrent nephroureterectomy may be indicated. Otherwise, with the diseased colon and ureter resected, the decision to reconstruct both systems, and the techniques employed, should be made based on the patient's individual characteristics.

The most common surgical intervention, by virtue of the colon and its relationship to the ureter, is a sigmoid colectomy coupled with retrograde ureteral stenting. If the fistula exists elsewhere, a segmental colectomy of that affected region is performed in the usual fashion (Fig. 5.3). If possible, any anastomosis should be constructed away from the resection bed to limit the possibility for fistula recurrence.

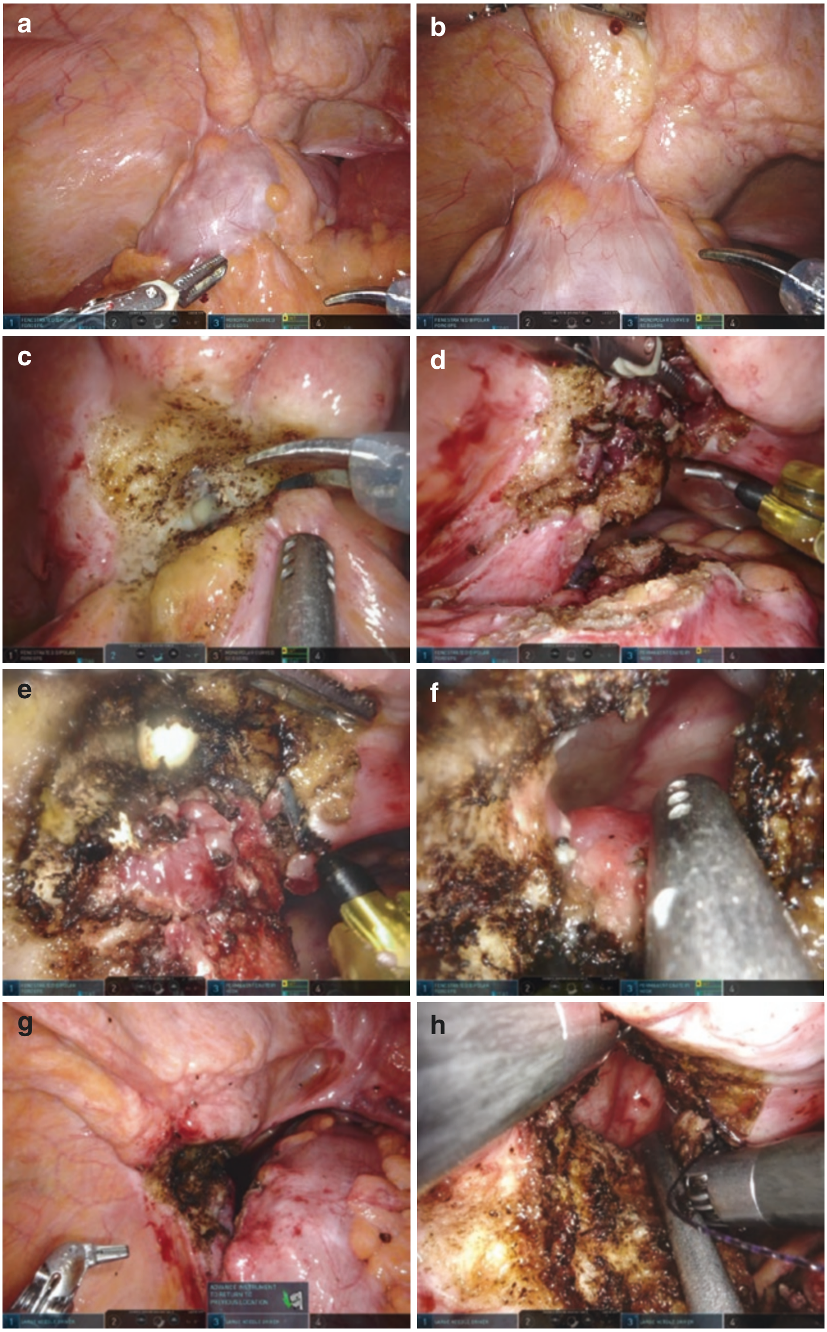

Fig. 5.3 Intraoperative assessment and dissection of UCF, (**a**) Sigmoid colon adherent to lateral sidewall. (**b**) UCF site close up. (**c**) Dissection of UCF with opening of chronic abscess cavity. (**d**) Colon fully mobilized off ureter and abscess cavity debrided. (**e**). Ureteral stent visible in opened abscess cavity. (**f**) Examination of significantly dilated ureter. (**g**) Fully mobilized colon and debrided abscess cavity. (**h**) Closure of ureteral defect

Omental or retroperitoneal fat can be used as a buttress over the ureteral side of the resection bed.

Minimally invasive radiologic techniques to divert the urinary stream may reduce infectious sequelae, and potentially allow for spontaneous closure without directly addressing the fistula site itself. In one series of 25 patients with uretero-enteric fistulas, utilization of percutaneous nephrostomy and double “J” stent allowed for closure of 8 uretero-enteric fistulas over the course of 7–16 weeks [4]. The carefully selected patients included in the study had heterogenous fistula types and etiologies, so the results are not generalizable. However, the authors did demonstrate some success employing interventional radiology techniques across a range of pathologies.

For cases that seem to arise from more esoteric origins, a multi-disciplinary discussion should be convened to assess optimal treatment strategy.

Conclusion

Ureterocolic fistulas are a rare entity. Our understanding and management of this is based largely on experience documented in case reports. In recent years, the number of case reports has increased along with the rise in popularity and prevalence of minimally invasive urologic, colonic and pelvic procedures. This may be related to usage of energy devices in close proximity to the ureter, causing iatrogenic delayed thermal injury and inflammation which subsequently develops into a fistula tract. Therefore, judicious application of energy when operating in the retroperitoneum should be practiced. A high index of suspicion should be maintained when evaluating patients with vague symptoms and chronic urinary tract infections in the post-operative setting, or for those patients who have such symptoms in the setting of recurrent, relapsing, or chronic illness related to diverticulitis and urolithiasis. Management of UCF should then be tailored to the patient’s particular circumstances, with definitive management requiring careful surgical planning and discussion of preservation and reconstruction of the enteric and urinary tracts.

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Chapter 6
Colovesical and Small Bowel Fistulas

Erik R. Noren and Kyle G. Cologne

Background

Colovesical fistula is a communication between a portion of the large intestine and the bladder. It is a problem that almost always requires surgical intervention to repair. Presenting symptoms and signs include recurrent urinary tract infections, pneumaturia, fecaluria or air within the bladder (without prior instrumentation) on cross sectional imaging. Common etiologies include diverticular disease, cancer, complications from prior surgery, and inflammatory bowel disease. Understanding the disease process is important, as each are approached slightly differently. This chapter will outline the diagnosis and management of colovesical fistula, and will include a variety of technical considerations in the surgical management of this disease process.

Etiology

More often than not, the colon is the site of origin for colovesical fistulas (compared to the bladder). While it is possible for bladder tumors to directly invade the colon and cause a fistula, it is much more common for colon pathologies to find their way to the bladder. This is important in deciding how to repair the fistulas, as if there is no disease within the bladder, a simple repair or extended duration urinary catheter may suffice to heal the bladder side of the fistula. The potential etiologies are discussed individually below. The mean age of presentation is 55–65 years, in part because the disease processes that cause these fistulas affect older adults [1].

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Diverticulitis

Perhaps the most common cause of colovesical fistula is sigmoid diverticulitis. Diverticula are false diverticula or outpouchings that form in weaker areas of the colon wall, usually where the vasa recta penetrate through the muscle layers from the mesentery. As a result, diverticula form on the anti-mesenteric side of the colon wall. A western diet and obesity are the principle risk factors for formation of these diverticula, with an incidence of 40% by the age of 60 and over 60% by age 80. The incidence has also been increasing over time [2, 3] and there is some suggestion there may also be a genetic predisposition [4].

If one of these diverticula becomes infected, diverticulitis results. It is this acute infection that has the potential to form a pericolonic or pelvic abscess, which may subsequently erode into adjacent organs such as the bladder. While uncommon overall (colovesical fistula is found in 3–4% of patients undergoing surgery for diverticulitis) [5, 6], the close proximity of the bladder to the sigmoid colon makes it an easy target for perforated diverticulitis with an abscess to erode through the bladder wall. In fact, when a fistula occurs, it involves the bladder 65% of the time, with less common organs involving the vagina, the appendix, other loop of bowel, the uterus or fallopian tubes or the skin [7]. In Asian countries, right sided diverticulosis may be more common (with up to 70% of cases involving this side) [8, 9], which may make fistula to the bladder less likely. Similarly, female patients who have not had a hysterectomy have relative protection against formation of a colovesical fistula. While a redundant sigmoid that flops over the uterus can still create a fistula, these are more common in men who do not have a protective organ blocking access to the bladder. As a result, colovesical fistulas are 2–3 times more common in men [10].

The degree of inflammation associated with perforated diverticulitis can be significant. Acute operative exploration of these patients often reveals dense fibrotic reactions that are some of the most difficult procedures a surgeon can be called upon to perform. Diverticulitis is also a spectrum of disease. Some patients have no prior acute attack of diverticulitis they can recall, and instead have a subclinical attack and initially present with a fistula. If a surgeon is forced to operate before a definitive diagnosis is obtained, these can mimic the degree of desmoplastic reaction seen in an aggressive cancer. It is important to differentiate these diagnoses. While a finger fracture technique to separate organs is appropriate (and in fact the main technique) in diverticulitis, it is not appropriate for cancer cases, where an en bloc resection should be performed (if possible).

Cancer

Colorectal, gynecologic, and bladder malignancies can be locally invasive and result in fistulas from the colon to the bladder. Cancer causes between 10–20% of all colovesical fistulas [11]. As these cancers grow, they directly invade adjacent organs. Fistulas can also occur as tumor shrinkage and necrosis occurs during cancer treatments, leaving a void which was once filled by viable tumor cells. Unlike other etiologies, the treatment of cancer fistulas requires an en bloc resection of all involved organs, if possible. This may mean a partial or even total cystectomy, depending on the degree of involvement, and ability to obtain negative margins. It is often difficult to determine intraop the difference between a desmoplastic reaction and invasive cancer, so a wide excision should be performed when surgery is performed with curative intent. The use of adjuvant or neoadjuvant therapies should be considered as part of a multidisciplinary process in borderline resectable cases.

Inflammatory Bowel Disease

Inflammatory bowel disease (in particular Crohn's disease) has the ability to form fistulas anywhere in the body. Crohn's disease is a chronic inflammatory process that involves the full thickness of the bowel wall and mesentery. There are several disease types including inflammatory, fibrostenotic and stricturing, and possible multiple foci of disease within the bowel (small bowel, ileocolic, colonic, perianal). Only a small percentage of these will go on to develop fistula to the bladder. Ileocolic fistulas are probably the most common, in part because that is the most common site of disease overall.

A unique aspect of fistulas caused by Crohn's is that initial treatment can be nonsurgical. Between 13% and 69% of fistulas close with medical treatment using infliximab (an anti-tumor necrosis factor monoclonal antibody), though the success rates are somewhat lower for intra-abdominal fistula compared with perianal locations [12, 13]. Because of the potential surgical morbidity as well as potential for recurrent disease, an initial attempt at treatment of these fistulas with aggressive medical management of the inflammatory process is often warranted. Overall, fistulas account for 15–24% of surgeries performed for Crohn's disease [14, 15].

Complications from Prior Surgery

Colonic stent perforations, anastomotic leaks from bowel surgery, and injuries during a procedure on an adjacent organ (e.g. hysterectomy) can also cause colovesical fistulas. While some of these can be diagnosed at the time of surgery, many may present in the perioperative period with classic symptoms of pneumaturia, fecaluria or recurrent UTI. A high index of suspicion is required to diagnose these complications.

Radiation

Radiation deserves special mention as it makes any attempt at surgical repair of fistulas exponentially more complex. Prior radiation may be given for a variety of disease processes, including gynecologic or testicular malignancy, prostate cancer, or other diagnoses. It is important to get this information during the history and physical. While radiation is very good at killing cancer cells, it also damages normal surrounding tissues. It may be many years after radiation that a patient develops a different disease process that results in a colovesical fistula. However, if the fistula is in the prior radiation field, there becomes a much higher chance of failure with any attempt at surgical repair.

Other

Other causes of colovesical fistula are exceedingly rare and include tuberculosis, lymphoma, foreign body perforations, penetrating abdominal trauma, and appendicitis.

Diagnosis

Clinical Symptoms

Classic symptoms of a colovesical fistula arise from passage of material across the fistula, most commonly from a high pressure (colon) side to a low pressure (bladder) side. This results in pneumaturia (can be even with small fistulas) or fecaluria (with larger fistula sizes), one of which is present in over 90% of patients with a colovesical fistula [16]. Recurrent UTI's may result from colonic bacteria entering the urinary system via the fistula. While it is possible for urine to pass into the rectum, this is rare, and may be more common with lower fistulas (e.g. rectovesical fistulas or those arising from post-cystectomy complications, which is beyond the scope of this chapter).

Additional symptoms may arise from the underlying etiology, such as abdominal pain or fever with diverticulitis, crampy abdominal pain and diarrhea with Crohn's, and rectal bleeding with colorectal cancer.

Physical examination is often unremarkable, and again may be more related to the underlying diagnosis. While patients with an evolving colovesical fistula that still have an abscess may have left lower quadrant or suprapubic pain, there is often minimal tenderness associated with the fistula itself, once it has formed. Once the diagnosis of colovesical fistula is made, additional workup is designed to sort out the underlying etiology, as well as identify the location of the fistula. It is sometimes difficult to differentiate between colovesical, colovaginal, and rectovaginal fistulas large enough to cause passage of feces. A thorough history can help differentiate these with some clues as outlined above.

Laboratory Evaluation

Labs can help confirm the diagnosis. A urinalysis and culture will usually be positive, though there may be times where it is falsely negative, particularly if drawn after a course of antibiotics. Cultures usually grow mixed enteric flora, though previous antibiotic treatment may suppress these results. E. coli is found in up to 81% of cultures, due to its prevalence within the lower GI tract [17]. Other lab values are non-specific and may not be particularly useful to make a diagnosis (such as creatinine, white blood cell counts, C-reactive protein, etc.).

Imaging

Once a fistula is diagnosed based on symptoms, cross sectional imaging (such as a CT scan of the abdomen and pelvis with intravenous contrast) can be extremely insightful. It can confirm the diagnosis if air is seen within the bladder, provided there is no prior instrumentation of the urinary tract, such as recent urinary catheter placement or removal. Air within the bladder under these circumstances is pathognomonic for a colovesical fistula (Fig. 6.1). Cross sectional imaging can also give

Fig. 6.1 Sagittal CT image demonstrating sigmoid diverticulosis and colovesical fistula with characteristic gas within the bladder lumen

clues as to the underlying etiology, such as a thickened sigmoid with multiple diverticula in the case of diverticulitis, or an inflamed, hyperenhancing terminal ileum and cecum with significant fat stranding and bowel loop separation from mesenteric thickening in the case of Crohn's disease (Fig. 6.2). Cancer can be more difficult to diagnose, though on some instances a mass can be identified in one of the pelvic organs that points to a diagnosis or organ system.

If there remains doubt about where or whether a fistula is located, a CT scan with rectal contrast, a water soluble contrast enema, and/or cystogram can be useful in identifying the location. However, these are not required adjuncts in the majority of cases.

Endoscopy

Endoscopic evaluation of the lower GI tract with a colonoscopy, or at minimum a flexible sigmoidoscopy is critical to determine the location and etiology of a fistula. Often, the fistula itself is small and difficult to definitively identify. However, the surrounding area of colon must be evaluated to exclude malignancy. Multiple diverticula and thickened folds (with or without erythema suggestive of diverticular colitis) suggests diverticulitis, whereas marked erythema, loss of vascularity and lead-piping of the intestine can suggest inflammatory bowel disease. Abnormal areas should be photographed and biopsied, to help obtain a histologic diagnosis as well. If the endoscopic examination is normal, additional testing is warranted to determine possible etiologies.

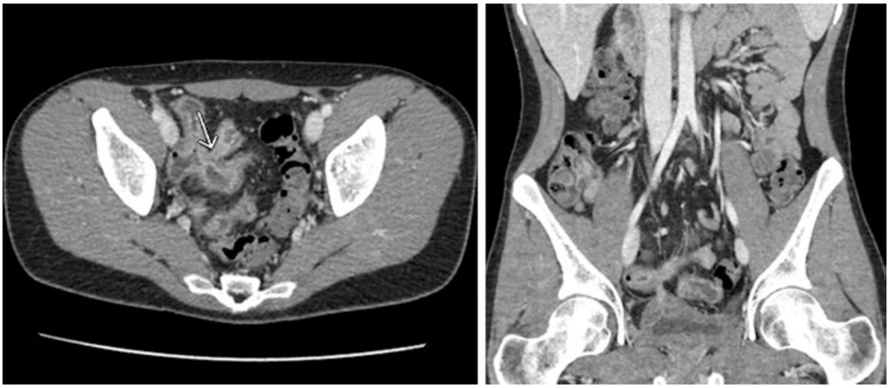

Fig. 6.2 Axial & Coronal CT images demonstrating Crohn's disease associated enterovesical fistula. Note terminal ileitis, stricture and entero-enteric fistula on axial views

Cystoscopy

Cystoscopy is not typically required, though if a patient is referred to a Urologist because of symptoms, that may be the first test performed. In most cases of colovesical fistula, the pathology is on the colon side, revealing normal cystoscopy, or there may be a small opening identified. When identified, it is important to note the location of the fistula opening—as dome fistulas are much easier to treat than those located in the trigone. Also, if there is any suggestion of more diffuse bladder wall thickening or bladder mass, gross hematuria, or any other suspicion for bladder cancer, particularly in a patient with a significant smoking history, cystoscopy is indicated. Finally, in cases where the course of the ureter is uncertain, or abuts an area of inflamed colon, a cystoscopy can be performed intraoperatively along with ureteral stent placement, where the bladder side of the fistula can be evaluated. It can also be performed after repair of a colovesical fistula, to confirm technical success of closure of the bladder side of the fistula, which may be advisable in a radiated field.

MRI

Magnetic Resonance Imaging may have a role in select cases. If the location of the fistula cannot be determined, and there is a suspicion of a possible rectovaginal or other location of the fistula tract, MRI may help better identify the fistula, particularly when done using a protocol to look for areas of inflammation. T2 images and or STIR (short inversion time inversion recovery) sequences can be particularly helpful. Additionally, MRI may be used in Crohn's disease as an enterrography to identify other areas of bowel involvement.

Other

In cases where endometrial or other cancer is suspected, a pelvic ultrasound, hysteroscopy or a pelvic exam under anesthesia can help identify other causes of fistula, such as rectovaginal or other locations which can be confused with colovesical fistula in some instances.

Management

Surgery is required for definitive treatment of colovesical fistula in the vast majority of cases (except possibly for inflammatory bowel disease which responds to medical treatment). These operations are most optimally undertaken in the elective setting after any infectious complications at presentation are successfully treated. The surgeon should avoid operating in an acutely inflamed setting (if possible) and should have a good understanding of the diagnosis and relevant anatomy before proceeding to the operating room.

Role for Antibiotics

The simple presence of colovesical fistula is not an indication for antibiotics. There are, however, specific patient factors, such as immunocompromise or ongoing chemotherapy, that when present may make suppressive antibiotic treatment beneficial in order to prevent sepsis due to a urinary tract infection. In cases of frequently recurrent urinary tract infections, suppressive antibiotics may also be considered while awaiting definitive surgery, particularly if hospitalization or previous sepsis has occurred.

In cases where there is abscess formation associated with the fistula, antibiotics targeted at enteric flora should be administered with or without percutaneous image-guided drainage (usually indicated for abscess size >3–4 cm) [18]. Common antibiotic regimens may utilize a third-generation cephalosporin or fluoroquinolone in combination with metronidazole or alternatively piperacillin/tazobactam. Pericolonic and pelvic abscesses should be evaluated for possible percutaneous drainage [19]. Intramural abscesses that form within the wall of the colon or bladder are not amenable to drainage and are treated with antibiotics.

Surgical Technique

The surgical repair of colovesical fistula is simple in principle, but in practice it can often present remarkable technical challenges. As outlined above, the principle is to remove the diseased organ (usually the colon) and in doing so obliterate the fistula. If the bladder is the site of origin, or if cancer is present, a wider excision field is required, with repair/reconstruction of both the colon and the bladder. In cases where the bladder is normal, often no repair is needed.

The patient is placed in the lithotomy position and a Foley catheter is inserted. It is useful to do this after sterile prep, which allows ongoing access to the urinary system in case cystoscopy or instillation of dye into the bladder is required during the operation to identify or test a site of fistula closure.

The fundamental elements of the procedure, when performed for benign disease, include careful dissection to separate the colon off the bladder with division of the fistulous tract between them. This maneuver can be performed sharply, with monopolar cautery or an advanced energy device. Quite often the most effective technique, particularly if there is extensive inflammation is to use a blunt "finger-fracture" technique. In minimally invasive (laparoscopic or robotic) approaches, this can be used with the suction irrigator. Blunt separation is followed by resection of the inciting diseased segment of colon and primary anastomosis if the patient status and tissue quality are safe to do so. Identification of the left ureter is paramount before any bowel or vessel ligation is performed, in order to protect this structure. Depending on the disease process, a medial to lateral dissection may actually facilitate identification of this structure, as the fistula tends to involve the serosa. Dissection under the mesentery is often free of the intense fibrosis that is seen surrounding the fistula. However, the surgeon must be prepared to adapt to the environment, and multiple approaches may be necessary. If the ureter cannot be identified, a cystoscopy and ureteral stent, injection of indocyanine green (with robotic approaches), and/or conversion to open techniques may be required.

In cases of diverticular disease, the segment that includes the fistula and must be resected most often is the sigmoid colon. The extent of proximal resection is determined by identification of the transition to healthy, non-inflamed (soft) proximal colon, usually somewhere in the descending colon. The distal extent of resection should be the rectosigmoid junction, as marked by the splaying and disappearance of the taenia. Leaving remnant distal sigmoid colon will increase the risk for recurrent diverticulitis down the road and possible recurrent fistula. While a high ligation of the mesentery close to the origin of the feeding vascular pedicle is not always required, it may be helpful to create an anastomosis. If a large portion of mesentery is left in situ, and this is divided close to the bowel wall, it creates a “speed bump” that may make a tension free anastomosis difficult. If otherwise safe to do, and when the ureter can be clearly identified, the authors prefer to do a cancer-type resection, not because adequate lymph node yield is required, but because it makes the technical aspects of an anastomosis easier, particularly in obese patients.

In cases of Crohn’s disease, all inflamed, diseased segments should be resected back to grossly normal bowel. The serosa in addition to the mesentery can be markedly inflamed. One must be prepared to have multiple methods available to control bleeding from what can be a very dangerous mesentery, where significant blood loss can occur very quickly if the surgeon does not proceed with caution. There is often a stricture in addition to an abscess, multiple areas of bowel involvement, and concurrent malnutrition. The surgeon must be mindful of these complex cases and have a strategic plan prior to going to the operating room. In cases where there is extensive colonic involvement (but rectal sparing), a total colectomy may be required. Otherwise, if more limited involvement occurs, a segmental (such as ileocolic resection) is possible, provided the remaining ends of bowel are without disease or inflammation.

Following dissection of the colon off the bladder, a definitive fistula tract is frequently not visualized, as the opening itself is often small. In these cases, formal repair of the bladder is not routinely necessary, and decompression with an indwelling catheter to allow the bladder wall to heal is adequate. If a defect or obvious fistula tube is present and identified, it is repaired by resecting a small area to get back to healthy tissue. The bladder can then be repaired in 2 layers with absorbable suture. When there is doubt concerning the presence of a bladder defect or the integrity of the repair, a bladder leak test can be performed by filling the bladder with methylene blue dyed saline using the previously placed Foley catheter. Prior to abdominal closure, in higher risk cases, the surgeon may choose to place a closed suction drain in the pelvis adjacent to the bowel anastomosis and bladder and mobilize of an omental flap to interpose between the colon and bladder, though these additional steps are not always required.

Proximal fecal diversion with stoma creation is not routinely required when performing surgery for colovesical fistula. However, ileostomy creation for fecal diversion may be considered in cases where there is elevated risk for anastomotic leak. The presence of a large abscess with extensive inflammation, prior pelvic radiation, malnutrition with weight loss, chronic corticosteroid use, and poor quality tissue at the site of anastomosis are factors that increase the risk for leak and primary anastomosis with diverting stoma should be considered in such cases. If surgery is performed in the emergent setting, particularly in the presence of sepsis or hemodynamic instability, creation of an end colostomy is preferred over anastomosis, particularly if there is a size mismatch between ends of the bowel for an anastomosis, marked fecal contamination, or a hemodynamically unstable patient.

Malignant Fistula

There are special considerations when approaching surgery for malignant colovesical fistula that deserve particular attention. After undergoing appropriate staging, cancer cases with locally advanced disease should be reviewed at a multidisciplinary tumor board to determine if there is a role for neoadjuvant therapy (as this may convert borderline resectable disease to potentially curative resections [20, 21]. In cases where a course of neoadjuvant therapy is to be administered, we will often recommend pre-treatment fecal diversion to reduce the risk of treatment interruption by recurrent urinary tract infections.

Malignant fistulas must be resected en-block with the originating organ and the secondarily invaded organ along with an appropriate lymph node harvest. If the malignant fistula is of colorectal origin, it is often possible to perform a partial cystectomy as long as the trigone of the bladder is uninvolved. In cases of fistula due to locally invasive bladder cancer, radical cystectomy is performed with partial colectomy. The surgical plan in each individual case is determined by specialist consultation between the urologist and colorectal surgeon. The principle goal is to obtain an R0 resection. Frozen sections can be a useful adjunct, though if there is a large desmoplastic reaction, these can be unreliable. As much as possible, the extent of resection should be planned prior to surgery based on previous involvement of abnormal imaging done preoperatively. The principles of ureter identification and safe construction of an anastomosis are the same as with diverticular disease. With colon cancers, an extra step is to ensure adequate lymph node harvest. In sigmoid colon cancers, this requires at minimum resection of the superior rectal artery, at the junction with the left colic. For right sided tumors that have invaded into the bladder, the ileocolic pedicle must be resected at the origin off the superior mesenteric artery. Additional vessels can be taken with the specimen as needed, and it is critical to document this information in the operative report.

Small Bowel Enterovesical Fistula

The approach to management of fistulas between the small bowel and bladder is primarily dependent on the inciting etiology. Crohn's disease is the most common cause of small bowel enterovesical fistula, specifically involving the terminal ileum in most cases [22]. As previously discussed, it is important to have a high index of suspicion and investigate the possibility of Crohn's disease because medical treatment with Anti-TNF agents is often successful. Surgical management is best reserved for patients with perforation, high grade fibrostenotic stricture, disease refractory to optimal medical therapy, inability to wean steroids or in patients unable to tolerate optimal medical therapy [23].

When surgery is to be performed for small bowel enterocutaneous fistula the approach to surgery is similar to that described for diverticular disease. The bladder itself is not involved in the disease process and therefore aggressive removal of the bladder is not required for treatment. Removal of the inflamed intestine will usually suffice. A limited resection, to just the inflamed segment of bowel is adequate. There is no benefit in extended resection of non-involved bowel. An important consideration is putting some type of tissue (e.g. omentum) in place between any anastomosis and the bladder, as recurrence is more common than in other etiologies.

Malignant enterovesical is approached similarly to malignant colovesical fistulas. It is important to rule out metastatic disease prior to resection. The goals and conduct of the operation is similar to that for colovesical fistulas, with the additional requirement to achieve adequate surgical margins of 5–10 cm and mesenteric lymph node harvest based on the origin of the feeding mesenteric blood vessels [24].

Lastly, these patients are often malnourished, because there may be other areas of the bowel involved. Preoperative nutritional optimization is a key component of any surgical planning for colovesical fistula due to inflammatory bowel disease.

Radiation-Induced Fistula

As previously mentioned, radiation-induced tissue injury makes the approach to colovesical fistula surgery significantly more complex and dramatically increases the risk for failure of any surgical repair. Radiation not only can create an intense fibrosis that makes dissection much more difficult (sometimes loops of bowel are completely inseparable without making numerous enterotomies), but also any anastomosis or repaired tissues may simply fall apart. One of the key principles if one must operate for a symptomatic fistula in a patient with prior radiation, is to try to bring in non-radiated tissue or separate radiated areas with an adjacent tissue transfer (using omentum, peritoneum, or other well-vascularized tissues to reinforce the site of surgical repair. It was previously mentioned that the bladder side may heal with urinary catheter decompression alone. This may not be the case in a radiated field, so extra steps may be required.

Peri-Operative Management

Regardless of whether a formal bladder repair is performed or not, bladder decompression with indwelling urinary catheter facilitates bladder healing. Historically, the Foley catheters were left indwelling for longer periods even up to 10–14 days. More recently, periods as short as 3–5 days are more common for simple cases [25]. Cases in which a more extensive repair is performed may still warrant a longer period of bladder decompression, and this is ultimately at the discretion of the operating surgeon. In all cases we weigh the risk for infection with an indwelling catheter against the risk for urine leak with earlier withdrawal. Cystogram is not routinely necessary prior to catheter removal but may be useful in individual cases where there is specific concern for non-healing.

Patients undergoing colovesical fistula repair benefit from enhanced recovery after surgery (ERAS) interventions and protocols that have been demonstrated to improve clinical outcomes in both colorectal and urologic surgery [26, 27]. These interventions include early ambulation, multimodal pain control and early feeding among others.

Prophylactic antibiotics should be administered in all patients. For uncomplicated cases, perioperative antibiotics alone is adequate. In cases where an abscess is encountered and drained, we prefer at least 24 h of additional antibiotics, though there is limited evidence to support that prolonged course will prevent a recurrent abscess.

Laparoscopic and Robotic Surgery

A significant body of literature exists to demonstrate the benefits of minimally invasive, laparoscopic and robotic surgery to decrease morbidity, reduce complication rates and accelerate recovery for patients after colorectal surgery. Retrospective investigations that have specifically looked at minimally invasive surgery for colovesical fistula have demonstrated the safety of the approach. Patients who underwent successful laparoscopic surgery were more likely to have had a lower complication rate and more rapid recovery measured by hospital length of stay [28, 29]. One notable caveat is a reported open conversion rate that is higher than other laparoscopic procedures (29–36%) [30–32], indicative of the technically demanding nature of these cases.

Endoscopic Closure

Endoscopic technology and technical expertise have progressed significantly in recent decades. These advanced endoscopic techniques have enabled ever more complex interventions, including many that previously required invasive surgery, to be performed entirely endoscopically. Limited efforts have attempted to apply over-the-scope clips and luminal covered stents to enteric fistula closure [33, 34]. While some reports, primarily from Europe, are encouraging, they report very limited numbers and overall heterogenous efficacy. Rates of durable enteric fistula closure are reported between 37.5–100% [35, 36]. Endoscopic closure is unproven at this time and surgical resection remains the standard of care for colovesical fistula, but endoscopic closure may be considered in patients who are high risk or otherwise unfit for surgery. While the authors have attempted this on a few such occasions, it often requires a combined approach with cystoscopy/colonoscopy. Even then, getting to and closing a fistula (which is often in an inflamed segment of colon) can prove technically very challenging.

Conclusion

Colovesical fistula is a common and highly morbid condition that usually does not resolve without surgical intervention. It is marked by pneumaturia and fecaluria, vague abdominal pain and recurrent urinary infections. The most common etiology results as a complication of diverticulitis, however there are alternative etiologies that must be considered and significantly complicate the approach to management when present. Surgery can be technically challenging but is required for definitive treatment of colovesical fistula in almost all cases.

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Chapter 7
Vesicocutaneous Fistula

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Abbreviations

CT	Computed tomography
MRI	Magnetic resonance imaging
PBS	Prune Belly syndrome
VCF	Vesicocutaneous fistula
VCUG	Voiding Cystourethrogram

Introduction

Vesicocutaneous fistula (VCF) is a rare condition characterized as an aberrant connection between the urinary bladder and the skin. These fistulas may externally communicate to the abdominal wall, perineum, buttocks, scrotum or very rarely thigh and they have a very negative impact on the quality of life of patients due to continuous urinary leakage [1]. Its formation is associated with many different causes and there is no formal classification for its study.

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Definition, Etiology and Specific Considerations

Vesicocutaneous fistula is the abnormal communication between the bladder and any part of the skin with the consequent leakage of urine.

There are many situations where a VCF can form, some of them are congenital but most common causes are acquired and iatrogenic. In all of the cases perivesical inflammatory processes pre-exist as: (1) direct erosion of the bladder wall [2–8], or (2) Inadvertent injury during resection or removal of an offending agent [9].

Congenital Causes

Prune Belly Syndrome

Prune belly syndrome (PBS) is a rare genetic disease with a broad spectrum of anatomic defects and different levels of severity, affecting 1 in 40,000 births, almost 97% of those affected are male [10–12].

Abdominal examination frequently shows a small cutaneous fistula opening below the umbilicus pouring urine, a distended urinary bladder, associated with an absence of abdominal muscles and wrinkled abdominal skin [12, 13]. The bladder usually appears massively enlarged with a pseudodiverticulum at the urachus. The urachus is patent at birth in 25–30% of children [14].

They are secondary to the persistence or incomplete obliteration of the urachus, and manifests itself early after birth as a visible structural anomaly of the umbilicus and/or as small urine leakage or clear liquid drainage, their tract is often short, beginning near the navel and ending at the apex of the funnel-shaped bladder [15, 16]. The leakage can be evident after the umbilical cord falls, although in certain circumstances, it appears in later stages of life, even in adulthood, justifying the theory of an incomplete closure of the duct [17]. Drainage usually occurs with a full bladder or during micturition [16].

Diagnosis is performed through prenatal ultrasound, in the second trimester sometimes as early as 12 weeks, depending on the severity of the urinary tract obstruction and oligohydramnios [18]. Micturating or voiding cystourethrogram (VCUG) allows the identification of the fistula between the urinary bladder and abdominal skin, when performed postoperatively can show different grades of vesico ureteric reflux associated to urethral atresia [13].

Persistent Urachus

This anomaly results from the persistence of the allantoic canal after birth, which is a 3-layered canal that connects the allantois to the fetal bladder, in the embryonic stage, by the fifth month of gestation, the descent of the bladder elongates the urachus and due to the condensation and fibrosis of its elements subsequently obliterates itself, giving rise to the middle umbilical ligament [17, 19]. After birth, this process may remain incomplete, producing an epithelialized communication between the bladder and the umbilicus [17, 19].

This anomaly is frequently detected during the neonatal period by physical examination in which the presence of continuous urinary drainage from the umbilicus, and related abnormal appearances of the navel, including an edematous umbilicus, granulomas or delayed cord stump healing [20, 21]. The fistula can also has an onset in adulthood, manifesting itself as a cutaneous sinus through which urine drains persistently or intermittently according to the associated lower urinary tract obstruction [22, 23].

Ultrasound is the modality of choice for initial assessment, especially in children. Demonstration of a tubular structure with an hypoechoic wall and anechoic content extending from the bladder dome to the umbilicus is pathognomonic [21, 24].

Acquired Causes

Any pelvic inflammatory process that compromises the rectum or the bladder, conditioning thinning or erosion of its wall, carries an increased risk of developing a fistula [15]. Pre-existing abdominal fibrosis or adhesions due to previous surgeries or chronic inflammatory disorders can make bladder dissection difficult and increase the risk of intraoperative injuries and subsequent urinary fistula development.

Postoperative

Formation of VCF has been associated with several complications of surgical procedures, such as, incisional hernia repair, radical hysterectomy, hip surgery, radical prostatectomy and less frequently, extensive trauma related with pelvic fractures, bladder trauma repair with fistula onset at the site of primary surgical closure site and bladder entrapment after external fixation of traumatic pelvic fracture have been reported [2–4, 25–29].

Gynecologic Surgery

In the setting of obstetric and gynecological surgery, scar tissue and adhesions from prior laparotomies can be challenging for providers to perform surgical care. Development of the surgical dissection plane between the vaginal wall, bladder and rectum can be impaired by dense abdominal adhesions due to different prior conditions such as endometriosis, pelvic inflammatory disease or previous surgeries. Occasionally, when direct bladder trauma or substantial loss of a portion of the bladder wall befall, urine output can occur through the surgical wound [19, 21].

Meshplasty

Mesh migration after hernia repair has long been recognized as a potential complication after inguinal or incisional hernia repair either open or laparoscopic approach [2, 13] and has been recognized as a potential cause of VCF [2, 3]. There are 2 known mechanisms for mesh migration. The former are displacements of the mesh along paths of least resistance brought about by either inadequate fixation or by external displacing forces. Secondary migrations are a slow and gradual movement of the mesh through trans anatomical planes. Due to foreign-body reaction-induced erosion, the mesh can migrate across different anatomical planes to create a fistulous path [13]. Mesh fixation technique may affect migration rates by compromising the tensile strength and movement of the mesh. Even though, the nature of the mesh biomaterial are generally stable, non-immunogenic and non-toxic, they are not biologically inert, and have the ability to trigger a foreign body reaction to the surrounding tissue. Biological surface coatings are being used with increasing frequency in abdominal wall hernia repair, since they have shown to reduce foreign body reaction and its potential complications secondary to infections. Mesh size, shape and positioning may also be considered as an independent risk factor.

Stones

The formation of bladder stones represents 5% of all urinary stones and it is related to bladder outlet obstruction, urinary stasis, urinary tract infection and foreign bodies, causing irritative symptoms of lower urinary tract, hesitancy, hematuria, kidney failure, bladder rupture and in rare cases, VCF can be formed [5, 6]. The most common fistula opening site in the skin is suprapubic, located in the surgical scar of the previous cystolithotomy, although perineal and inguinal drainage with a single or multiple discharge sinuses has also been documented [5, 7, 9, 30]. A connection between the bladder and the skin secondary to bladder stones is a rare entity with only 6 cases reported in world literature [5].

The time of presentation of VCF related to previous cistolithotomy ranges from 5 to 20 years, manifesting itself most frequently 5 years after the prior surgical procedure. Defects in the abdominal wall, muscle weakness, previous abdominal surgery, presence of stones and chronic cystitis, favors the erosion of the bladder wall and the subsequent formation of the fistula [21, 30]. Cystostomy catheter and urinary tract infection can also induce fistula formation [9].

Radiotherapy

The development of VCF after radiotherapy is an infrequent event, with no more than 8 cases reported in the world literature [8, 31–33]. Among documented cases, age range from 46 to 81 years, however, most of the cases have been reported over the eighth decade of life, mainly related to prostate cancer treatment, cervical cancer, bladder and vulvar cancer. Constant urine discharge results in maceration and skin damage secondary to moisture and early diagnosis and management of the disease is often complex [22, 33]. The most commonly described discharge site or opening sinus was the upper and medial thigh and inguinal surface, either unilateral or bilateral, followed by the hypogastric or suprapubic region and a single case reported in the sacrum [22, 34].

The predominant prodromal manifestation is the development of a lump or a cyst-like mass, located in the inguinal region or thigh, associated with pain that increases in volume or size during urination, which may appear from weeks to months before the fistula onset associated with urinary tract infection, lower urinary tract symptoms and hematuria [34]. When performing percutaneous aspiration or spontaneous drainage of this cyst-like mass, bacterial infection and purulent fluid have been identified, in addition, it can be associated with abscess, necrotizing fasciitis, cellulitis or sepsis [31].

Other Causes

Less common causes of VCF include chronic pelvic inflammatory problems, utilization of vacuum assisted wound closure devices [30], groin or thigh abscess, pubic bone osteomyelitis [23, 28], chronic pelvic actynomicosis [5, 6], bladder malakoplakia, pressure ulcers [7], ectopic kidney with pyonephrosis [9] genitourinary tuberculosis [8] among others.

Clinical Features

The clinical scenario of the VCF is characterized by urinary output through a single or multiple discharge sinus in the skin where the fistulous path is established [1, 4, 26]. Systemic symptoms can manifest as fever, chills and malaise. Cutaneous hyperemia, edema and purulent drainage generally denote skin infection as local symptoms [4, 8, 23, 26]. Afterwards, when the tract is established, the systemic manifestations often cease, and the clinical scenario is characterized mainly by urinary leakage through the cutaneous opening [1]. Genitourinary symptoms when they are present are nonspecific, and include abdominal pain, urinary frequency, hesitancy and recurrent cystitis.

When the fistulous tract is long and irregular away from the bladder, urine output is often scarce [23]. Due to this long tract fistula presentation, the tract can obliterate and lead to cause an inflammatory reaction, purulent fluid collection or abscess through the path of the fistula and compromise adjacent structures such as the bones of the pelvic ring [26, 28]. On physical examination, hyperemia, local hyperthermia, tenderness, pain and discomfort, associated to urine or purulent output can suggest the diagnosis.

Diagnosis

Given the high clinical suspicion, it is essential to demonstrate the presence of the fistulous tract, for which imaging contrast studies are usually performed. Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are the most sensitive diagnosis techniques for fistula detection, and associated compromised organs.

Sequenced VCUG and intravenous urography can, indirectly, suggest an inflammatory process by the irregularity and filling defects caused by mucous edema, and occasionally evidence the fistulous path. Cystoscopy confirms the diagnosis in most of cases and allows selective sampling for anatomopathological study [24]. Some other indirect methods such as staining dyes and histochemical stains can be useful for diagnosis.

Computed Tomography CT Scan

The most valuable advantages of this technique is that it allows the evaluation of the general characteristics of the bladder and nearby organs as well as the abnormalities among them. The capability of this technique in providing three-dimensional reconstructions and multiplane images constitutes a valuable instrument for therapeutic strategies. Contrast enhanced phases such as CT urogram may advert the fistulous tract (Fig. 7.1).

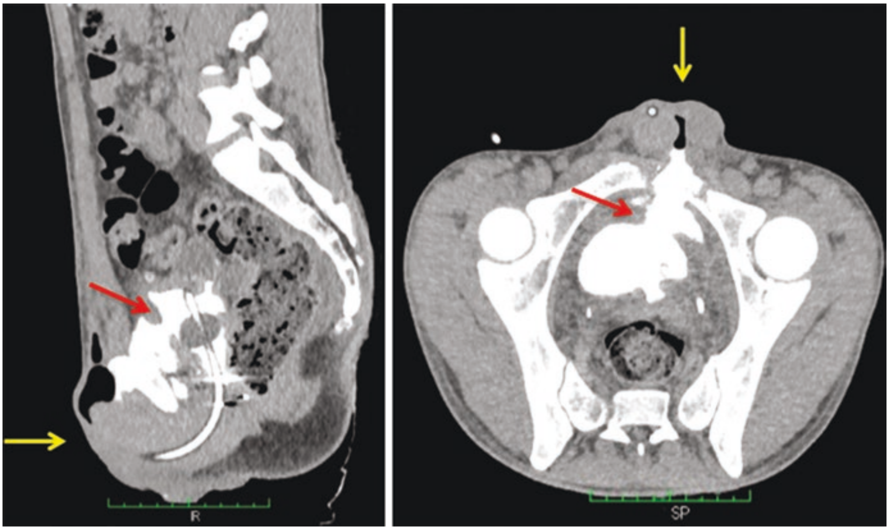

Fig. 7.1 Tomography images with contrast intravenous and through the urethral catheter. Red arrow shows the defect in the bladder and yellow arrow indicates the place on the skin where urine came out intermittently. Left: sagittal view. Right: axial view. (Images courtesy Dr. Juan Arriaga)

Voiding Cystourethrogram (VCUG)

It may identify a bladder filling defect, associated with a foreign body or advert the passage of contrast media through the fistula path [2, 3].

Fistulography or Fistulogram

Enables to visualize the fistula, determine a single or multiple paths and confirms its emergence from the urinary bladder [5].

Abdominal and Pelvic Ultrasound

Although it is one of the most widely used imaging modalities, its findings are limited to identifying liquid collections, and it does not allow the visualization of the tract. Vesical ultrasound can help to assess the residual urine in the bladder in the postoperative control, since as long as the bladder does not empty completely, the fistula can be repeated or perpetuated.

Cystoscopy

The findings range from wall defects, diverticulum-shaped openings, well epithelialized fistulous tracts to partial or total migration of the prosthesis into the bladder, in certain cases, no alteration can be identified [1–3, 26–28]. When the history or precedent of malignant tumor or radiation therapy is known, in addition to identifying the internal opening of the fistula, its association with tumor presence or recurrence must be ruled out [34].

Methylene Blue Instillation

Organic or synthetic dyes such as *methylene blue* and *indigo carmin* are useful resources to demonstrate the fistulous path in cases where a high index of suspicion exists after a normal cystoscopy or inconclusive imaging studies results [2, 33].

Determination of Creatinine in Suspicious Drainage

Assessment of drain fluid creatinine range has been utilized by researchers as a guide for the initial diagnosis of urinary leaks in cases of high peritoneal drainage after surgery to discriminate from peritoneal fluid and lymphorrhea. Regmi, et al., determined a drain fluid creatinine to serum creatinine ratio (DCSCR) of >1.5 and a higher-than-expected drain output as a highly sensitive diagnostic range for urine leak and requires further confirmatory imaging studies [35, 36].

Treatment

The management of VCF rely on multiple factors and etiologies such as inflammatory disorders, pelvic trauma [2, 9], associated illness and injury and the general condition of the patient [7]. The available modalities of management of these cases range from conservative approach based on transurethral or suprapubic catheter placement for urinary bladder drainage, endoscopic or minimally invasive surgery to open surgical exploration [1, 13]. In half of the cases, spontaneous resolution of the fistula can be achieved by permanent diversion of the urinary tract through an indwelling urethral catheter for a period of 6 weeks, however, in some cases, a longer period may be required. Once the infectious process has resolved, a VCUG can confirm the resolution of the fistula [4, 29]. The urinary bladder must be kept empty to decreased intravesical pressure and subsequent urine leakage and enhance healing or obliteration of the fistulous tract, this can be accomplished with a transurethral or cystostomy catheter, although percutaneous nephrostomy catheters may be needed [7, 27, 29].

When systemic or local infectious manifestations take place, broad-spectrum antibiotics with or without necrotic tissue debridement or fistulectomy may be required [26, 28]. Whenever is possible, a two-layered watertight clousure of the bladder wall may be attempted [9, 29, 30]. However, primary closure can result quite challenging due to the extension of the compromised bladder tissue and scarring [37]. Closure of fistulous tract require the complete excision of all granulous tissue and mobilization of the bladder, subcutaneous tissue and skin to allow elimination of dead space and proper tension free approximation. Mesh migration related VCF requires an extensive surgical debridement with mesh removal and urinary bladder repair. When significant loss of bladder tissue occurs, the use of abdominal wall pedicle flaps can be very useful for the reconstructive surgical procedure of the urinary tract [19]. Rectus abdominis grafts should be considered primarily. The usefulness of these grafts relies on its favorable given by the inferior epigastric artery, however, these grafts may not be available due to dens adjacent tissue fibrosis and severe inflammation. In this context, the omentum may be an acceptable alternative. On certain occasion, such as traumatic, postoperative, and inflammatory fistulas, a urinary diversion may be required [12, 19].

The use of cyanocrylate as tissue adhesive through percutaneous, endoscopic or endovaginal access for the management of vesicocutaneous and post radical prostatectomy urinary fistulas has been successfully reported [1]. Important to consider that VCF associated with previous or current history of cancer or radiation therapy are always related to microvascular injury and tissue fibrosis [32].

Prune Belly Syndrome and patent urachus are well known congenital causes, when associated with acute renal failure, urinary sepsis, or bladder outlet obstruction from urethral atresia, a urinary diversion is required. When temporary urinary diversion is indicated, a cutaneous vesicostomy is the procedure of choice. A Blocksom technique cutaneous vesicostomy is often performed after excision of the VCF to palliate renal failure [12].

Traditionally, the patent urachus is surgically excised using a transverse or midline infraumbilical incision, alternatively, urachal remnants can be removed laparoscopically, even in children younger than 6 months of age [20]. It has been proposed that the management of symptomatic urachal remnants in adults differs from that in children, since conservative management is often advocated for children who are diagnosed within the first year of life. Several reports shows that spontaneous involution of the urachus occurs within 1 year of birth with complete resolution of symptoms [28]. However, persistent urachal remnants in adults eventually become symptomatic and require surgical intervention [38].

Conclusions and Recommendations

Vesicocutaneous fistula is an infrequent condition and even when its etiology may be congenital, most of the cases are acquired or iatrogenic inflammatory causes that condition bladder and perivesical inflammatory process. The clinical presentation is characterized by urine output through a skin sinus, regardless of the etiology. Computed tomography cystography may be the best diagnostic imaging procedure resource supported by an experienced radiology team. The treatment must be individualized for each particular case. Adequate bladder emptying must be ensured in order to achieve the complete closure or obliteration of the fistula.

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Chapter 8
Urinary Fistula After Kidney Transplant

Abhijit Patil and Mahesh Desai

Introduction

Urological complications are one of the most common complications after kidney transplantation. Among them, ureteral leaks (urinary fistula) and ureteral obstructions are most common complications. The native ureter receives its blood supply from renal and pelvis vasculature while the transplant ureter derives its blood supply only from the branches of the anastomosed renal artery. The "golden triangle" formed by the perirenal fat bordered by the ureter and lower pole of the kidney is of utmost importance for maintaining the vascularity of the lower ureter (Fig. 8.1).

The early studies (1970s–1990s) reported an incidence of 4.2–14.1% [1–4] for urological complications, while the later studies ranged from 3.7% to 6.0% [5–10]. The incidence of urinary leak or fistula in the studies ranged from 1.5% to 6.0% [4, 7–10].

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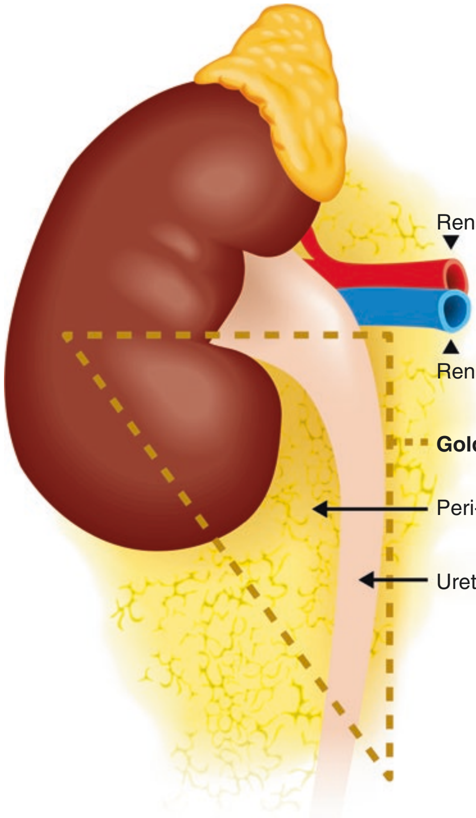

Fig. 8.1 The "golden triangle" formed by the perirenal fat bordered by the ureter and lower pole of the kidney

Risk Factors

Most urological complications occur within first 2 weeks of transplantation. Most of the complications could be attributed to technical errors during kidney retrieval, bench preparation or ureteric reimplantation. Urinary fistula occurring early (within first 24 h) after transplantation could be due to technical reasons like anastomotic breakdown, misplacement of ureteral sutures, unrecognised ureteral or renal pelvic transection, iatrogenic injury to bladder, ureteric anastomoses under tension due to insufficient length of ureter or urinary retention leading to high bladder pressures causing reflux and leak [11]. Other rare causes include renal calyceal perforation due to acute ureteral obstruction, extrusion of a ureteral stent or a post-transplant graft biopsy causing injury to renal pelvis may also lead to urinary fistula [12]. The cause for delayed fistula (within first 2 weeks) is lower ureteric necrosis due to devascularisation of ureter during organ retrieval or injury or thrombosis of lower polar artery [10]. Preserving vascularity to the ureter during transplantation is of utmost importance as over 70% of cases of ureteral necrosis are found in the distal ureter [13]. In our early experience, when cortisol was being primarily used as immunosuppressant, we experienced higher rates of urinary fistulas. This could be attributed to higher doses of steroids. The change in immunosuppressants have led to decrease in such fistulas. Overall, male recipient, African American recipient, and the "U"-stitch technique and multiple donor arteries were the factors associated with increased complications [14, 15]. Laparoscopic donor nephrectomies were not associated with more urinary complications as described in literature and our experience [15].

Krol et al. determined that an important factor in determining ureteral complications after renal transplantation is the vesicoureteral anastomosis technique [16]. The ureterovesical anastomosis associated with the lowest rate of complications continues to be a subject of debate. The Leadbetter-Politano technique was primarily used in the early days of kidney transplantation [17]. This has been largely superseded by the less technically demanding Lich-Gregoir technique [18]. The Taguchi technique has been associated with unacceptably higher incidence of complications compared to the Lich-Gregoir technique [19, 20]. In a recent meta-analysis, which included two randomized controlled studies and 24 observational studies, the Lich-Gregoir technique was found to significantly reduce the incidence of ureteral leaks when compared to the Leadbetter-Politano and Taguchi techniques [21].

Clinical Features and Diagnosis

Urine leaks generally present in the immediate or early post-transplant period (3 months) [22].The presentation of urinary fistula could be subtle or obvious. In the early post-operative period, it presents as decreased urine output, abdominal distention, sudden increase in abdominal drain output or increase in wound soakage. It may even collect to presacral region and scrotum through the inguinal canal [23]. In later period, it presents as perigraft collection or delayed healing of wound with continuous wound soakage. Urine leak should be part of the differential diagnosis in the early posttransplant period whenever there is decreased urine output, a new perigraft collection, new wound soakage or delayed graft function.

The drain/aspirated fluid and urinary creatinine along with serum creatinine needs to be assessed. Drain creatinine values close to urinary creatinine rather than serum creatinine proves the fact of urinary fistula. An ultrasound can detect a perigraft collection, but not its source. The urine leak would look as well-defined anechoic collections without septations, if not infected (Fig. 8.2a). This collection may lead to compression over ureter leading to hydronephrosis. Ultrasound would be useful for diagnosis and monitoring of the collection. Plain CT would show an isodense collection (Fig. 8.2b). CT Urography may be done, but with caution for graft nephropathy. A cystogram may show leak at ureterovesical junction or bladder leak. In cases where diagnosis is difficult, radionuclide imaging such as Tc 99m or MAG 3 scan can be employed. The retention of radionuclide dye in the graft bed is suggestive of urinary fistula.

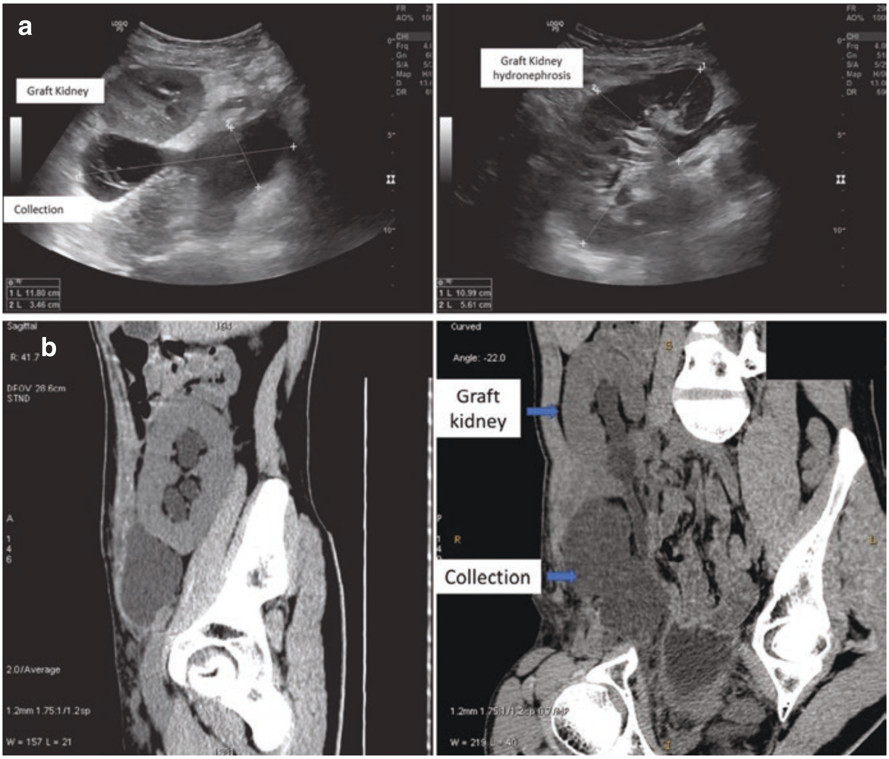

Fig. 8.2 (**a**) Ultrasonography depicting peri-graft collection leading to graft kidney hydronephrosis. (**b**) Plain CT scan showing perigraft collection which can be aspirated for analysis. The resultant graft hydronephrosis can also be well appreciated in the first image

Treatment Approaches

The urinary fistula can be managed conservatively, endoscopically or open surgically depending upon the amount of leak. The management of urinary fistula based upon location of the fistula is described in Table 8.1. If the leak is small and the patient has indwelling ureteral JJ stent and no Foley catheter, catheterizing by Foley catheter often resolves the leak. The catheter should remain in place for at least 2 weeks.

If the fistula does not settle with catheter or if the patient does not have indwelling ureteral stent, the antegrade ureteral stenting with nephrostomy should be attempted. Retrograde placement of stent in a transplant ureter can be technically challenging because of the ectopic position of the ureteric orifice and lack of periureteral supports. This diversion temporarily decompresses the pelvi-calyceal system and allows the healing to take place at the leak area. If the leak if large, it generally compresses the transplant ureter leading to hydronephrosis. In such

Table 8.1 Management of urinary fistula based upon site of leakage

Site of leak	Cause	Timing after transplant	Management
Bladder	Missed iatrogenic injury	Early	Conservative, per urethral catheter insertion for mild leaks
Uretero-vesical junction	Technical error, necrosis of distal ureter	Technical errors—early Necrosis—delayed	If minor leak- percutaneous DJ stent If major, surgical repair including repair of anastomoses, new uretero-neocystostomy, anastomoses with native ureter, Boari flap or ilieal replacement
Renal pelvis/ ureter	Iatrogenic kidney retrieval injury or diathermy injury	Early post-operative period (2 to 4 weeks)	Conservative, antegrade DJ stenting for minor leaks
Calyx	Distal obstruction	Late	Conservative, management of distal obstruction, generally DJ stenting

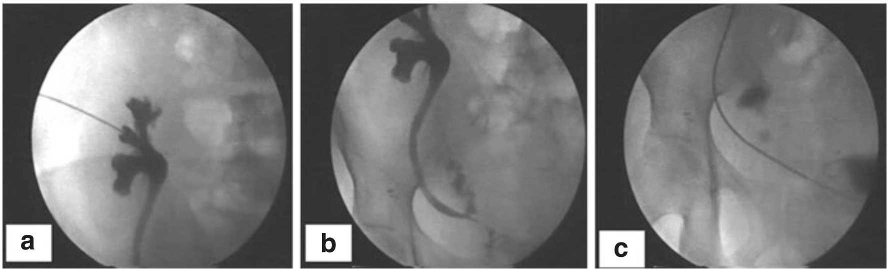

Fig. 8.3 (**a**) shows antegrade puncture of pelvicalyceal system (ultrasound guided), (**b**) shows the distal ureteral anastomotic leak on antegrade dye study, (**c**) shows antegrade DJ stenting

cases, antegrade access should be achieved. Antegrade dye study helps to know the location and amount of urinary leak, following which an antegrade ureteral stenting and nephrostomy should be performed (Fig. 8.3). If abdominal drain has been removed, a Malecot catheter drain can be placed in the perigraft collection using ultrasound guidance. The per urethral and drain output should be monitored. If drain output decreases, then nephrostomy and ureteral stent be placed for 6 weeks. After 6 weeks, nephrostogram is performed to exclude leak, followed by clamping of nephrostomy and removal after 48 h if urine output and graft function remained stable. The management of calyceal leak depends upon the cause of leak. If obstruction is the cause, then the obstruction should be managed. If the segmental renal infarction due to ligation or thrombosis of polar artery, then it can be managed conservatively.

The next step if the conservative or endoscopic approach fails is to manage open surgically. The approach depends upon the location of leak and extent of ureteral necrosis. During open exploration, we first instil bladder with irrigating fluid. If there is small leak from uretero-vesical junction and the distal ureter is well

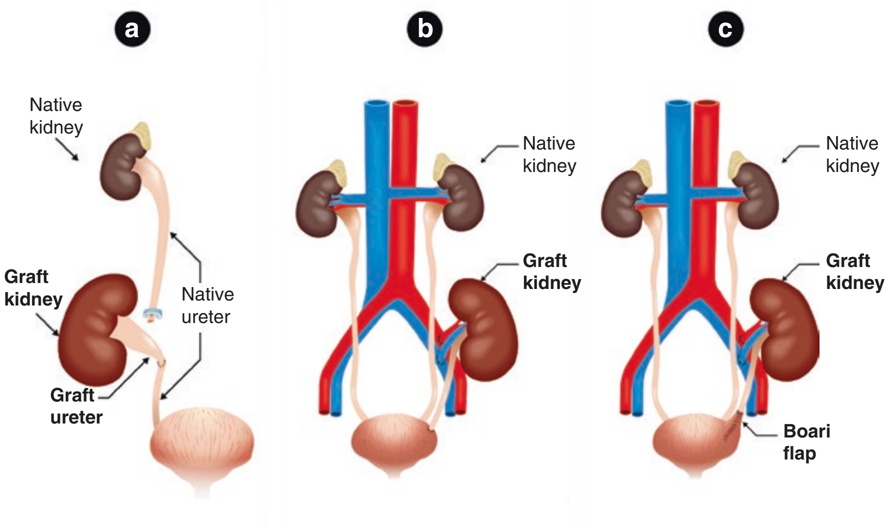

Fig. 8.4 (**a**) The graft ureter is anastomosed with ipsilateral native ureter; the proximal native ureter can be tied off without native ipsilateral nephrectomy. (**b**) Simple uretero-neocystostomy at new site. (**c**) Boari flap

perfused, then additional interrupted sutures at the junction over ureteral stent would suffice. If perfusion of distal ureter is poor with necrosis, then the distal ureter should be trimmed back to healthy perfused location. If the ureteral length is enough, then simple uretero-neocystostomy at new site over ureteral stent should be performed (Fig. 8.4a).

If more ureteral length is required for tension free anastomosis or if the bladder is small due to long-standing oliguric patients, then the graft ureter can be anastomosed with ipsilateral native ureter. The advantage of native ureter is that its long segment can be repositioned without tension, excellent ureteral blood supply and no interference with bladder volume. The proximal native ureter can be tied off without native ipsilateral nephrectomy (Fig. 8.4b).

If ipsilateral native ureter is not available, the options could be transposition of contralateral ureter, Boari flap or ileal ureter. Sometimes Boari flap may not be possible in atrophied previously anuric patients as it decreases the bladder volume. Boari flap when feasible can provide 10–15 cm additional length. Full thickness U-shaped bladder flap with the width of flap 3–4 times the diameter of ureter is created. Ureter is anastomosed in submucosal tunnel of the flap or end-to-end fashion with flap apex over ureteral JJ stent (Fig. 8.4c). The flap is tacked to the facia of ipsilateral psoas muscle with interrupted three sutures and bladder is closed. In situations with large ureteral tissue loss and when there is no donor or recipient ureter available, then a pyelovesicostomy or an ileal ureter can be refashioned.

Table 8.2 Golden points to minimize urinary fistula after kidney transplant

Golden points to minimize urine leak after kidney transplant
• Maintain peri-ureteral tissue during kidney retrieval • Maintain the fat in the "Golden triangle" • Avoid damaging or sacrificing lower polar artery • Perform a tension-free anastomoses between well-vascularized ureteral end and bladder mucosa • Keep the ureteral length optimum • Stent the ureter is cases where the vascularity of ureter is not optimal, fragile bladder mucosa, dysfunctional bladder, deceased donor transplant, multiple vessel donors

Prevention (Table 8.2)

We believe that gentle handling of the ureter and periureteric tissue and keeping the length of the ureter as short as possible without tension is of key importance. A ureter that appears ischemic after reperfusion should be resected proximally until an adequately perfused area is reached. The handling of kidney during donor nephrectomy is very important to prevent excessive skeletonization of ureter. The distal end of ureter should be bleeding well and should have good peristalsis after declamping in recipient surgery. In a recently published Cochrane database systematic review, it concluded that routine prophylactic stenting reduces the incidence of major urological complications and that 13 transplant recipients need to be treated (with using JJ stent) in order to prevent one major urological complication [24]. We at our institute have the policy to selectively stent the indicated patients as opposed to routine prophylactic stenting.

Complications

Undrained urinoma may get infected and lead to perinephric abscess which may require percutaneous or surgical drainage. The infected urinoma may lead to disruption of vascular anastomoses leading to life threatening haemorrhage. The urinoma may get absorbed via peritoneum leading to raised serum creatinine. The collection ay compress ureter leading to hydronephrosis and delayed graft dysfunction.

Conclusions and Recommendations

Urine leak is most commonly anastomotic due to ureteral necrosis. It generally presents in the early post-transplant period. It presents as abdominal distention, decreased urine output or increase in drain output or wound soakage. It is generally diagnosed by ultrasound and analysis of collection fluid. Minor urinary leak can be managed conservatively with per urethral catheter insertion or percutaneously by antegrade DJ stenting. Major urine leak would require surgical repair depending upon the location of leak and amount of remaining vascular ureter. Prevention is of utmost importance. The preservation of periureteral tissue during kidney retrieval and proper ureteric anastomoses technique is very important for prevention of urinary fistula. We have explained our ureteral anastomoses technique which we have modified our 40 years to decrease urinary complications (Fig. 8.5). We have summarized our recommendation in the following flowchart (Fig. 8.6).

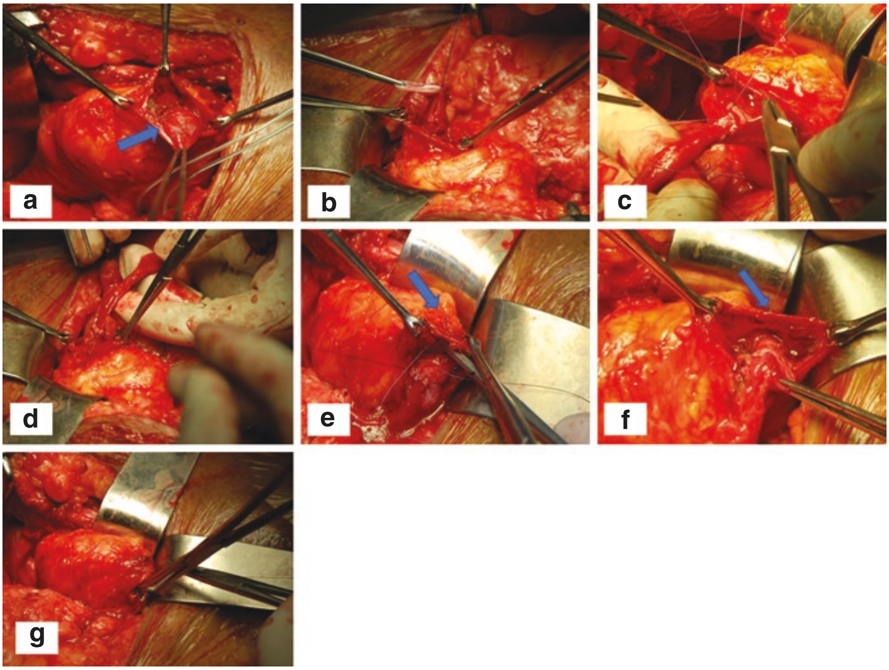

Fig. 8.5 Our technique of ureteric reimplantation (**a**) detrusor is incised on the anterolateral surface of bladder. The mucosa is dissected gently to avoid injury to mucosa. (**b**) the bladder mucosa is opened and the distal ureteral end is spatulated and the proximal angles are anastomosed separately with double needle absorbable sutures at angle of ureter. The distal end of ureter is anastomosed with bladder mucosa using single needle absorbable suture. (**c**) the ureter mucosa to bladder mucosa is anastomosed with final anastomoses as shown in (**d**). (**e** and **f**) shows that the distal ends of the suture material are brought out from the detrusor at the end of the tunnel. (**g**) the detrusor is closed over the ureter leading to a tunnel. This closure of tunnel should not be tight to avoid ureteral stenosis

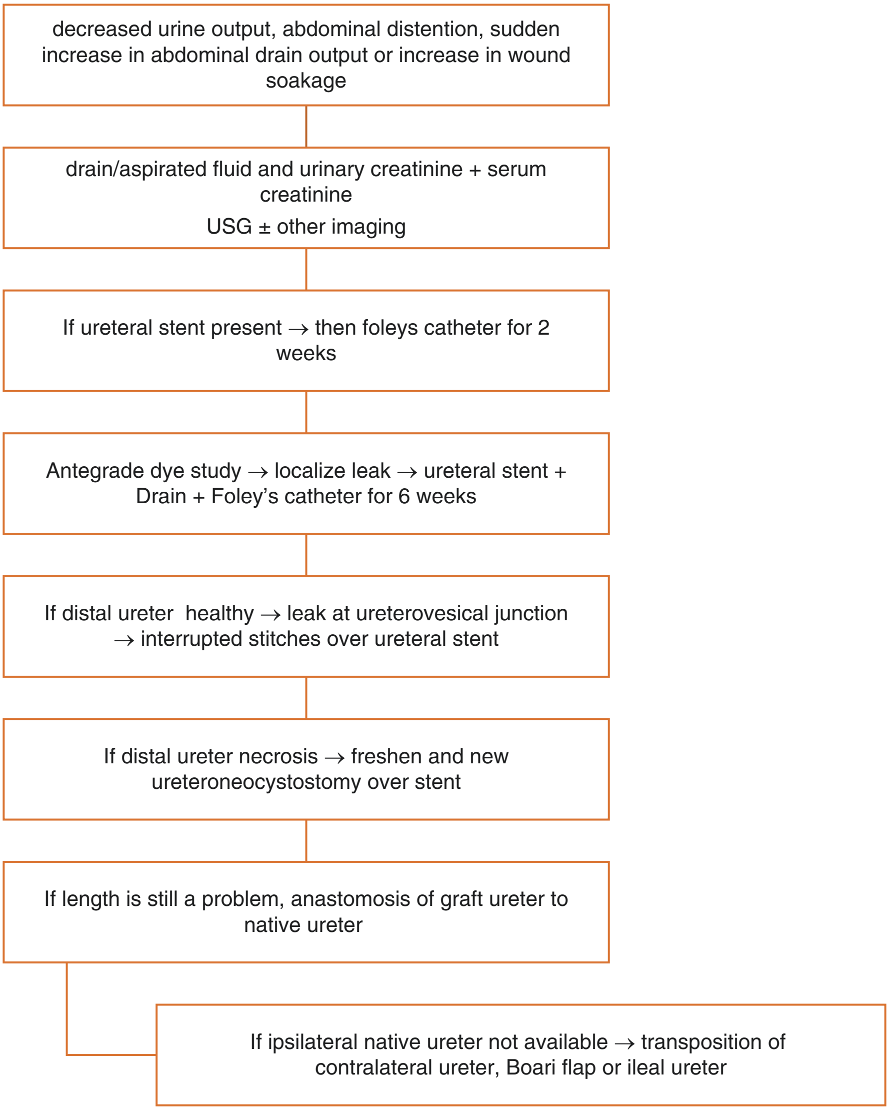

Fig. 8.6 Management protocol for urinary fistula after kidney transplant

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Chapter 9
Vascular-Urinary Fistula

Tycho M. T. W. Lock, Kyara Kamphorst, Frans L. Moll, and Roderick C. N. van den Bergh

Definition, Specific Considerations, Classification

Definition

A vascular-urinary or urinary-vascular fistula is defined as a confirmed abnormal passageway between any vascular structure and any part of the urinary tract. Due to pressure differences between the arterial or venous structure and the (obstructed) urinary tract, the fistula will usually result in flow of blood from the higher pressure vascular side of the fistula into the lower pressure urinary part of the fistula. The vascular side of the fistula may include an arterial structure, venous structure, aneurysm, pseudoaneurysm, or vascular grafting material. The location of the vascular side of the fistula may be orthotopic (normal anatomy; such as renal artery/vein, aorta, caval vein, common iliac artery or vein, external artery or vein, internal artery or vein)), or ectopic (altered anatomy; such as bypassing or crossing vascular graft, or transplant kidney vessels). The urinary tract side of the fistula may also be orthotopic (normal anatomy; such as the renal pyelum, ureter, bladder, or urethra), or ectopic (altered anatomy; such as urinary conduit (including ileal conduit, Indiana pouch, or other types of urinary pouches), ureter-ureterostomy, ureter bowel interposition, or bladder augmentation).

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Specific Considerations

Vascular-urinary fistulas are uncommon, but they are a potentially life-threatening condition. The most frequent type is arterio-ureteral fistula (AUF), with a fistula between (common, internal, or external iliac) artery and ureter. In 2021, until so far, the largest series of 445 cases were collected and reviewed [1]. Since the diagnosis is so infrequent, it may easily be missed in clinical practice. The mortality rate is 7.1 to 23% and strongly related to diagnostic delay [2, 3]. Vascular-urinary fistulas may present with either intermittent (micro-) hematuria or massive hematuria leading to hemodynamic instability. Due its scarcity, the level of evidence in the literature on this entity is low. The available evidence in the literature is mainly based on retrospective data, including some case series and mostly single-case-reports. In patients with hematuria, in whom more common causes have been ruled out after conventional work-up as recommended by guidelines (cystoscopy and imaging of the upper urinary tract using ultrasound or CT), vascular-urinary fistula (most commonly arterio-ureteral fistula) should be incorporated in the differential diagnosis, especially in patients with risk factors. Different risk factors are recognized, and may include a history of pelvic oncologic surgery, pelvic radiation therapy, and the presence of vascular graft material or indwelling urinary stents.

Incidence

An increase in the number of arterio-ureteral fistulas has been reported [1]. The underlying reasons for this observation may be multifactorial. Overall, life expectancy has been increasing, patients experience longer periods of medical treatment, and combinations of pathology. Also, more extensive pelvic treatments for varying oncological, as well as (endo)vascular procedures are being performed in current surgical practice. Indwelling ureteral stents are more commonly used. Finally, the indication for primary or salvage pelvic radiation therapy has widened, and higher radiation doses are generally used. However, other non-medical reasons may also be accounting for the rising incidence. Medical registration and electronic patient file registries have improved, resulting in an simpler identification of vascular urinary fistulas encountered during surgical procedures or during clinical follow-up. Also, a publication bias cannot be ruled out, with a tendency towards a lower threshold to publish these cases as single case reports or combined into small patient series, leading to a higher reported frequency when based on PubMed or other medical literature.

It remains difficult to estimate the true incidence of vascular-urinary fistulas or—more specific—arterio ureteral fistulas. It is likely that some will not be identified as they do not result in clinical symptoms, and in other patients with symptoms, the true cause may remain unrecognized as the symptoms are not contributed to a vascular urinary fistula. From a national survey study in The Netherlands, 56 cases were identified retrospectively over a timeframe of 10–15 years, leading to an estimated five new cases of arterio-ureteral fistula a yearly basis (±17 M inhabitants in

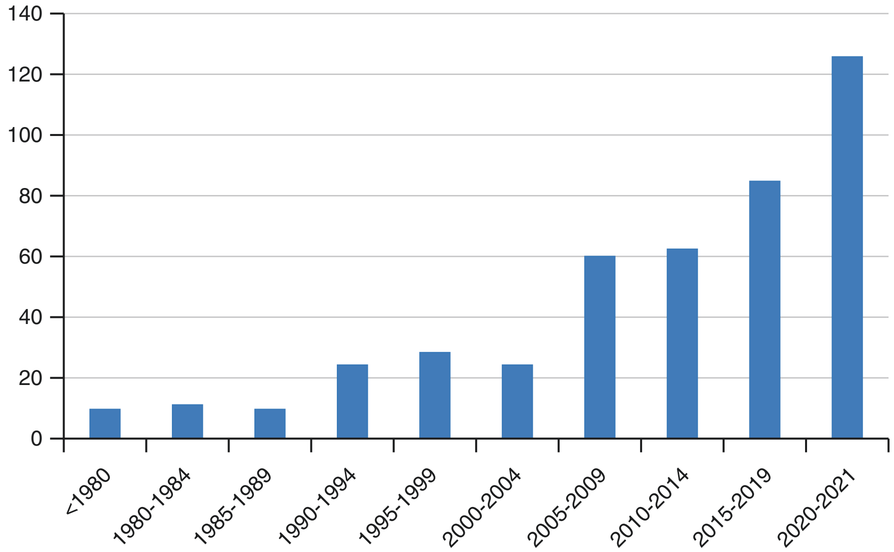

Fig. 9.1 incidence of arterio-ureteral fistulas as PubMed indexed

The Netherlands in 2021) [4]. When divided by the number of registered urologists with average of 25 years in practice, this makes it likely that a urologist, vascular surgeon, or interventional radiologist will encounter this entity at least once or twice during his career. The awareness for this underlying rare cause in patients with intermittent episodes of hematuria, especially when risk factors are present, remains important. The reported incidence of vascular-urinary fistulas other than arterio-ureteral fistulas (such as venous urinary fistulas or arterio-ileal conduit) is much lower and even more difficult to estimate.

Figure 9.1 presents the incidence of arterio-ureteral fistulas as reported in the different literature.

Classification

Vascular-urinary fistulas can be classified according to different anatomical and other characteristics.

1. Anatomy
   (a) Vascular location
      - Arterial versus venous versus (pseudo-)aneurysms.
         – Orthotopic: Aorta, renal vessel, iliac vessel, transplant vessel, other
         – Ectopic: Vascular graft material, (crossing) bypass

(b) Urinary tract location

- Orthotopic: Pyelum, ureter, bladder, urethra.
- Ectopic: Ileal conduit, neobladder, pouch, uretero-ureterostomy.

2. Other

(a) Symptomatic versus asymptomatic
(b) Acute onset versus chronic symptoms
(c) Primary (in absence of risk factors) versus secondary (result of one or more risk factors)

Etiology

Since arterio-ureteral fistula is the most common type of vascular-urinary fistulas, the etiology behind this entity is described here below. The etiology behind other types of vascular-urinary fistula resembles etiology behind vascular-urinary fistula.

An arterio-ureteral fistula is the final result of an eroding inflammatory fibrotic process of a constantly pulsating artery in poor condition against a fragile ureter, resulting in necrosis, and passage of blood into the urinary tract, or urine into the vascular structure. Blood flow into the ureter is the most common result. Previous surgical procedures may result in a situation of fibrosis in which increased friction exists between the artery and the ureter. Foreign body material or prosthesis on vascular or urological side of the fistula decreases flexibility and tolerability to movements. In a normal anatomical situation, the ureter crosses the common iliac artery or iliac artery bifurcation and thus physiologically there is already a close correlation between these structures. This situation may have been altered by urological or vascular surgical procedures such as ileal conduits, uretero-ureterostomy, or vascular bypassing or crossing stents. For the frequently used urinary diversion using an ileal conduit according to Bricker, the anastomosis between the ureters and ileal conduit is often located directly ventrally to the right common iliac artery. Previous radiation to the area of the fistula, stimulates fibrosis and reduces vascularisation and flexibility of the tissue. Indwelling urinary stents such as double-J catheters fixate the ureter, increasing friction with the vascular structure. Figure 9.2 graphically represents the main combined etiological factors behind the development of an AUF.

Some more specific causes of vascular-urinary fistula have also been described. The use of Acucise endo-ureterotomy (Applied Medical Resources Corp, Laguna Hills) is one of the specific causes described [5–7]. This technique comprised a semi blinded approach to incising a ureteral stricture using wire diathermy via retrograde approach. This could result into incision of not only the ureteral stricture, but also the vascular wall. Later, improved diagnostics of vascular structures in close relation to the ureter by using CT-scan reduced the chance of perforating a vascular structure using Acucise. This technique is currently less frequently used in modern clinical practice. Another example of a period specific cause of arterio-ureteral

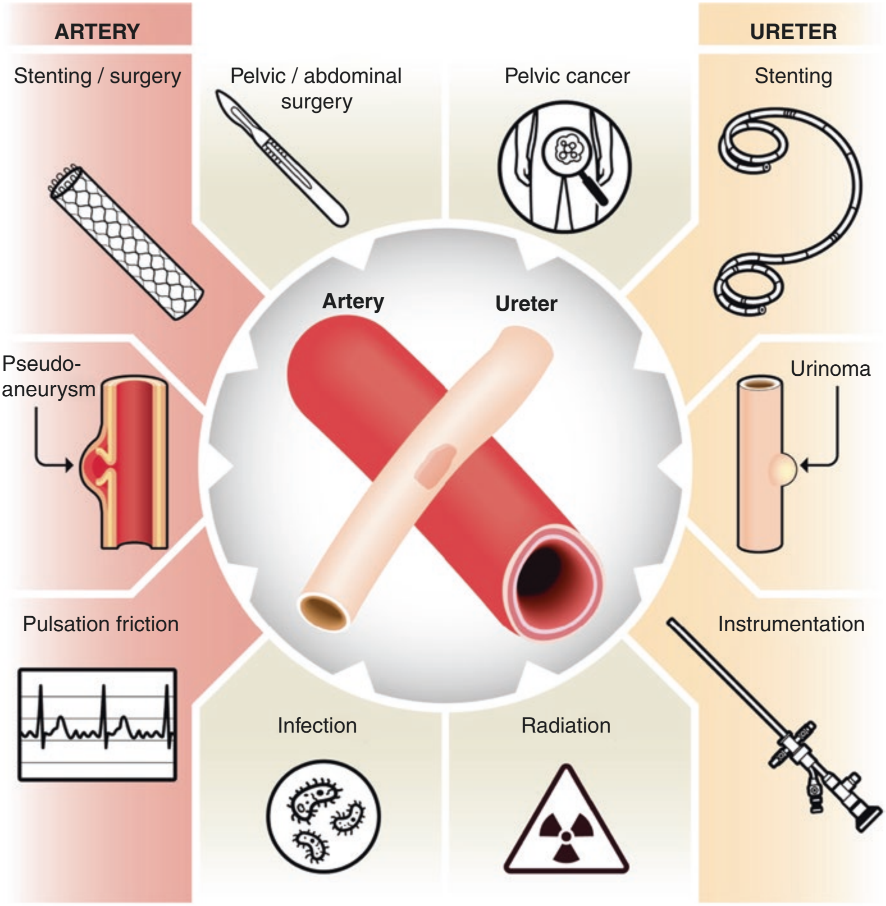

Fig. 9.2 Schematic representation of the main etiological factors behind the development of an arterio-ureteral fistula

fistulas is the historic use of rigid stenting of the ureter during pregnancy [8–10]. When required, flexible stenting using double-J stent is now the preferred methods of drainage, reducing friction between ureter and artery, and thus the risk of developing a vascular-urinary fistula.

The development of a spontaneous vascular-urinary fistula, in absence of any of the risk factors or procedures described above, will be very rare.

Clinical Features, Diagnosis

In most patients, the main symptom of a vascular-urinary fistula will be hematuria. As hematuria may be caused by a wide variety of other urologic diseases, the specificity for a vascular-urinary fistula is low. The severity of hematuria may also vary significantly. In some patients short episodes of limited or even microscopic hematuria may be present, while in others gross hematuria may be the symptom of initial presentation, leading to hemodynamic instability and/or need for transfusion or even may be lethal. Slumbering intermittent hematuria should be associated with the existence of a vascular urinary fistula. The size and location of the fistula may be associated with the severity of the presenting symptoms, but the underlying etiology and anticoagulant situation may also be predictive. Clot formation may temporarily close off the fistula passageway, only leading to episodic symptoms. This temporary sealing blood clot may act as a valve within the fistula, temporarily dissolved by new anticoagulant therapy or due to physical manipulation such as physical activity or ureteral stent manipulation or replacement.

When confronted with the suspicion of vascular-urinary fistula (most commonly arterio-ureteral fistula) in clinical practice, the medical history should focus on the possible risk factors for the development of an arterio-ureteral fistula, including a background of pelvic oncological or vascular pathological features or surgery, abdominal or pelvic radiotherapy, urinary deviation surgery, (pseudo-)aneurysms, and/or ureteral stenting.

Patients in whom an arterio-ureteral fistula develops can be divided in two groups, based on certain combinations of risk factors. In the first group, the fistula associated with degenerative disease of the iliac artery or earlier arterial reconstructive surgery. The fistula is typically situated at the location where the ureter crosses the anastomosis of an arterial graft with the native artery. In the second group, patients underwent a combination of pelvic oncological extirpative surgery, urinary diversion, radiation therapy and ureteral stenting. These procedures result in a situation in which friction exists between the artery and ureter [11].

The condition can be life-threatening owing to potential massive blood loss, but, because of its scarcity, the diagnosis can easily be delayed or even missed. The clinical outcome is strongly inversely associated with the length of the diagnostic delay. If an AUF leads to hemodynamic instability, the mortality rates can reach 23%.

Different diagnostic tools have been used in the literature, to confirm the presence of a vascular urinary fistula, although some of these have become obsolete. The modalities nowadays available include ureteral contrast studies, contrast angiography, and/or CT angiography. In the largest review on arterio-ureteral fistula, (CT) angiography was the modality most commonly confirming diagnosis. However, the clinical suspicion remains the most important factor during clinical decision making. Negative findings during diagnostics do not rule out the presence of a vascular urinary fistula. In a review articles, 62% of angiography studies confirmed an arterio-ureteral fistula, and 51% of the ureteral contrast studies [1]. Surgical exploration remained an often applied intervention to confirm the fistula.

The presence of flow from artery or vein as seen on contrast studies into the ureter or other urinary structure, or more diffuse bleeding, seen to be very suggestive of the level of one of these urinary structures, and provides evidence on the presence of a vascular-urinary fistula. Urine or contrast injected into the urinary tract may also flow vice versa into an artery or vein, but this is less likely due to the difference in natural pressures in the different structures. During contrast studies, active manipulation of the blood clot in the fistula passageway may be performed, but could excite gross active bleeding which potentially causes hemodynamic instability and therefore requires extensive preparation [12, 13]. However, care should be taken, as this is not a standardized procedure.

In many reported cases, a renal origin was suspected to cause the hematuria. This led in some cases to undergo nephrectomy or renal artery embolization, only to find out later that the diagnosis of vascular-urinary fistula was missed, as hematuria persisted afterwards.

Vascular (pseudo-)aneurysms and hydronephrosis are other signs potentially indicating the presence of a vascular-urinary fistula. Both are suggestive of an inflammatory or fibrotic process causing obstruction of the ureter or leakage of the artery.

Treatment Approaches

Any vascular-urinary fistula, including arterio-ureteral fistula, is an uncommon diagnosis. The appropriate awareness for the diagnosis in order to be able to instigate the correct management, require the combined multidisciplinary expertise of the urologist, vascular surgeon, and interventional radiologist. Patients presenting with the disease may have a very different background, having varying (combinations of) underlying comorbidity and risk factors leading to the development of this abnormality. This may cause possible difficulties in accurate diagnosis and treatment. Patients in whom the condition had not been recognized before intervention have a higher risk of lethal outcome than patients in whom the vascular urinary fistula had been recognized at an earlier stage. In general, an individual treatment approach should be chosen, dependent on previous treatment. Different endoscopic, percutaneous, and open surgical treatment modalities are available, all with their specific advantages and disadvantages. Besides the patient characteristics and previous history, physician preference and experience, and the availability of different treatment modalities in the treating centre may play a role in the exact therapy chosen. Endovascular therapy options should be available in the treating hospital, as this is the main first intervention in recent years, with good outcomes [1, 11]. Patients suspected of vascular-urinary fistula may need to be treated in specialized oncology centres, with all required specialists and treatment modalities available. In an acute setting, more pragmatic options may need to be considered.

In line with the treatment of other fistulas, the aim of treatment should ideally be to close the fistula on both sides. Different options are available to reach this target for both the vascular side as well as the urinary side of the fistula. Combinations of therapies are of course possible and sometimes even required. The appropriate treatment of the fistula may thus comprise different steps.

First, the direct passageway between the vascular structure and the urinary side of the fistula needs to be closed. As vascular blood pressures, especially arteria flow, are much higher than the urinary tract, closure of the vascular / arterial side of the fistula will have the main priority for closure, especially in the acute setting in which gross haematuria may lead to hemodynamic instability. Endovascular covered stent placement has been the treatment of first choice in many of the cases described more recently. The endovascular approaches have been associated with more favourable outcomes than open surgical methods [11]. Figure 9.3 presents a schematic representation of the endovascular treatment of an arterio-ureteral fistula. Endovascular options have the advantage that they guarantee vascular supply and stop acute bleeding issues. Therefore, this option should be the treatment of first choice in most cases. However, endovascular treatment has some disadvantages. The ureteral side of the fistula is in essence not treated or closed, although this may not be necessary directly. Also, chronic infectious processes may persist, such as infected pseudoaneurysms. The presence of infected previously infected graft material may prohibit insertion of new stenting material, although the acute clinical situation may still require this step. Long-term treatment with antibiotics may be indicated in patients who harbor a chronic infection. If the haematuria is not resolved after the first stent placement, some cases report successful placement of a second stent [14–17]. If endovascular stenting is not an option or appears unsuccessful, different other more invasive options have been described, including open femoral - femoral bypass, open axillofemoral bypass, open aortic-bifurcation prosthesis placement, or primary oversewing the defect. If necessary, ureteral stenting may still be required to prevent urine leakage. Open closure of the ureter over a stent may also be performed. More rigorous treatments may include revision or creation of ileal conduit, nephroureterectomy, uretero-ureterostomy, or exceptional surgical procedures such as kidney auto-transplantation. During open surgery, the contact between the affected tissue need to be distanced. This may either be achieved with the stenting used on both sides of the fistula, or by omental plasty. Finally, following surgical correction of the fistula, the reversible risk factors leading to fistula formation need to be reversed. Urinary leakage needs to be controlled, but long-term stenting of the ureter needs to be avoided.

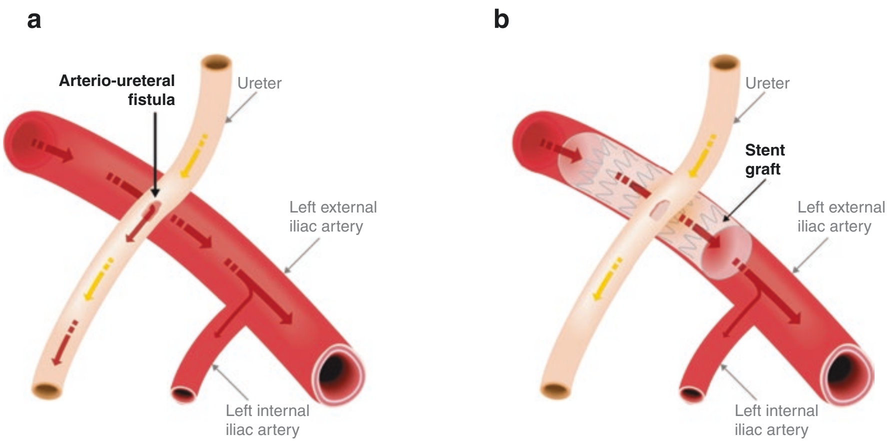

Fig. 9.3 A presence of passage between iliac artery and crossing ureter (arterio ureteral fistula). B endovascular stent placement as a treatment for arterio ureteral fistula

Preventive measures for the occurrence of vascular-urinary fistulas include omental plasty during open surgery especially in patients with risk factors such as radiation, avoidance of long-term ureter stenting, and avoidance of placing the ileal conduit directly over the arteries.

Outcomes

The mortality rate of arterio-ureteral fistula is 7.1 to 23% [2, 3]. A diagnostic delay has been related to a higher mortality. Mortality rates have decreased over time, a development which has been associated with an increasing use of endovascular stent placement is the primary therapy option. Patients developing a vascular-urinary have different (oncological) risk factors. These risk factors also contribute to a limited overall survival of this patient group.

Conclusions and Recommendations

Vascular-urinary fistulas are a rare but potentially life-threatening condition. Arterio-ureteral fistula is the most common of these types of fistula. The main initial presenting clinical symptom is hematuria, which can vary from intermittent limited hematuria to acute gross hematuria leading to hemodynamic instability, dependent on clot formation temporarily closing off the fistula passage. In a patient with a combination of the known risk factors presenting with hematuria, in whom the most frequent causes for hematuria have been ruled out using cystoscopy and cross-sectional imaging, a vascular-urinary fistula should be considered, especially if risk factors are present. These risk factors include a history of treatment of pelvic oncological diseases or vascular surgery, a history of pelvic radiation therapy, long term use of indwelling ureteral stents, infectious pelvic processes, and (pseudo)aneurysmatic processes.

In most patients who had a fatal outcome after encountering a vascular-urinary fistula, or in patients who had ineffective initial radical therapies such as nephroureterectomy, the diagnosis had not been considered before intervention. Awareness of the possibility of this condition, and knowledge of the underlying risk factors, could avoid delay of the diagnosis. Angiography or ureteral contrast studies confirmed the diagnosis most frequently, especially when active bleeding is present or excited by manipulation, although laparotomy has been often described when diagnosis remained uncertain.

Multidisciplinary planning and treatment of this condition is preferable. Endovascular therapy is the quickest and least invasive approach to solving the vascular (most lethal) side of the fistula. More invasive and combined techniques may be required in patients with extensive medical history, to close both sides of the fistula and reduce the chance of recurrence, or in whom the initial chosen strategy appeared unsuccessful.

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Part III
Fistulas in Females

Chapter 10
Vesicovaginal Fistula: Open Approach

Rita P. Jen, Enanyeli Rangel, Dordaneh E. Sugano, and Larissa V. Rodriguez

Abbreviations

CT	Computed tomography
FSFI	Female Sexual Function Index
IIQ	Incontinence Impact Questionnaire
JP	Jackson-Pratt
OAB	Overactive bladder
PC sling	Pubococcygeal sling
RPCF	Refixation of the pubocervical fascia
SSI	Surgical site infection
SUI	Stress urinary incontinence
UDI	Urogenital Distress Inventory
UTI	Urinary tract infection
VVF	Vesicovaginal fistula

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Introduction

Vesicovaginal fistula (VVF) is an abnormal communication between the bladder and vagina that results in involuntary urine loss through the vagina. The cause of VVF worldwide varies, but they are most commonly due to obstetric injuries and injury during pelvic surgery. Regardless of the etiology, VVF can lead to enormous psychological distress, social isolation, and significant morbidity.

Surgical repair continues to be the gold standard for treatment. A vaginal or an abdominal approach can be used for VVF repair with the latter being performed either robotically or in an open fashion. This chapter focuses on the open abdominal approach to repairing VVF caused by non-obstetrical trauma.

Epidemiology

The vast majority of VVF in the world, over 90%, are caused by obstetric complications in places where there is challenging access to emergency obstetrical services [1–5]. Prolonged obstructed labor leads to VVF due to tissue necrosis of the vesicovaginal septum from the pressure caused by the fetal head in the birth canal [6]. These individuals are often otherwise healthy and young. In other places in the world where obstetrical care is readily available, 90% of all VVF result from inadvertent injury to the urinary tract during pelvic surgery, like in gynecologic and urologic procedures [5, 7]. It is estimated that 75–80% of VVF resulting from surgical procedures are at the time of hysterectomies [1, 2, 4, 8]. Laparoscopic hysterectomy carries the greatest risk of VVF at 2.2/1000 while the transabdominal approach has an incidence of 1/1000 and the transvaginal approach has an incidence of 0.2/1000 [1]. About 2% of surgical VVF are due to urologic or colorectal surgeries [4]. With iatrogenic causes, VVF results from ischemia of tissues due to a thermal injury, devascularization during dissection, or unintentional suture placement through the bladder with subsequent delayed necrosis.

Other infrequent causes of VVF include radiation, malignancy, inflammatory diseases, trauma, infection, and foreign body, like a retained pessary. Radiation to the pelvis, which is usually administered for treatment of cervical or uterine cancer, has an estimated VVF rate between 1–5% with greater risk of fistula formation when the original disease has bladder involvement [9, 10]. Radiation causes VVF through tissue necrosis by mechanism of tissue fibrosis and radiation-induced obliterative arteritis, which can be seen microscopically [11]. Radiation-induced VVF can present as early as a few months after the end of radiation treatment to up to decades later [4, 11–13]. The involved tissues are often fixed, fibrotic, and poor in blood supply. VVF as a result from malignancy is quite rare, estimated between 3–5% of all VVF [2].

The actual incidence of VVF worldwide is unknown but is estimated to be 0.3–2% [1, 2].

Diagnosis

Presentation and Patient History

Clinical history is important in diagnosis of VVF. Establishing the temporal relationship between the onset of symptoms and the likely inciting event is key. Individuals usually complain of continuous urinary leakage day and night, with the degree of leakage dictated by the size and location of the fistula. The interval of time between the inciting event and presentation can range from a week to years, depending on the mechanism of injury. VVF secondary to an unrecognized injury during pelvic surgery usually presents within 5–14 days post-operatively [4]. Besides urinary leakage, the patient may also have signs of infection, ileus, fever, abdominal pain, or hematuria. VVF associated with a history of pelvic radiation may present significantly later, ranging from 3 months to 30 years [4, 11–13]. Patient's other medical and surgical histories must also be obtained.

Examination

Vaginal examination is essential for diagnosis and identifying characteristics of the VVF that may affect surgical planning. Instruments that may aid in diagnosis include a speculum, packing gauze, long cotton-tipped swabs, urethral catheter, saline, and a dye, like methylene blue or indigo carmine. The size of the fistula, number of fistulae, location, the quality of the vaginal tissue, vaginal depth and vaginal diameter, mobility, and presence of prolapse and stress urinary incontinence must be noted. Urine in the vaginal vault is strongly suggestive of a fistula. If there is substantial fluid within the vagina, it can be collected and sent for creatinine, which indicates urine if the fluid creatinine is elevated relative to serum creatinine levels.

However, if no urine or fistula tract is found, the bladder can be distended with a solution of methylene blue, indigo carmine, or betadine, and the vagina inspected. Additionally, gauze can be packed into the vagina, and after having the patient ambulate, the gauze can be removed and inspected for the dye. One must be aware that there could be dye on the gauze on the distal end if the patient has concomitant stress urinary incontinence. The most common site of a fistula after hysterectomy is at the vaginal cuff [14]. A double dye test may be employed to evaluate for ureterovaginal fistula. The patient first takes oral phenazopyridine, which will cause the urine to turn orange. Then, the bladder is instilled with methylene blue and the vagina packed as previously described. If the gauze has orange on it, then the patient likely has a ureterovaginal fistula.

Diagnostic Studies and Procedures

In addition to the pelvic examination, vaginoscopy and cystoscopy may be useful in VVF diagnosis and localization. On cystoscopy, the proximity of the fistula or fistulae to the bladder neck, trigone, and ureters must be established. The presence of any foreign bodies should also be ruled out. If the cystoscopy and pelvic examination are performed under anesthesia, bilateral retrograde pyelography should be included to rule out a ureterovaginal fistula, which is present with 10–15% of VVF [15]. If the fistula is small, a ureteral access catheter or wire can be passed to establish the anatomy of the tract. Biopsy should be performed for those with suspicion of or a history of malignancy. Although not necessary, imaging with computed tomography (CT) urogram, cystogram, or voiding cystourethrography may also be used for additional information about VVF and rule out involvement of upper tracts or other structures/organs.

In patients with a concern about post-operative bladder function, especially those with a history of radiation, video urodynamics should be used preoperatively to evaluate bladder compliance and capacity as they may benefit from a concurrent augmentation enterocystoplasty at the time of fistula repair [13]. Of note, an adequate urodynamic exam may be challenging due to continuous leakage from the fistula during the filling portion of the exam. Additionally, presence of stress urinary incontinence (SUI) must be evaluated if possible as those with fistulae encompassing the bladder neck or urethra often have SUI despite successful repair [16]. Concomitant fascial sling placement may be in order if this is the case.

Classification

There is no standardized system of classifying urogenital fistulae, but several factors are consistently used in the literature to describe them to gauge prognosis of successful repair and the degree of surgical difficulty [3, 5, 17, 18]. These factors also apply to VVF and are summarized in Table 10.1 [15, 17–19]. In general, simple fistulae are single, less than 2.5 cm in size, do not involve other structures, are not caused by radiation or malignancy, and do not have a history of previous failed repair.

Table 10.1 Classification of VVF

	Simple	Complex
Size	Less than 2.5 cm	Greater than 2.5 cm
Number	Single fistula	Multiple fistulae
History	No history of failed repair	History of failed repair
Radiation	No history of radiation	History of radiation
Location	No involvement of ureters or bladder neck	Bladder neck, ureters, or other organs/structures involved

Timing of Repair

There is considerable debate on the timing of VVF repair in relation to the inciting event, with timing categorized as "early" or "late." Though there are no standard definitions for these intervals of time, early repair is usually considered within 3 months of inciting event and late repair is after 3 months. General principles of wound healing suggest waiting 3–6 months after the inciting event before undertaking a surgical repair to allow the fistula to mature and fully declare itself. However, multiple retrospective series suggest this practice may only be applicable in cases of obstetric fistulae or radiation-induced fistula where large amounts of necrotic tissue could still develop and threaten breakdown of any surgical repair [20]. Although the series are small and include varying approaches to VVF repair, that is transvaginal or transabdominal and with or without an interposition flap, they all suggest that early repair of VVF in settings of iatrogenic injury are acceptable with success rates over 93% [21–27]. The results are summarized in Table 10.2. All of the authors advocate for early repair of VVF to reduce patient distress from the condition. There are even a few studies supporting early repair of obstetric fistulae although the success rates were lower at 87.8% and 95.2% [28, 29]. Patient selection is key; the consensus is if the tissues appear healthy, then surgical VVF repair can proceed without delay. Caution should be taken in patients with prior radiation, obstetrical trauma, and prior failed repair.

Table 10.2 Series evaluating timing of VVF repair and outcomes

Author, year	Timing of repair	Number of patients	Surgical approach	Follow up	Success rate
Wang, 1990	<3 months or >3 months	16–7 early, 9 late	TV	1–60 months	93.7%
Blandy, 1991	<6 weeks or >6 weeks	25–12 early, 13 late	TV	3 months	100%
Blaivas, 1995	<3 months or >3 months	23–13 early, 10 late	TV or TA, used interposition flaps when necessary	6–48 months	96%
Kostakopoulos, 1998	<3 weeks	20	TV or TA	24 months	100%
Tsivian, 2006	<8 weeks	26	TV or TA	12 months	100%
Lee, 2010	14–289 days	5	LAP	6 months	100%
Giusti, 2018	<3 weeks	16	LAP with fibrin sealant patch	3 months	100%

TV transvaginal, *TA* transabdominal, *LAP* laparoscopic

Conservative Management

If surgical repair is not immediate, conservative measures that may be undertaken include continuous bladder drainage with an indwelling catheter, fulguration of the fistulous tract, or the use of fibrin or cyanoacrylate glue in the tract [3, 5]. Fulguration or application of glue can be performed transvaginally or endoscopically. There are limited case reports and case series on conservative measures with resolution ranging between 67–100% [5, 30, 31]. With catheter drainage alone, one meta-analysis only reported an 8% success rate over 4 weeks [5]. In another study, the authors used platelet rich plasma injections transvaginally for a success rate of 91.7% [32]. Conservative management can be considered if there is less than 3 weeks between fistula onset and inciting event, long and tortuous fistula tract, fistula size less than 1 cm, no history of radiation, and improvement in leakage with bladder drainage [3, 5, 33].

Indications for Abdominal Approach

The decision for an abdominal approach for VVF repair is largely driven by patient and surgeon preference as well as the need for concomitant abdominal surgeries like augmentation enterocystoplasty, ureteral reimplantation, or repair of an enteric fistula. Other factors to consider, listed in Table 10.3, include location of fistula, history of irradiated tissue, and history of unsuccessful repair [34–36].

The open abdominal approach to VVF repair can be quite morbid with longer operative times and greater blood loss when compared to the transvaginal approach although data are mostly based on retrospective reviews and not derived from randomized controlled trials [19, 37, 38]. It seems that most surgeons in the literature prefer a transvaginal approach to VVF repair with simple fistulae [15, 19, 37].

Table 10.3 Factors influencing decision for abdominal approach for VVF repair

Patient preference
Surgeon preference and experience
Type of fistula and location, including presence of other fistulae
Severely irradiated tissue
Repeated previous failures
Vagina too scarred, limiting access
Need for a graft or another abdominal procedure at the same time (repairing fistulae involving other pelvic organs, ureteral reimplantation, augmentation cystoplasty)
Hospital resources, access to anesthesia

Preoperative Care

Patients undergoing surgery should be optimized nutritionally and be treated with antibiotics if there is an active infection preoperatively. Although Waaldjik reported in a cohort of 1,716 with obstetric fistulae that perioperative antibiotic prophylaxis was not necessary for successful repair, both the American Urological Association and American College of Obstetricians and Gynecologists recommend perioperative antibiotic prophylaxis prior to VVF repair [28, 39, 40].

Another consideration to improve tissue quality is with transvaginal estrogen. Even though there are no studies specifically evaluating its effects on successful fistulae repair, some have supported their use given estrogen's impact on cell proliferation and blood supply in the vaginal epithelium [41].

Surgical Technique

The basic principles for VVF repair should include adequate mobilization of tissues, tension-free and watertight closure, multilayered suturing with non-overlapping suture lines, and postoperative bladder drainage [3, 38]. These are summarized in Table 10.4. Hemostasis is crucial so that a hematoma that may put tension on the repair does not develop. Conversely, there must be adequate blood supply to the tissues so that healing is not hindered. As such, electrocautery, if utilized, must be precise so that the blood supply of surrounding tissues is not compromised.

There are several techniques in VVF repair with an abdominal approach that can be categorized by how the fistula is initially identified and addressed—either transvesical or extravesical and either transperitoneal or extraperitoneal. Either way, all transabdominal VVF repair techniques begin with prophylactic preoperative antibiotics, and the patient placed in either dorsal lithotomy or supine, frog-legged position, which permits cystoscopy and access to the vagina. The genitals and abdomen are both prepped for the procedure.

Table 10.4 Surgical principles in VVF repair

Tension-free closure
Watertight closure
Maximal drainage
Closure in layers
Hemostasis
Maintenance of blood supply to tissues

Cystoscopy is performed to examine the bladder and identify the fistulous tract. If found, the tract should be cannulated with a 5-French open-ended catheter or a wire, which will aid in manipulating the tissue and identifying the tract. As previously stated, biopsies can be taken if there is any suspicion of malignancy, and the ureters can also be evaluated if they have not been already. Ureteral stenting can also be performed at this time if there is concern that they are close to the repair. Although there are no studies evaluating the protective advantages of ureteral stenting at the time of VVF repair, this is a best practice the European Association of Urology Robotic Urology Section recommends [42]. At this time and a Foley catheter is placed on the field to drain the bladder.

Either a Pfannenstiel incision or infraumbilical midline incision can be used to enter the abdomen and space of Retzius. Regardless of transvesical or extravesical approach and transperitoneal or extraperitoneal approach, the bladder is first maximally mobilized extraperitoneal as much as possible, including the posterior plane. A sponge stick or circular sizer in the vagina can aid in dissection by retracting the vagina away from the bladder, especially in the case of prior hysterectomy.

If the plane between the posterior bladder and vagina is difficult to develop, the peritoneum can first be entered, and the bladder opened in a sagittal plane until the fistula is encountered [34, 43]. This tends to be the case in prior hysterectomy. Once the bladder and vagina are fully separated and mobilized, the defects can be repaired with absorbable suture like 2-0 Vicryl.

In the transvesical extraperitoneal approach, which was first described by O'Conor, et al., the bladder is bivalved in a vertical fashion from the dome and carried posteriorly until the fistula is reached after initial mobilization of the bladder extravesically and extraperitoneally [44]. Stay sutures are placed at the dome to aid in retraction. If necessary, the peritoneum can be entered to afford further mobilization between the posterior bladder and vagina so that a two-layer closure can be performed without any tension. The O'Conor technique is suitable in cases where the fistulous tract is unknown [6]. Once encountered, the fistulous tract can be excised if desired or if there is concern for malignancy. In the absence of malignancy, there is debate regarding the need for fistulous tract excision with studies noting no difference in success rates with or without fistula excision and with those performing excision as preference [45, 46]. The ureteral stents can then be removed, and efflux confirmed. Thereafter, the cystotomy is closed in two layers with an absorbable suture like 2-0 Vicryl, and the vagina is closed transversely in similar fashion with 2-0 Vicryl. The integrity of the bladder closure can be assessed with retrograde filling of the Foley catheter with saline. The O'Conor technique is arguably the most accepted method of VVF repair and allows for uncomplicated tissue interposition given excellent mobilization of the bladder and vagina [6].

VVF repair can also be performed extravesical and extraperitoneal if the site of the fistula is known. As in the O'Conor technique, the bladder and vagina are first dissected extravesically and extraperitoneally as much as possible. The previously cannulated fistulous tract will then be encountered in the vesicovaginal space during this dissection. Once there is adequate mobilization, the cannula is removed, and the

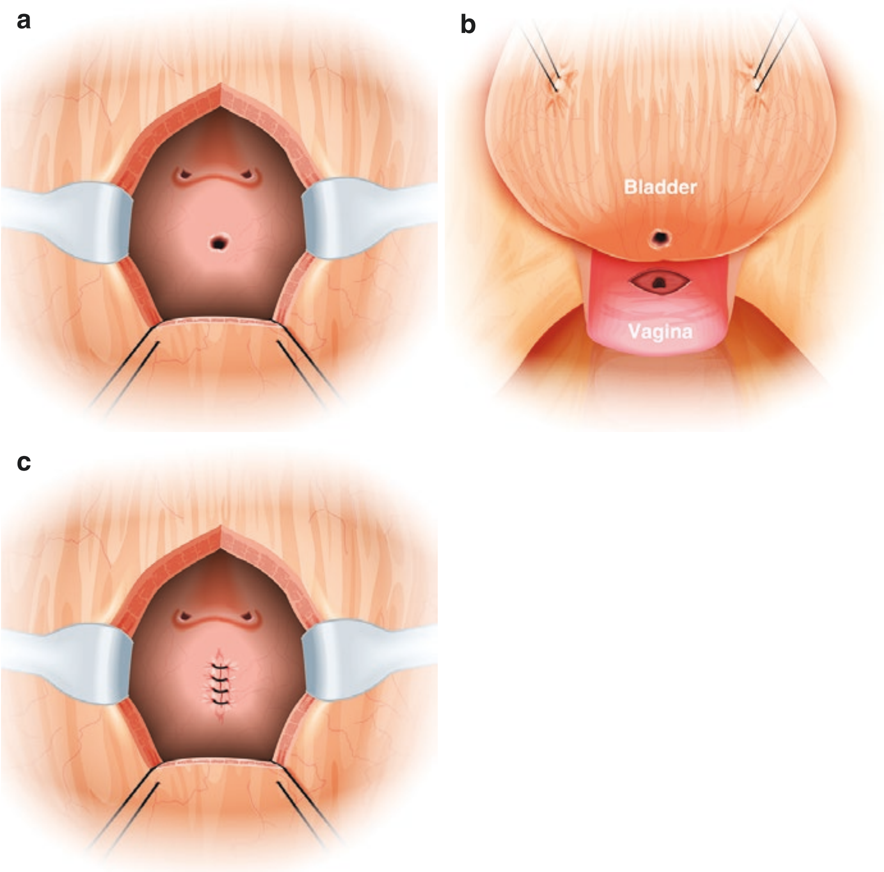

Fig. 10.1 Transvesical approach to vesicovaginal fistula repair. (**a**) Cystotomy exposing the fistula. (**b**) Maximal mobilization vesicovaginal plane. (**c**) Final transvesical repair

fistula repaired in layers as described above with absorbable suture, with or without fistula tract excision. The technique minimizes trauma to the bladder by avoiding its bivalving. The ureteral stents can alternatively be removed at the end of the procedure. Figure 10.1 illustrates a modified O'Conor approach where the bladder is opened but only for identification of the fistulous tract and for a transvesical repair so that the cystotomy is minimized.

An alternative approach to VVF repair is the transvesical vesical autoplasty [47]. The bladder is opened with a sagittal incision, and the fistula identified. Once the tract is excised and the plane between the bladder and vagina is developed around the excised tract, the vagina is closed so that the edge is inverted away from the bladder. Next, a wide-based posterosuperior muscular bladder flap is created transvesically and advanced caudally over the closed fistula tract.

After repair, cystoscopy is routinely performed to confirm ureteral efflux and no inadvertent injuries to the urinary tract. Intravenous sodium fluorescein, methylene blue, or indigo carmine can be given to aid in visualization of the ureteral jets.

Post-operative Care

Once the repair is complete, maximal and uninterrupted bladder drainage are essential to allow for healing without tension. A suprapubic catheter can be placed should there be concern that the urethral catheter would be inadequate. Jackson-Pratt (JP) drains are recommended when a transvesical approach is utilized as they allow monitoring of leaks. The drain should be placed in the cul-de-sac and removed after the output is less than 30 mL in 24 h, which is usually after 2–3 days post-operatively. If there is any concern for a leak, the JP fluid can be evaluated for creatinine.

A retrograde cystogram can be performed to confirm no leak prior to catheter removal although some practitioners do not perform any evaluation before catheter removal [8]. In a retrospective study evaluating 10, 12, or 14 days of catheter drainage, there were no significant differences in repair breakdown among these periods [48].

Nothing should be placed within the vaginal for up to 2 months post-operatively to avoid disrupting the vaginal closure. Patients often experience bladder spasms post-operatively, so intradetrusor onabotulinumtoxinA can be administered at the time of the repair or oral anticholinergics or β_3 agonists administered during convalescence [2].

Concomitant Procedures

Tissue Interposition

In VVF repair, interposition tissues function as barriers to prevent suture overlapping and introduce vascularized tissue to poorly vascularized areas [38]. There are no well-defined criteria for the use of interposition tissues. Furthermore, there are limited randomized, controlled trials comparing interposition flaps and their success rates. In general, tissue interposition is used in large or multiple coexisting fistulae, in irradiated tissues, or after failed repairs [16, 49–51]. Even though the surgeon may plan for a certain tissue flap preoperatively, the ultimate decision for which tissue is used is typically made intraoperatively [49]. A summary of available flaps is provided in Table 10.5.

The omental flap, supplied by the right and left gastroepiploic arteries, is the most used interposition tissue in transabdominal VVF repairs given its ability to reach the pelvis, availability, neovascularity, and ability to function as a bladder patch should the bladder have any defects after closure [49, 51, 52]. Harvesting the

Table 10.5 Summary of available interposition flaps during abdominal approach for VVF repair

Tissue flap	Vascular supply	Advantages	Disadvantages
Omental	• Omental branches of the left and right gastroepiploic arteries	• Commonly used • Rich in lymphatics and blood vessels • Angiogenic properties	• Potential need for mobilization • Potential anatomical restrictions or scarring due to prior procedures
Peritoneal (parietal)	• Deep circumflex iliac, lumbar, intercostal, and inferior and superior epigastric arteries	• Available when omentum is not • Minimal dissection	• Challenging to identify if surrounding inflammation or scarring is present
Urachal	• Deep circumflex iliac, lumbar, intercostal, and inferior and superior epigastric arteries	• Easy to identify • Straightforward dissection • Variation of the peritoneal flap	• May be compromised from prior radiation
Rectus Abdominis	• Inferior epigastric pedicle	• Non irradiated tissue • Rich blood supply of rectus • Can also be used for vaginal reconstruction	• Potential risk of incisional hernia • More complicated dissection than omental or peritoneal flaps
Gracilis	• Medial femoral circumflex artery	• Non irradiated tissue • Can also be used for vaginal reconstruction	• Additional incisions in the leg required

omentum starts with the division of one gastroepiploic artery and the vasa recta along the greater curvature, with mobilization off the transverse colon enabling rotation of the omentum deep into the pelvis, supported by the remaining gastroepiploic pedicle. The flap is then seated in between the bladder and vagina and secured without tension.

When the omentum is not available or cannot be mobilized, a flap of peritoneum may be used for interposition. The peritoneum can be procured from the dorsal or caudal margin of the fistula, anterior to the rectum or from the lateral parietal pelvic peritoneum [49, 53]. A wide base and harvesting peritoneum with its underlying fat will ensure adequate blood supply to the flap. The flap is then anchored without tension between the bladder and vagina with absorbable suture.

If a peritoneal flap is difficult to identify, a urachal flap can be used, which is a variation on the conventional peritoneal flap [54]. The urachus is first ligated distal to the umbilicus and then mobilized from the anterior abdominal wall along with lateral peritoneal wings as the pelvis is approached. The bladder must be fully mobilized anteriorly and filled as well to dissect the urachal flap off the bladder in the cephalad direction [54]. Once the urachal flap is fully free, it is folded posteriorly between the bladder and vagina, and secured with absorbable sutures. James and colleagues reported a 92% success rate using the urachal flap in their series of 13 patients [54].

In patients with very large post-radiation defects, a local muscle-based flap may be used. One such flap is the rectus abdominis, which can be harvested unilaterally or bilaterally. With a midline incision through the linea alba, the rectus is dissected from the anterior sheath above the arcuate line. Small perforating vessels must be controlled while the inferior epigastric vessels are preserved. After adequate dissection, the muscle is divided at its insertion at the tenth costal margin or more inferior depending on the flap length required [55, 56]. After the superior epigastric vessels are identified and ligated on the posterolateral surface, the posterior sheath is incised so that the muscle can be delivered into the abdominal cavity and then into the pelvis inferiorly. A portion of the posterior sheath can be kept on the muscle flap superiorly to provide scaffolding on which to secure sutures [57]. If the muscle flap cannot reach the pelvis without tension, further mobilization can be achieved by dissecting the rectus from the insertion at the pubic symphysis [12, 55, 57].

Another local myofascial flap is the gracilis muscle flap [58]. The gracilis muscle is first freed from its distal attachments and overlying skin and subcutaneous tissues in the medial thigh through three small skin incisions, all on the inferior margin of the muscle belly [59]. Horizontal incisions are made in the urogenital diaphragm and endopelvic fascia, and the muscle is tunneled through these incisions from the upper thigh through the urogenital diaphragm and endopelvic fascia medial to the pubic arch [59]. Once in the pelvis, the gracilis flap can be secured between the bladder and vagina with absorbable sutures.

With large defects, like circumferential vaginal defects, a myocutaneous version of the gracilis or rectus abdominis flaps can be used for reconstruction [56, 60, 61]. Instead of dissecting the muscle away from the overlying subcutaneous tissues, the skin overlying the muscle is also procured with the muscle flap [60, 61]. The flap can be folded or even tubularized with the skin facing the lumen of the vagina to cover significant defects and serve as tissue interposition [56, 60, 61]. Alternatively, in the case of a rectus abdominis flap, the anterior sheath can be harvested with the muscle alone and used to reconstruct the vagina and serve as tissue interposition [56].

Augmentation Enterocystoplasty

Radiation fibrosis of the bladder can reduce bladder compliance and capacity, which can be exacerbated by fistula repair given potential need for cystotomy in a transvesical approach. In patients with defunctionalized bladders or irradiated bladders with poor compliance and capacity, an abdominal approach to VVF repair allows for concomitant augmentation enterocystoplasty. As mentioned earlier in the chapter, video urodynamic evaluation in patients with history of radiation or suspected defunctionalized bladders may help guide decision for concomitant augmentation. Principles of tension-free closure and prolonged, uninterrupted bladder drainage are as important as ever given that a leak in the augment or repair can lead to a more disastrous fistula. Tissue interposition in this setting is recommended.

Ureteral Reconstruction

Ureters should be evaluated either prior to surgery or at the time of surgery using retrograde pyelogram, with attention to stricture, possible hydronephrosis, proximity of the ureters to the fistula.

A ureteroneocystostomy is recommended when there is concomitant fistulae or ureteral injury to the pelvic ureter or if the fistula is near the ureteral orifice. The ureteroneocystostomy should be performed using a transvesical approach before closing the bladder incision. If tension is present at the reimplantation site, further mobilization of the bladder and ureter may help, or a Boari flap or psoas hitch may be performed.

Complications and Outcomes

Peri-Operative Complications

Like any other surgery, peri-operative complications from open, transabdominal VVF repair include pain, infection, blood loss, ileus, bowel obstruction, and injury to surrounding organs or structures. It is difficult to make conclusions on post-operative complication rates across all transabdominal VVF repairs due to the heterogeneity in the VVF's and the diversity in methods of transabdominal VVF repairs. In one retrospective study comparing the cost effectiveness of vaginal (n = 32) versus transabdominal (n = 15) VVF repair, Warner and colleagues reported no perioperative complications or 30-day readmissions in either group [62]. Another study by Theofanides, et al., data analyzed from the American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) showed that 23.2% of patients (n = 70) had post-operative complications with urinary tract infection (UTI) (12.9%) being the most common complication then need for blood transfusion (7.1%) [63]. Other complications included deep venous thrombosis (1.4%), sepsis (4.3%), superficial surgical site infection (SSI) (2.9%), and organ/space SSI (1.4%); and the authors reported a 10% 30-day readmission rate [63]. These complication and readmission rates, except for UTI, were statistically significantly greater in the patients undergoing abdominal VVF repair compared to vaginal VVF repair [63]. Unfortunately, the ACS-NSQIP data lack granularity regarding VVF characteristics and success rates.

Success of Repair

One of the most tragic complications of VVF repair is failure of the repair. The highest rate of success is with an initial repair ranging from 86 to 95.79%, but additional fistulae, surgeon, and technical factors may also contribute to repair success

[46, 50, 62]. In 102 patients who underwent transabdominal VVF repair, Özkaya, et al., reported a success rate of 95.79% in those undergoing primary repair and only 80% success in secondary repairs [46]. Furthermore, success rates were not affected by surgical approach, either transvesical or O'Conor, in their cohort [46]. Mancini, et al., also found that the number of closure attempts affected their success rates of repair in their retrospective review of 138 women undergoing transabdominal VVF repair [64]. On the contrary, a retrospective study of 123 women undergoing VVF repair by Zhou, et al., found no difference in success rates based on primary or secondary attempt; however, they did find number of fistulae and the presence of perifistula fibrosis to be statistically significant factors associated with failed repair [65].

In another retrospective study analyzing 73 consecutive women who underwent VVF repair, Ayed and colleagues found etiology, size, multiplicity, and type of VVF to be prognostic factors in success of VVF repair [66]. Specifically, obstetrical cause, fistula size greater than one centimeter, the presence of multiple fistulae, and complex fistulae involving the bladder, cervix, or urethra were factors that contributed to repair failures [66]. They also found that UTI present before the repair was a poor prognostic factor [66]. Similarly, in their review of 41 patients with VVF and urethrovaginal fistula, Ockrim and colleagues reported that fistula size was a major contributor to fistula success with size greater than three centimeters being a negative factor [50]. They also found that the use of a tissue flap, specifically omental, contributed to higher success rates; success rate with any abdominal approach was 75% versus 94% among those who had an omental flap [50].

When comparing transabdominal versus transvaginal VVF repair, success rates appear to be comparable although there are no randomized controlled trials evaluating them. Furthermore, there are numerous factors besides surgical approach that could affect success of a repair. Warner, et al., compared cost-effectiveness of vaginal versus transabdominal approach to VVF repair and found no statistically significant difference in success rates, 91% in vaginal and 86% in transabdominal [62]. However, they did find the total cost for successful repair was statistically significantly less in patients undergoing a vaginal approach, likely due to the difference in length of inpatient stay [62]. Similarly, Gedik, et al., did not find a statistically significant difference in success rates with transvaginal (100%) versus transabdominal (96.4%) approach in their retrospective review of 53 consecutive women undergoing VVF repair [36]. In contrast, one investigation pooled data from three other studies and concluded that closure rates were statistically significantly greater in the transvaginal group compared to the transabdominal group with 90.9% versus 84.0% [8].

Urinary Outcomes

Besides success of fistula closure, bladder and sexual functional outcomes are also important in VVF repair. These long-term complications include overactive bladder (OAB) and stress urinary incontinence (SUI). Like idiopathic OAB, OAB following VVF repair is also treated with oral anticholinergics and β_3 agonists as well as third-line therapies such as onabotulinumtoxinA and sacral neuromodulation.

SUI following successful VVF repair most commonly occurs in those with fistulae that involved the bladder neck or urethra, which occurs predominantly in those with obstetrical fistulae, upwards of 30% [16, 67, 68]. The type of SUI is thought to be due to intrinsic sphincter deficiency [16]. Classically, an interval of 6 months post-VVF repair was recommended prior to addressing the SUI [69]. A retrospective study (n=140) on post-VVF repair SUI surgery with placement of a sling (either fascia lata, rectus fascia, or polypropylene mesh) demonstrated that there was not an insignificant risk with placement of a sling in a delayed fashion [70]. *De novo* fistula was seen in 18.7% of patients undergoing fascia lata sling, 12.5% in rectus fascia, and 13.3% in those undergoing synthetic sling [70]. Due to the high rate of injury with delayed sling placement, some have advocated for sling placement, even prophylactically, at the time of VVF repair and potentially less invasive strategies including urethral bulking and urethropexy [67, 69]. Previously used urethral plugs are no longer available on the market [71, 72].

A retrospective review comparing three SUI procedures performed at the time of VVF repair—pubococcygeal sling (PC sling), refixation of the pubocervical fascia (RPCF), or both PC sling with RPCF—revealed no statistically significant difference in VVF repair success rates or post-operative continence [73]. The authors reported 84% success in the PC sling group, 89.9% success in the RPCF group, and 93.8% success in the group having both PC sling and RPCF; furthermore, there was residual stress incontinence in 49%, 47.8%, and 43.8% of those groups, respectively [73]. Unfortunately, this study did not compare outcomes of using a concomitant SUI procedure with outcomes of VVF repair alone.

However, the authors did subsequently perform a randomized clinical trial comparing PC sling to autologous slings that were prophylactically placed at the time of VVF repair [74]. The 11 patients undergoing PC sling had VVF closure rate of 90.9% and residual incontinence rate of 63.6%. Ten patients underwent autologous fascial sling and had a closure rate of 80% and incontinence rate of 50%. The differences in success rates and incontinence rates between the two groups were not statistically significant [74]. From these studies, it seems that performance of an anti-SUI procedure at the time of fistula repair is acceptable to reduce risk of urinary tract injury at the time of delayed repair. Furthermore, the type of procedure—PC sling, autologous fascial sling, or RPCF—did not appear to affect surgical and continence outcomes although more studies comparing these procedures with each other and with VVF repair alone are needed to definitively make these conclusions.

Sexual Function Outcomes

There are also limited studies evaluating sexual function following VVF repair. The majority of sexual function outcome studies surround transvaginal VVF repair or are retrospective comparisons of transvaginal versus transabdominal repairs. In those undergoing a transvaginal approach, it is known that decreased vaginal caliber and size of fistula greater than three centimeters contribute to sexual dysfunction despite successful VVF repair [75]. A great majority of women have improved sexual function following successful VVF repair [75]. However, there are few retrospective studies comparing sexual functional outcomes of those undergoing transvaginal VVF repair with transabdominal VVF repair. Lee, et al., retrospectively compared urinary and sexual functional outcomes of 66 patients divided into three surgical groups—first-time repair attempt, second repair attempt, and more than 2 previous attempted repairs [76]. Using the Female Sexual Function Index (FSFI), Urogenital Distress Inventory-6 (UDI-6), and Incontinence Impact Questionnaire-7 (IIQ-7), the authors found no difference in urinary symptoms among the three groups; however, there was presence of female sexual dysfunction in those undergoing transabdominal VVF repair, although this was not statistically significant [76]. Unfortunately, only 22 women reported to have sexual activity following surgical repair, limiting interpretation of study results.

Mohr, et al., prospectively compared the clinical and sexual functional outcomes of 99 patients who had fistulae repaired at their institution [77]. All patients initially had a trial of conservative management with indwelling Foley catheter for 12 weeks. If the patient continued to leak, either a transvaginal or transabdominal VVF repair was performed. The patient underwent an abdominal approach if the fistula was greater than one centimeter, if the patient had no vaginal descent on straining, if the genital hiatus was less than two centimeters, or if the fistula was closer than 1.5 centimeters to the ureteric orifices. The authors followed patients for at least 6 months and evaluated clinical outcomes with the FSFI and visual analog scale to gauge general bother by the fistula. Ninety-nine patients were recruited, 60 undergoing transvaginal repair and 31 undergoing transabdominal repair. The authors found statistically significant improvement in sexual function following surgical repair of VVF regardless of surgical approach [77]. They also reported continence rates of 82% after transvaginal repair and 90% after transabdominal repair. Of note, only 64 of the 99 patients were sexually active during the follow-up period.

Similarly, Panaiyadiyan, et al., retrospectively compared sexual and urinary outcomes between women undergoing transvaginal and transabdominal VVF repairs [78]. Among the women who answered the FSFI, the transabdominal and transvaginal groups had mean scores that were not statistically significant (30.9 versus 28.7, respectively). Additionally, urinary function measured by the International Consultation of Incontinence Questionnaire-Short Fort was also not statistically significantly different between these two surgical approaches [78]. Interestingly, patient age at the time of repair and multiparity were the only two factors that were statistically significantly associated with higher sexual dysfunction [78]. Of note, the patient population of these studies are vastly different regarding age of patients, etiology of fistula, and culture as the above studies were performed in Malawi, the United States, Switzerland, and India. In general, surgical approach did not appear to affect sexual outcomes but more studies are needed to identify factors contributing to sexual dysfunction following VVF repair.

Conclusion

VVF is a devastating condition affecting women worldwide. The most common etiology varies from obstructed labor and obstetrical trauma in regions with limited access to emergency obstetrical care to iatrogenic injury to the urinary tract during pelvic surgery. In iatrogenic causes, early repair should be the goal. Bladder and sexual function must be considered as well, especially in radiation-induced fistulae. Regardless of surgical approach, principles of tension-free closure, adequate mobilization, prolonged bladder drainage, and potential use of interposition flap all contribute to a successful repair.

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

Aref S. Sayegh, Luis G. Medina, and René Sotelo

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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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).

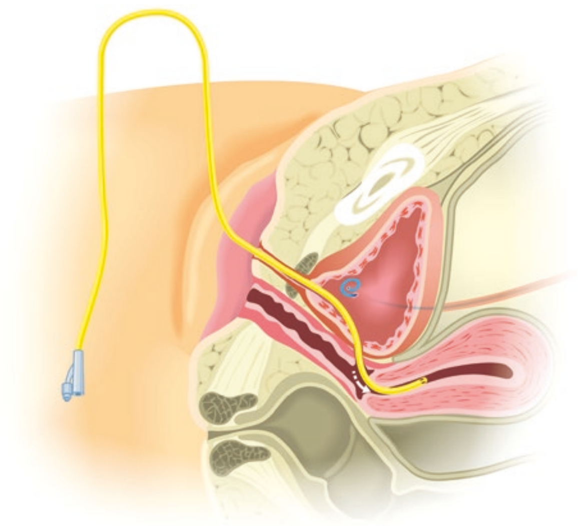

Fig. 11.1 Urethral catheter used to identify the vesicovaginal fistulous tract

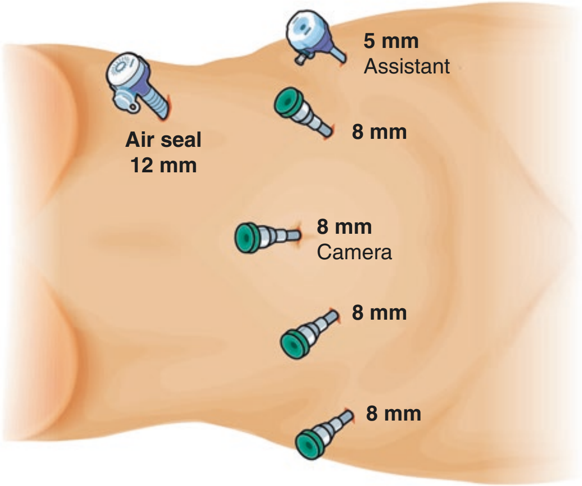

Fig. 11.2 Schematic drawing represents the robotic six-port transperitoneal configuration for VVF repair

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).

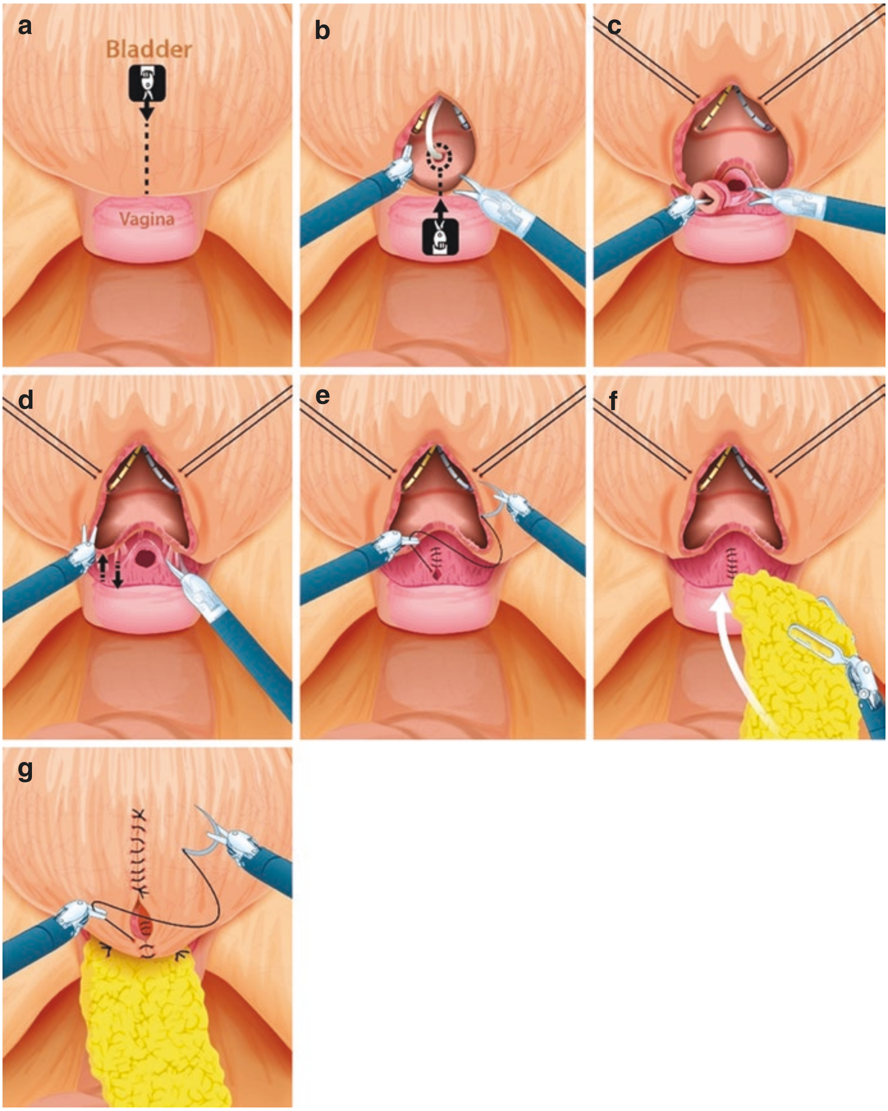

Fig. 11.4 Step-by-Step robotic VVF surgical repair. (**a**) A posterior longitudinal cystotomy performed with monopolar scissors in a downward fashion. (**b**) Schematic drawing represents vesicovaginal fistulous tract catheter, and dissection margins. (**c**) Fistulectomy performed with a combination 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

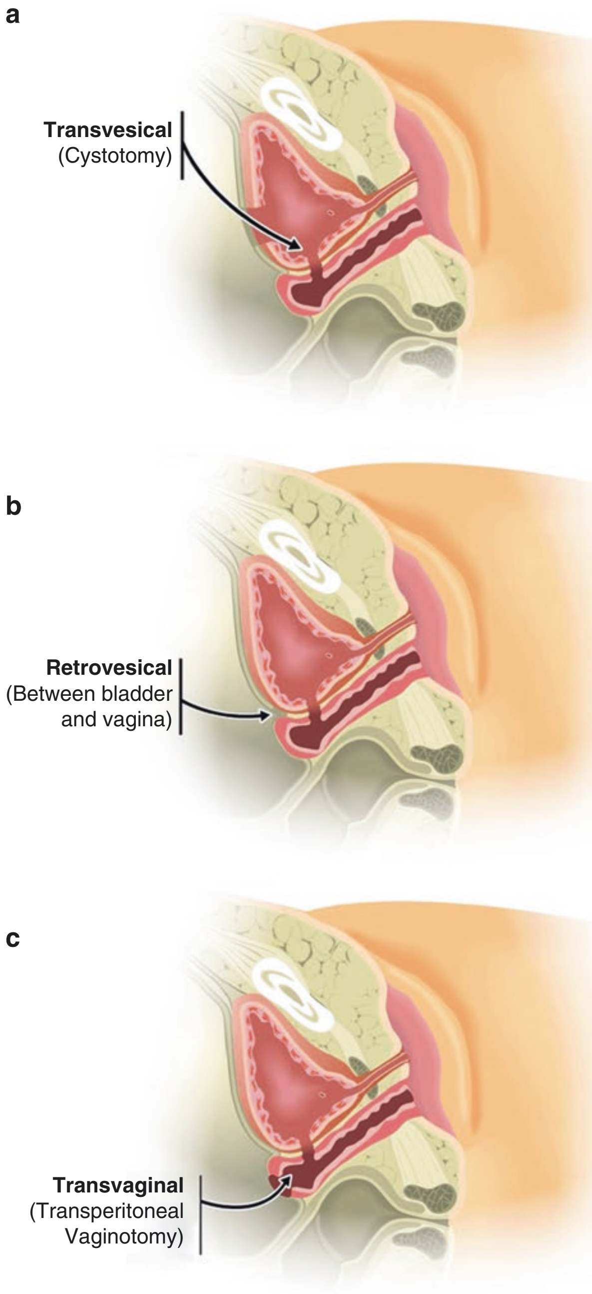

Fig. 11.5 Robotic surgical approaches for VVF surgical repair. (**a**) Transvesical: longitudinal cystotomy towards the fistula. (**b**) Retrovesical approach: extravesical access to the fistulous tract. (**c**) Transabdominal-transvaginal: opening the vagina towards the fistula

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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Chapter 12
Vesicouterine Fistula

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Abbreviations

CEUS	Contrast Imaging Using Ultrasound
CT	Computed tomography
HSG	Hysterosalpingography
IV	Intravenous
MRI	Magnetic resonance imaging
VUF	Vesicouterine fistula

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Introduction

A vesicouterine fistula (VUF) occurs when there is an abnormal communication between the bladder and uterus. Although it is a rare condition, accounting for only 1–4% of all urogenital fistulas, its incidence has been increasing because of increasing prevalence of cesarean sections [1–3]. It is a distressing condition as it can present with cyclic hematuria (menuria), urinary incontinence, secondary amenorrhea, and secondary infertility [4–15], especially because this condition impacts young women of parous age most often [7–16]. The most common cause today is iatrogenic, occurring in the setting of lower-segment cesarean section [1, 9, 17, 18]. The first case of vesicouterine fistula was reported in 1908 [19] and the first classification system was developed in 1957 [20].

Etiology

Although some VUFs are congenital, the vast majority are acquired [7, 18, 21–23]. Risk factors for acquired VUF include placenta percreta, manual removal of the placenta, previous cesarean section, uterine rupture, inflammatory bowel disease, and pelvic irradiation [6, 11, 16, 24]. The fistula communication usually occurs between the posterior supratrigonal part of the bladder and the anterior inferior portion of the uterus [12].

Acquired: Cesarean Section

In developed countries, two-thirds of VUFs occur in the setting of a lower cesarean section [6, 7, 13, 14]. The VUF can develop during a cesarean section due to insufficient caudal mobilization of the bladder, direct injury to the bladder or inadvertent incorporation of the bladder into the uterine repair [12, 13, 15, 17, 25–27]. Specifically, inadequate inferior and lateral mobilization of the bladder during the delivery of a large fetal head can predispose to the development of a VUF [25]. In addition to the cesarean procedure itself, prolonged and obstructed labor prior to carrying out a cesarean section can increase the risk of injury [13, 25, 28].

Acquired: Vaginal Delivery

Intraoperative cesarean delivery is not the only risk factor for VUF development [13]. Patients who have undergone previous cesarean delivery are at risk for developing a VUF in subsequent vaginal delivery [12, 13]. In this situation, the bladder may become adherent to the thinned uterine scar from the prior cesarean section; during the subsequent vaginal delivery this area is prone to injury [12, 13, 15, 25].

Immediate VUF development occurs when there is direct injury to the bladder. However, a VUF can develop in a delayed fashion due to ischemic necrosis and progressive devascularization of the posterior bladder wall [12, 13].

Congenital

Although most VUFs are acquired, congenital cases of VUF can also occur [18, 21, 22, 29]. Congenital VUF is associated with genital tract abnormalities involving the Mullerian ducts or the urogenital sinus [21]. As a result, congenital VUFs usually occur concomitantly with vaginal atresia or vaginal agenesis. The congenital VUF most likely develops at or after the fifth month of fetal life as canalization of the vagina occurs during this time. If there are any arrests or defects in this process, a VUF may develop. Specifically, abnormal anterior extension of Mullerian tubercle liquidation or increased fetal intrauterine and intravaginal pressure during the second half of gestation may predispose to this condition [22, 23, 30]. The increased pressure during fetal development can damage the thin uterine or vaginal wall resulting in the defect.

Epidemiology

VUFs are a rare condition and encompass 1–4% of all urogenital fistulas. In the first half of the twentieth century VUFs were most reported as a post-obstetric complication [15, 31, 32]. In recent years, worldwide VUF prevalence has been increasing and the most common association has been identified as cesarean sections as previously described [6, 25]. VUFs most often impact women between the ages of 25 and 33 [14, 16]. However, women of other ages can also be affected, as in the case of congenital VUF and VUF secondary to radiation therapy and non-obstetric gynecologic surgery [33].

Classification

Youseff's Syndrome

The clinical presentation of VUF was clinically described in 1957 and referred to as Youssef's syndrome after the author of the classification [20]. This triad of symptoms occurs due to a VUF above the internal uterine os and is characterized by menouria (cyclical blood-stained urine during the expected time of menstruation), amenorrhea and urinary continence. Patients remain continent because of higher intrauterine pressure that prevents the reflux of urine into the uterine cavity. Furthermore, the uterine endometrium may exhibit a sphincter-like effect, occluding the fistula and preventing urinary leakage into the uterine cavity [13, 20, 25].

Updated Classification

As the prevalence of VUFs has continued to rise since the original description by Youssef, the presentation has become more varied. As a result, VUFs have been reclassified by Józwik and Józwik to provide a clear and clinically significant picture of the patient's symptomatology [7]. The updated classification system is based on the direction of urinary and menstrual flow in order to physiologically categorize patients.

As a result, VUFs are subdivided into three types. Type 1 presents with menouria, amenorrhea and urinary continence, representing the original Youssef's triad [20]. Thus, in this type of VUF, both menstrual and urinary flow occur via the bladder, and neither occurs via the vagina. Type 2 presents with menouria, vaginal menses, and constant or periodic incontinence of urine. Urinary incontinence in this type of fistula occurs due to increased patency of the fistulous tract causing leakage through the cervix to the vagina. In this type of fistula, urinary and menstrual flow occur via the vagina and the bladder. A VUF occurring below the internal os presents with urinary incontinence without menstrual abnormalities and is consistent with Type 3 of the Józwik and Józwik classification system [13]. Thus, there is normal menstrual flow through the vagina (and none via the bladder) and urine flow via both the bladder and the vagina.

Complications

Fertility

A VUF can have a notable impact on fertility. VUFs are associated with secondary infertility and first-trimester spontaneous abortions [25, 34]. Both open and laparoscopic VUF repair have been shown to restore fertility [24, 35, 36]. In one study, a pregnancy rate of 31% was achieved after VUF repair, with a term delivery rate of 25% [10]. It is generally recommended that patients with successful VUF repair undergo cesarean section for subsequent deliveries in order to prevent the recurrence of VUF [25, 32]. For those with congenital VUFs, hysterectomy is often recommended. These patients often lack a cervical mucosa, making conception highly unlikely and rendering efforts to preserve fertility unwarranted [22, 37].

Social Impact

VUFs are associated with significant social and psychological distress [12, 14]. Patients develop different attitudes towards conception after VUF repair. Some patients have a desire to move forward with trying to conceive whereas others are fearful that another pregnancy could result in redevelopment of the VUF [10, 12]. The incidence of VUF recurrence following repair has not been rigorously assessed.

Diagnosis

Presentation

Despite the classic VUF being Type 1 in the Józwik classification system, the most common presenting symptom is urinary incontinence, representing Type 2 and 3 VUFs. Patients can present with vaginal leakage of urine, which flows from the bladder to the uterus, cervix, and vagina. When seeing patients with urinary incontinence, especially those with history of cesarean deliveries, a differential diagnosis of a VUF should be considered [38].

Unfortunately, the timing of the presentation varies, and diagnosis can be delayed. The delay is due to the nonspecific clinical presentations. In addition, findings on examination classically used to depict the fistula may be absent [39]. For example, Ugurlucan et al. reported a case of a VUF in a 55-year-old woman who presented with urinary incontinence thirty years after a cesarean delivery [40]. Atypical presentations such as findings of a prolapsed umbilical cord through a urethral meatus which was hypothesized to track into the bladder through a fistula developed during a previous cesarean delivery have also been reported [41].

Diagnostic Techniques

Several techniques can be used for evaluation of VUFs. Hysterosalpingography (HSG)is the gold standard investigation in demonstrating the fistulous tract. In Tancer's review of published reports, HSG was found to be the most reliable diagnostic technique [15]. The diagnosis of VUF is often confirmed by cystoscopy. However, cystoscopy, even when repeated, can fail to confirm the fistula. Methylene blue instilled into the uterine cavity, through the urethra, or via catheterization of a visible lesion in the bladder wall can confirm the fistula. This test, however, does not directly show the fistulous tract and its specific location. Moreover, this test can be negative in patients with long and tortuous fistula tracts [15].

Imaging techniques such as urography, ultrasonography and magnetic resonance imaging can be used; however, each has its limitations. Intravenous urography can show the fistula when the contrast medium enters the vagina, but distinguishing vesicovaginal fistula and VUF may be difficult. Although VUFs are difficult to diagnose sonographically, Park et al. reported that ultrasound can demonstrate the fistulous tract as double echogenic lines between the endometrium of the anterior wall of the uterine body and the mucosal layer of the posterior wall of the bladder [42]. However, it may be difficult to differentiate the fistula tract from different patterns of a cesarean scar using this technique.

Helical computed tomography (CT) is another tool that can be considered for diagnosis of a VUF [43]. The utility of this imaging modality depends on the location of the VUF. For VUFs that appear below the uterine isthmus, CT after IV contrast injection has high sensitivity for VUF detection. If the location of the fistula is more cephalad, helical CT, performed after HSG, gives more information about the precise topography of the fistulous tract [44]. Helical CT has the disadvantages of the need for IV contrast administration and additional procedures such as HSG. CT cystogram can also be used for evaluation and can provide better visualization than a CT with intravenous contrast alone. A CT cystogram can outline the fistulous tract and provide multiple imaging orientations with improved delineations [45].

Magnetic resonance imaging (MRI) is another noninvasive method for VUF detection and has the benefit of avoiding potentially allergenic and nephrotoxic contrast medium. It can also be more accurate in distinguishing between different soft tissues in the pelvis [46]. High resolution T2-weighted MRI can clearly demonstrate the hypointense fistula tract and hyperintense endometrial cavity due to stagnation of urine. MRI can denote the exact position of the fistula and its surrounding anatomy. As a result, it can be very useful in the diagnosis of VUF with atypical clinical presentations.

Finally, acoustic contrast imaging using ultrasound (CEUS) has also been used to diagnose VUFs. The method consists of instilling ultrasound contrast in the bladder and evaluating the flow of contrast in the uterus. The method is advantageous in that it provides a dynamic observation of the flow within the fistula. It also eliminates the need for radiation exposure and can be cost effective [47]. When ultrasound contrast is not available, methylene blue can be injected in the uterine cavity and a transvaginal ultrasound can be used to observe the flow of this material in the bladder.

Therapy

Treatment options for VUF include conservative, medical or surgical treatment. Surgery is the treatment of choice in most cases. As with any condition, the patient's current symptoms and degree of bother, as well as the patient's preferences and goals should be taken into consideration and the optimal treatment plan should be developed in a shared decision-making fashion.

Conservative and Medical Treatment

Conservative treatment of VUF has been reported to result in spontaneous closure of the fistula in up to 5% of cases [48]. Long-term continuous bladder drainage may allow small fistulae to heal [49–51]. Hormonal suppression of menstruation has also been utilized as a therapeutic approach to VUF, particularly if small [48, 52]. It is proposed that cessation of stimulation by estrogens of ectopic endometrium or estrogen receptor-positive glandular epithelium results in endometrial atrophy followed by spontaneous fistula healing. Yokoyama et al. reported the case of a young woman with a pinpoint-sized VUF who was successfully treated with subcutaneous monthly injection of leuprorelin acetate (an LH-RH analog) for 6 months [52]. Others have utilized hormonal manipulation in conjunction with cystoscopic fulguration [53].

Surgical Repair

Endoscopic, vaginal, abdominal, and laparoscopic approaches have all been described for VUF repair. Proper patient selection and surgeon experience is key. As VUF is rare, comparative outcome studies are lacking. An overview of the approaches and key considerations is presented.

Timing of Repair

A delayed approach to surgical repair of urogenital fistula has classically been advised. Advocates of this approach for VUF, which postpones repair to typically around 3 months following the causative event, cite the advantages of potential for spontaneous closure of the fistula and greater technical ease of surgery, as there should be less inflammation of the fistula tract, which may lower complication rates. An early repair approach, however, has been demonstrated to be safe and effective for urogenital fistulae [54]. The negative impact fistula symptoms, as well as the positive impact fistula repair, have on a patient's mental health, functional status and overall quality of life cannot be overstated [55, 56]. Thus, an immediate or earlier repair may (and, in this author's opinion, should) be offered in properly selected patients. Bettez et al. reported on two patients who underwent early repair of VUF, at approximately 3 and 17 days following delivery [57]. Although the authors describe significant inflammation of the fistula tract during the procedures, they report successful outcomes of both repairs, which utilized omental flap interposition in both and a subtotal hysterectomy in one.

Fertility Considerations and the Role of Hysterectomy

The reproductive desires of the patient should be considered when developing a surgical plan for repair of VUF. For the patient not desiring of future fertility, abdominal hysterectomy with closure of the bladder defect should be considered.

The presence of other uterine pathology that may warrant hysterectomy should also be evaluated. In the absence of this, a uterus-conserving approach should be taken in the patient desiring to preserve fertility, and future pregnancy and term delivery is possible following VUF repair [58].

Technical and Postoperative Considerations

Ureteral catheterization may facilitate intraoperative identification of the ureters. Continuous bladder drainage is performed routinely postoperatively. While the optimum duration remains uncertain, most recommend 10–21 days of continuous drainage via a transurethral or suprapubic catheter.

Vaginal Approach

Vaginal repair of VUF is feasible in select patients. When the fistula involves the cervix and bladder and can be identified and accessed through the vagina, a vaginal approach may be appropriate. After isolation of the fistula tract, the bladder is mobilized off the cervix and lower uterine segment. The bladder can then be closed in layers, followed by reconstruction of the cervix. Rajamaheswari et al. described a vaginal approach for vesicocervical fistulae with a torn anterior lip of cervix [13]. Of four cases attempted vaginally, one was converted to abdominal approach. In two cases a Martius flap was utilized. Dual bladder drainage was utilized in all cases. The repair was considered successful in all.

Abdominal Approaches

The abdominal approach to VUF repair is similar to that of the O'Conor technique for abdominal vesicovaginal fistula repair. Principles of the technique of abdominal VUF repair include high cystotomy and careful mobilization of the bladder from the uterus beyond the fistula tract, closure of the bladder in multiple water-tight layers, and reconstruction of the defect in the uterus if no hysterectomy is being performed. Strong consideration should be given to tissue interposition between the two suture lines. Both omental flap and peritoneal flap interposition have been described with success [6, 13].

Laparoscopic and Robotic Approach

The technique of laparoscopic and robotic-assisted laparoscopic approaches for VUF repair follows the principles of abdominal VUF repair. Several small case series and reports have demonstrated that this technique can be performed safely and effectively [59–62]. Early robotic repair is also feasible [63]. As with the abdominal approach, tissue interposition such as with peritoneal or omental flap should be considered.

Other Approaches

Spinelli et al. described an approach combining transurethral resection of the bladder side of the fistula borders with injection of autologous adipose tissue [64]. In this single case report, there was no radiographic evidence of recurrence at 3 months. Others have described electrocauterization and endoscopic application of tissue sealants and fibrin glue. Success rates of these procedures are low. Surgical treatment remains the gold standard, but these approaches may be considered in the properly counseled patient with a small (≤ 1 cm) fistula.

Conclusions

VUF is a rare but distressing condition, which usually affects younger women following a cesarean section. High index of suspicion is required to make the correct diagnosis, as the classic triad of menouria, amenorrhea and urinary continence appears infrequently in practice. Multiple diagnostic modalities including endoscopy and various radiological techniques are available to assist in diagnosis. Because of the rarity of the condition, studies to evaluate the therapeutic approach are limited. Small VUFs may be treated by bladder drainage and hormonal manipulation, but surgical intervention is usually required. Vaginal, open abdominal and laparoscopic repairs with and without hysterectomy are possible; the choice of surgical approach must take into consideration surgeon experience, fistula anatomy and patient preference.

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Chapter 13
Ureterovaginal Fistula

Aref S. Sayegh, Enanyeli Rangel, and René Sotelo

Abbreviations

CT	Computerized tomography
Fr	French
JP	Jackson-Pratt
UO	Ureteric orifices
UVF	Ureterovaginal fistula(e)
VVF	Vesicovaginal fistula(e)

Introduction

Ureterovaginal fistulae (UVF) are abnormal communications between the ureter and the vagina (Fig. 13.1). They are rare entities with an incidence of approximately 0.16% [1]. Clinically, UVF presents as continuous urinary leakage through the vagina, having a staggering impact on a woman's quality of life [2].

UVF are commonly seen after iatrogenic ureteral injuries during gynecologic surgical procedures. Occurring in up to 11% of the cases [3]. Also, they originate after obstetric procedures such as Cesarean sections, prolonged labor, and instrumental deliveries. There is a higher incidence in developing countries (80% vs. 5%

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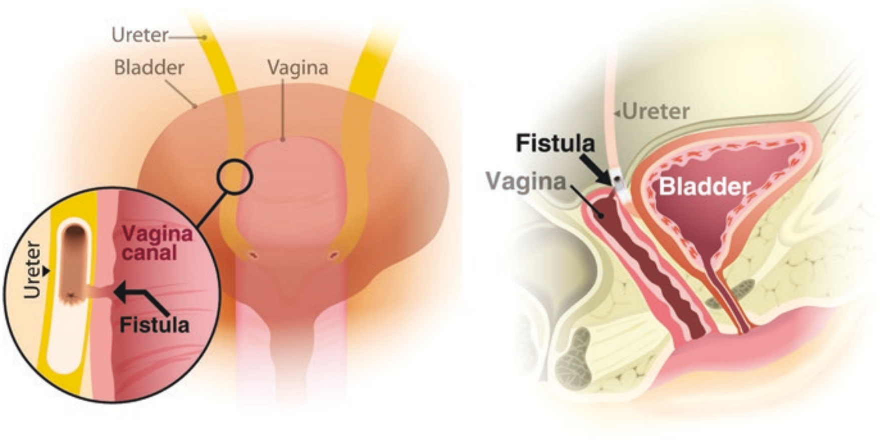

Fig. 13.1 Schematic drawing depicts a ureterovaginal fistula

in developed countries). Other causes include vaginal foreign bodies, retained pessaries, stone fragments after shock wave lithotripsy, radiation, infertility treatments, retroperitoneal fibrosis, or infection [2–6].

Clinical Features, Diagnosis

If the UVF were the consequence of a surgical event, the urine leakage through the vagina may be noted by the patient 1–4 weeks after the surgery.

Commonly UVF are mistaken with vesicovaginal fistulae (VVF) by its resemblance in the clinical presentation and causes. However, the sign that most differentiates the two, is the preservation of the normal bladder filling in UVF, due to the contralateral ureter [2, 3].

Once a UVF is suspected, the dual-dye tampon test is the diagnostic modality of choice in the clinical setting, due to its simplicity and cost-effectiveness. In the dual-dye tampon test the patients are instructed to take 200 mg phenazopyridine orally 2 h before the visit, later methylene blue dye instillation into the bladder using a Foley catheter is done. The purpose of this test is that methylene blue turns urine blue in the bladder while phenazopyridine turns urine orange in the kidneys. A vaginal tampon is placed and after 10–30 min if the orange staining is present UVF is confirmed.

Vaginoscopy/cystoscopy can be performed in order to obtain crucial information regarding fistula location and tissue quality. Also, cystoscopy can be used for the assessment of the ureteric orifices (UO), and to rule out the presence of VVF in unclear cases (12% of the cases presents with both fistulae concomitantly) [3].

Computerized tomography (CT) urogram, intravenous pyelogram/excretory urogram and retrograde ureterography are considered very useful in the diagnosis due to high sensitivity. With CT the fistulae can be identified, it gives additional information about the adjacent anatomical structures and may determine the presence of concomitant fistulae as well [7].

Classification

UVF can be classified by complexity, whereas complex fistulae include:

- Fistula size equal to or greater than 2 cm
- Fistula associated with radiotherapy
- Fistulas located at the bladder trigone or near the UO
- Multiple fistulous tracts
- Failed repair attempts
- Associated with ureteral strictures/injury or concomitant fistulae

Simple fistulae are ones that do not comply with the above (Fig. 13.2).

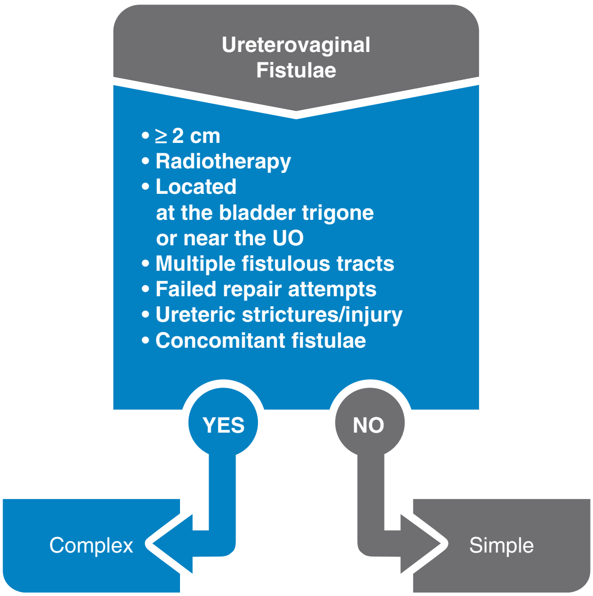

Fig. 13.2 Ureterovaginal Fistula classification based on complexity

Treatment Approaches

The caliber of the ureteral lumen and the complexity of the fistula will define the treatment approach.

Conservative Treatment

When the fistulae are considered simple conservative management can be attempted. In these cases, the ureters are patent or only partially stricture and are able to partially fill the bladder (Fig. 13.3a).

The conservative management consists of placement of a double J-stent for 6–8 weeks. The success rate of this approach is reported between 55% and 92% [2–5, 8]. If success is not reached after 8 weeks, ureteral reimplantation will be performed.

In cases where the stenting fails, the ureter is entirely occluded or the fistula is considered complex, a definitive surgical repair is recommended [3] (Fig. 13.3b).

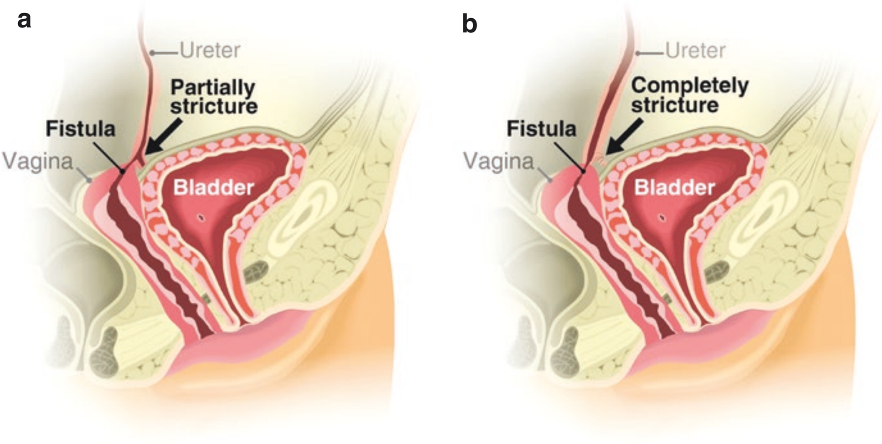

Fig. 13.3 (**a**) Partial stricture of the ureter, urine follows the fistulous tract and partially fills the bladder. (**b**) Complete stricture of the ureter presents with incontinence

Surgical Treatment

Currently, there is still controversy regarding the optimal time for the repair of UVF, ranging from 14 days up to 3 months. Nevertheless, performing the surgical repair 3 months after failed conservative management would allow for a decrease in the inflammatory response and edema in the surrounding tissues.

The best chance for a successful fistula repair is in the first surgical attempt [2]. Therefore, it is essential to maximize the efforts in the first try, as subsequent attempts will be more challenging.

The surgical treatment of UVF consists of ureteral reimplantation, which can be performed through an open, laparoscopic, or robotic approach. Depending on the location and length of the ureteral defect, several techniques are available.

As general rules to achieve successful repairs, the surgeon must ensure a complete excision of the diseased segment, maintenance of an adequate vascularization for the ureter, tension-free anastomosis, and sufficient postoperative drainage [9].

The ureteral reimplantation consists of transecting the ureter and performing a new ureterovesical anastomosis. Of note, mobilization of the ureter should be avoided to prevent the risk of necrosis. If the length of the ureter does not allow direct reimplantation, interventions to overcome these scenarios such as Psoas hitch, Boari flap, ileal substitution, or even renal auto-transplantation can be performed [3, 8, 10].

Nowadays, with the continuous advances in minimally invasive surgery, robotic approaches are gaining popularity among the field. Robotic surgery maintains the advantages of laparoscopic surgery with the added benefits of three-dimensional image visualization, increased magnification, tremor filtration, higher precision, optimized ergonomics, and the use of fluorescence imaging to ensure adequate blood supply of the related structures [2, 3, 11].

Step-By-Step Robotic Direct Ureteral Reimplantation Surgical Technique

Herein, we describe the step-by-step ureteroneocystostomy robotic approach for the repair of UVF.

Step 1: Patient Preparation

All patients should have mechanical bowel preparation and a single dose of prophylactic antibiotics (second generation cephalosporin or ampicillin/sulbactam + aminoglycoside) before surgery [12].

Step 2: Patient Positioning

After general anesthesia administration, the patient should be placed in dorsal lithotomy position.

Step 3: Port Placement and Docking of the Robot

Access into the abdomen is achieved with the Hasson technique [13]. Pneumoperitoneum up to 15 mmHg is established using a high-flow carbon dioxide Air-Seal insufflation system. A camera port is placed 5 cm above the umbilicus in the midline. Then, a 0-degree lens is used to assess for adhesions or bowel injuries that may have occurred during the initial access. Subsequent trocars placement under direct visualization in a six-port transperitoneal configuration is done. Bilateral 8-mm robotic ports are placed along the midclavicular line 3 cm above the level of the umbilicus. A 5-mm assistant port is placed several centimeters cephalad to the iliac crest on the right or left side of the 8-mm port previously placed which is used for suction irrigation.

Then, the patient in a steep Trendelenburg position. Docking of the da Vinci Surgical System is carried out. The Xi system is docked from the patient side, while the Si is docked between the patient's legs (Fig. 13.4). Adhesiolysis is performed using sharp and blunt dissection until the anatomical structures are identified.

Step 4: Ureter Dissection

The hemicolon is mobilized along the line of Toldt until the Psoas muscle is identified. The ureter is traced and carefully dissected preserving its blood supply. Then, the dissection is continued distally until the region of the ureteral lesion is encountered. Usually, the dissection plane becomes noticeable by the identification of fibrosis around the fistula site. The ureter is transected proximal to the fistulous tract. Debridement of the ureter edges is done, and the ureter is spatulated using robotic scissors.

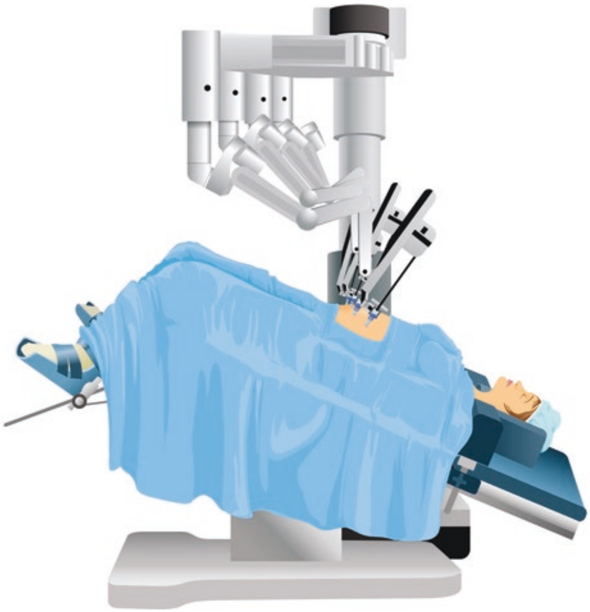

Fig. 13.4 Schematic drawing representing patient placed in steep Trendelenburg position

Step 5: Bladder Mobilization

First, the bladder is filled with 200 ccs of saline infusion. Next, the bladder is freed laterally by ligating and transecting the medial umbilical ligaments. Then, a cystotomy is created.

Step 6: Ureteroneocystostomy

The ureter is anchored in the detrusor muscle with two 2-0 Vicryl sutures at 5 and 7 o'clock positions, respectively. A non-refluxing ureteroneocystostomy is created using a 4–0 Monocryl on a 3/8 needle. Then, four sutures at 3, 6, 9, and 12 o'clock are placed. A double J-stent in placed and distal curl verified in the bladder prior to completion of the tension-free anastomosis. Next, bladder closure in a T-shaped fashion at the bladder dome (to prevent urine leakage) is performed. The mucosa and the bladder dome are closed using a 4-0 Monocryl and 2-0 Vicryl suture, respectively in a running fashion manner. Lastly, a 20 Fr urethral catheter and Jackson-Pratt (JP) drain are placed (Fig. 13.5).

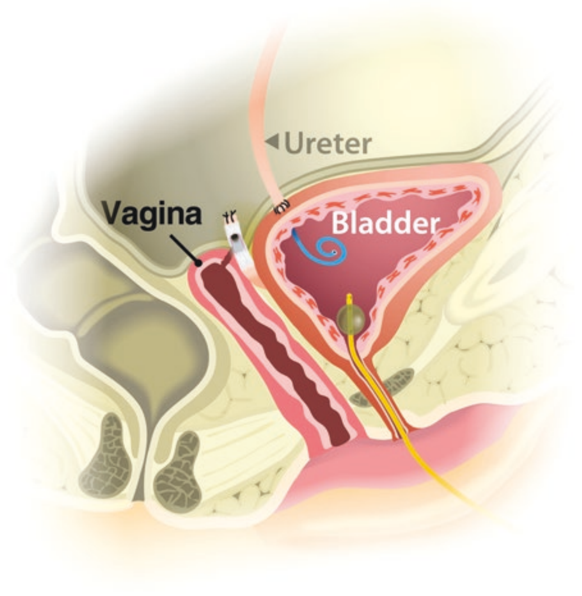

Fig. 13.5 Schematic drawing shows robotic-assisted fistula repair and ureteral reimplantation

Postoperative Management

A standard follow-up time frame has not been established. In the follow up, it is important to assess for strictures and ureteral obstruction. Ureteral anastomotic strictures have been reported to occur within 1-year after repair, in 6–38% of those managed conservatively and in 0.3–3.4% after ureteroneocystostomy [4, 14].

The JP drain is removed 3 days after surgery depending on fluid characteristics. Foley catheter should be removed at least 10 days postoperatively, and the double-J ureteral stent should be removed 4–6 weeks post-surgery. A single dose of prophylactic antibiotics is given when catheters are removed [9]. Once the stent is removed a CT urogram is performed 3 weeks after to confirm no anastomotic leak.

Conclusion

Ureterovaginal fistulae are rare but serious entities. While there is no standardized surgical management yet, the approach should be tailored individually to the patients' needs and the surgeon's experience and expertise.

The use of robotic-assisted repair has increased in popularity in the field, it has consistently demonstrated superiority over open repairs in terms of visibility, decreased blood loss, and shorter convalescence. However, further studies are needed to standardize the role of minimally invasive surgery.

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Chapter 14
Urethrovaginal Fistula

Mitchell G. Goldenberg and David A. Ginsberg

Abbreviations

AFS	Autologous fascial sling
BN	Bladder neck
FUDS	Fluoroscopic urodynamics
MRI	Magnetic resonance imaging
MUS	Mid-urethral sling
OF	Obstetrical fistula
TVU	Transvaginal ultrasound
UO	Ureteral orifice
UVF	Urethrovaginal fistula

Introduction

Urethrovaginal fistula (UVF) represents a relatively rare entity in the field of genitourinary reconstruction. Iatrogenic causes are responsible in most patients presenting to urologists outside of the developing world, where obstetrical trauma still causes upwards of 90% of cases [1]. UVF are defined as an anomalous connection between the urethra and vagina [2]. UVF require a specific approach in their investigation and management, and they differ substantially in their signs and symptoms from other genitourinary fistulae. Their presenting features are directly associated

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with the areas of the urethra that are involved. Their management is often surgical, and therefore it is essential that the clinician has completed a complete and competent workup of the patient prior to embarking on treatment.

Etiologies

Historically, patients presenting with UVF had classically acquired them from obstructed labor, often related to cephalopelvic disproportion. While US data indicates that less than 5% of urogenital fistula is related to complications during childbirth, this number is much higher in countries around the world without adequate access to obstetrical care. Historical cohorts have shown that in countries such as Pakistan, India, and Nigeria, the proportion of genitourinary that are caused by obstetrical trauma may be as high as 68%, 82%, and 91% respectively [3]. The data regarding UVF specifically is not as well documented. In a recent study of urogenital fistulae in Burkina Faso, urethral involvement was seen in 21% of patients [4]. Worldwide, it is estimated that over two million women are living with obstetrical fistula (OF), according to World Health Organization data, with an annual incidence of 50,000–100,000 women [5, 6]. Among the causes of obstetrical trauma, prolonged or unrecognized obstructed labor may lead to bladder neck or urethral necrosis, whereas instrumentation related trauma may be due to forceps or device-assisted delivery, with direct trauma applied to the anterior vaginal wall resulting in urethral compression or laceration. These patients are often from vulnerable populations, with those at risk for OF being younger, shorter, lower weight, and having a lower level of education and socioeconomic status [5]. Women carrying children at an age where pelvic development is not yet complete are at very high risk of OF development. One study of women in Northeastern Nigeria with OF demonstrated that 83.8% were diagnosed before age 15, and 93.7% of these cases were associated with obstructed labor [6].

In more developed countries, UVF is more commonly seen after iatrogenic injury, especially anti-incontinence procedures or treatments. Limited series in the developed world have looked at this association and found up to 30% of UVF are associated with anti-incontinence procedures, and 40% with urethral diverticulectomy and anterior colporrhaphy [3]. As opposed to data where there is less access to optimal obstetric care, only 26% were found to be obstetrical fistulae.

Polypropylene midurethral mesh slings (MUS) became widely used in the late 1990s, offering a less morbid approach to uncomplicated stress urinary incontinence management, with shorter recovery and no donor-site morbidity when compared to autologous fascial slings. The rising use of synthetic MUS has led to a corollary rise in the number of sling complications, which include UVF (see Fig. 14.1). These fistulae result from simultaneous erosion of the mesh into both the

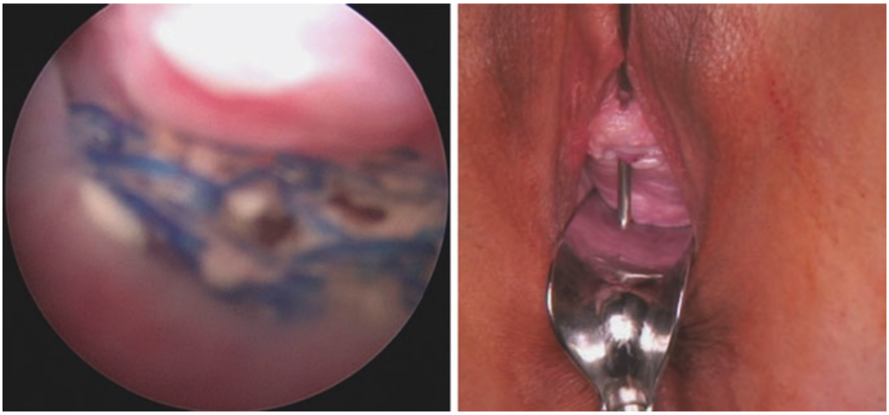

Fig. 14.1 Urethroscopy showing erosion of a polypropylene mid-urethral sling and subsequent urethrovaginal fistula, which is then cannulated intraoperatively. (Adapted from: *Reisenauer C, Janowitz J, Wallwiener D, Huebner M. Urethrovaginal fistulae associated with tension-free vaginal tape procedures: a clinical challenge. Int Urogynecol J. 2014 Mar;25* (3)*:319–22)*

urethra and vagina, thought to be related to tension necrosis [7]. Over-tensioning the MUS at the time of placement may increase the risk of UVF, as well as attempts to loosen the sling postoperatively with dilation, a practice that is now discouraged by the SUFU/AUA guidelines [8]. Other surmised technical causes associated with MUS placement include occult urethral injury at the time of placement, or dissection in a plane too close to the urethra. Patient factors may also influence the formation of UVF, including urogenital atrophy, history of local radiation, and recurrent inflammation or infection. Unlike other traumatic causes of UVF, patients with MUS may have significant urethritis and dysuria at the time of presentation [9].

Urethral diverticular repair may also lead to urethrovaginal fistula formation in up to 8.9% of patients [10]. Similar patient and surgical factors that lead to UVF after sling placement may also increase the risk following diverticula repair, with the added factors of delayed repair, size of the diverticula greater than 4 cm, and complex diverticula configuration (i.e. saddle diverticulum) [11].

Less common iatrogenic causes of UVF have been described. Chronic catheterization in women in the context of neurological diseases affecting the lower urinary tract, or in the setting of prolonged illness (such as ICU admission), can lead to UVF in a small number of cases due to chronic pressure necrosis on the urethra. Similarly, incorrect placement of a urethral catheter with balloon inflation in the urethra, or displacement of the balloon into the urethra during labor, can lead to delayed formation of a UVF [12, 13]. Rare presentations have been described following other urethral pathologies, like urethral cancer [14], vaginal laceration in the context of pelvic trauma [15], and Behcet's Disease [16].

Clinical Features and Diagnosis

Presenting Symptoms

Making the diagnosis of UVF can be challenging given the often-nebulous presenting symptoms and features. Broadly, the symptoms of UVF are divided based on the anatomical location of the fistula, specifically the urethral opening's relationship to the external urinary sphincter complex (see Table 14.1). The external urinary sphincter (EUS) complex in women is widely accepted to be found in the middle three-fifths of the urethra's length and is composed of slow-twitch muscle fibers who's resting tone generates urinary continence [17]. Therefore, fistulae that form *proximal* to this will likely result in either continuous, or certainly severe stress urinary incontinence. The size of the fistula tract also can correlate with the presence of, or degree of, incontinence. This relates mainly to the extent of damage to the EUS mechanism by the fistula tract itself and may in fact be a result of the underlying insult as opposed to the fistula itself in some cases [18].

Distal UVF can present in a variety of ways, again relating to size, etiology, and relationships with anatomical structures such as the urethral meatus. Typically, these patients are either asymptomatic, discovered during routine vaginal examination, or present with vaginal voiding, splayed urinary stream, post-void dribble, recurrent UTI, or skin irritation/fungal infection [17].

The time to presentation of UVF is dependent in part on the severity of the patient's symptoms, but there are also important associations between the etiology of the fistula and the time at which patients present. Evidence suggests that in cases of obstetrical trauma, patients will typically have immediate onset of symptoms, and conventional teaching ascribes that three-quarters of patients present within 24 h of their injury [19]. Conversely, UVF that result from iatrogenic, transvaginal surgical injury typically present approximately 1 week after that procedure, likely relating to the time necessary for local ischemia to lead to tissue breakdown and fistula formation [20]. In the context of radiation-induced UVF formation, patients may not present for months to years after treatment, due to the slow process of microvascular damage and cell turnover that are the hallmarks of radiation-related injuries.

Table 14.1 Presentations of UVF grouped by anatomical relationship to EUS

Symptoms	Relationship of fistula and external urinary sphincter	
	Proximal	*Distal*
	Continuous incontinence	Asymptomatic
	Stress urinary incontinence	Vaginal voiding
	Vaginal irritation/fungal infection[a]	Splayed stream
		Post-void dribble
		Recurrent UTI
		Vaginal irritation/fungal infection[a]

[a]Local irritation may be present in all UVF types

Diagnosis and Evaluation

Urethrovaginal fistulae are diagnosed through a combination of history, physical examination, cystoscopy and radiological investigations. Physical examination remains the bedrock of UVF diagnosis and given the distal location of UVF compared to VVF, it is often all that is required to make the diagnosis.

In addition to the elements of the history outlined above, special attention is paid to a detailed surgical history, particularly around vaginal, urethral, and endoscopic surgeries of the genitourinary tract. It is imperative that the clinician note in detail any prior use of mesh material in the pelvis, of course in particular previous synthetic MUS placement. Past medical history should include any conditions that may mitigate normal tissue healing, such as radiation, poorly controlled diabetes mellitus, and immunocompromised states such as long-term corticosteroid use.

Physical examination should begin with general inspection of the patient's wellbeing and nutritional state, and a focused abdominal examination should be carried out to note any prior surgical incisions. A full and detailed examination of the external genitalia, introitus, urethra, and vaginal canal should be carried out, with the aid of a vaginal speculum. Vaginal atrophy should be noted, as this could point to a contributing cause, or indicate the need to treat this prior to repair. Hiatal width should be noted, as this may impact surgical approach, including the need for episiotomies at the time of repair. Incisions on the labia and inner thigh may indicate the previous use of fibrofatty tissue flaps. Large lesions are often readily visible, especially after anterior vaginal wall laceration (i.e. obstetrical injury). Vaginal suture lines may be present in the presence of prior repair and kinking or indentation of the urethra may be visible if a tight sling had previously been placed. Palpation of the distal anterior vaginal wall should be done to feel for mesh if the history indicates prior use. The urethral meatus should be carefully examined, and palpation around the urethra may illicit areas of tenderness or fluctuance. Importantly attention should be paid to the entirety of the vaginal mucosa anteriorly, looking for other possible fistulous tracts, as well as the presence of a vaginal cuff that indicates prior hysterectomy. Nearly 20% of patients with UVF will have a concomitant VVF, and it is vitally important to rule out other genitourinary fistulae prior to repair [21].

Cystourethroscopy is a key component of UVF diagnosis, with the exception being in cases of very distal fistulae wherein both sides of the tract are visible on inspection alone. Cystoscopy should include identification of the ureteric orifices, to rule out injury of these structures. The bladder neck should be examined circumferentially, as continence post-UVF repair may be highly compromised in these cases. The urethra should be meticulously examined on pull-back urethroscopy, looking for the location and size of the luminal defect. Flexible cystoscopy with a zero-degree lens scope may be preferable to a rigid scope, not just to allow better maneuverability, but also because the irrigation outflow channel opens proximal to the lens when using the latter. The bladder can be left full following cystourethroscopy, and a cough stress test (CST) can be carried out to look for the presence of stress incontinence. In cases of prior radiation or genitourinary or gynecological neoplasms, a biopsy of the fistula tract may be carried out endoscopically if desired, to ensure there is not recurrent neoplastic disease. Finally, it is crucial to look for the presence of a urethral stricture at the time of diagnosis, especially those distal to the fistula tract itself, as this may have important implications for ongoing management.

Upper tract imaging should also be included in the workup of any lower urinary tract fistula. The gold standard remains pyelography, whether carried out in a retrograde fashion endoscopically, antegrade in cases where access to the renal pelvis is available, or radiologically in the form of computed tomography (CT) with a urographic phase. Concomitant ureterovaginal fistula or ureteral obstruction must be identified prior to surgical repair of UVF.

There may be a need for additional investigations in these patients, depending on the context in which the fistula has occurred and the symptoms with which they present. Urodynamics (often preferable to be done with concomitant fluoroscopic evaluation) may be appropriate in certain patients, especially those with challenging anatomical factors such as those with concomitant significant pelvic organ prolapse (POP) or prior lower urinary tract reconstruction. Detrusor function can be objectified in patients with a strong suspicion for impaired compliance (i.e. radiation) or acontractility, that may impact the intraoperative and postoperative management of these patients. Transvaginal ultrasound may be indicated in cases where an underlying malignancy is suspected. Magnetic resonance imaging (MRI) may be extremely useful in certain circumstances, especially in patients with a history of urinary tract reconstruction, urethral diverticulum and in cases where the fistula tract is difficult to identify on physical exam and endoscopy. Historically, double balloon urethrography was performed regularly in UVF patients to radiologically identify the presence and location of UVF but has fallen out of favor in the years succeeding the introduction of pelvic MRI into regular clinical practice.

Urethrovaginal and Genitourinary Fistula Classifications

To study, compare, and treat genitourinary fistulae one can group presenting pathologies under a standardized disease classification system. Two primary classifications are currently used by physicians when describing genitourinary fistula including vesicovaginal fistula, but they are particularly relevant in reference to UVF. The included classifications were originally described in reference to patients with fistulae as the result of obstructive labor, but have been used in the iatrogenic injury at the time of assisted-vaginal delivery or other obstetrical and gynecological procedures.

In 1995, Waaldjik proposed grouping GU fistula into three main categories: (Type 1) not involving the urethral ‘closing mechanism’; (Type 2) involving the urethral closing mechanism; (Type 3) broadly including those involving one or both ureters or ‘exceptional fistula’ [22]. According to Waaldjik, Type 2 fistula should be further subdivided by the extent to which the urethra is involved, and whether a circumferential or partial urethral defect is present. This classification was based on, and designed for, experience with obstetrical fistula, but has been applied in some series to iatrogenic surgical fistula as well [23]. While this system has been used in the published literature extensively, especially in case series of obstetrical fistula in the developing world, it depends on the subjective interpretation of the clinician, and therefore its generalizability may be limited. This is especially problematic when attempting to use this classification as a predictor of surgical outcomes or for prognostication of patients prior to repair [24].

These issues were the basis for the development of a more objective set of classification, published by Goh et al. in 2004 [25]. The authors believed that providing a more quantitative and standardized means of categorizing genitourinary fistula would allow clinicians to better understand their impact on clinical outcomes. Surgeon subjectivity is important when making a diagnosis in the context of a single patient, but when used in the literature generates heterogeneity in reporting that creates bias in comparisons across populations regarding investigation and treatment. Their classification groups fistulae by three categories (See Table 14.2). This classification has been compared with older models such as Waaldjik’s [24, 26–28]. In a series of patients with obstetrical fistula in the Democratic Republic of Congo, Capes et al. showed that Goh’s classification method better predicted successful fistula repair outcomes, with Type 4 fistula having the highest rate of reoperation [24]. In a study of over one thousand women in sub-Saharan Africa and Southeast Asia, Goh’s classification was found to be a statistically significant prognosticator for genitourinary fistula repair, however its discriminatory ability was found to be ‘fair’ only (AUC 0.60) [28].

Table 14.2 Goh’s classification

Distance of urethral meatus to distal edge of fistula		+	Fistula size in the largest diameter		+	Fibrosis, vaginal length, and special considerations	
Type 1	>3.5 cm		(a)	<1.5 cm		(i)	Minimal Fibrosis and TVL > 6 cm
Type 2	2.5–3.5 cm		(b)	1.5–3 cm		(ii)	Moderate Fibrosis and/or reduced TVL
Type 3	1.5–2.4 cm		(c)	>3 cm		(iii)	Special Considerations: Ureteral Involvement, Post-Radiation, Circumferential Urethral Involvement
Type 4	<1.5 cm						

Adapted from Goh JTW, A new classification for female genital tract fistula. Aust N Z J Obstet Gynaecol, 2004

Treatment Approaches

Management of patients with UVF requires a careful approach, balancing clinicopathological aspects of a patient's case with rigorous surgical execution. Clinicians should first ensure that all aspects of a patient's history have been considered, as pre-operative factors have a significant impact on the timing and nature of repair. First principles of fistula management must be adhered to when managing UVF, and failure to do so can have a significant negative impact on patient outcomes. Surgeons may seek to use local, well-vascularized tissue to support the repair, and multiple flap techniques have been described in this space.

Perioperative Considerations

Patient characteristics and the etiology of the fistula tract are of paramount importance when determining the timing and type of repair to be undertaken. As with other genitourinary fistulae, a history of radiation use to the pelvis is a key determinant of surgical planning. Although no high-level evidence exists regarding timing of repair of UVF [3], traditionally in non-radiated patients surgical repair can proceed immediately if the patient is less than 7–10 days from the causative insult [29, 30]. These patients often have a very clear cause for their fistula, such as obstetrical or iatrogenic injury. However, if these cases are not recognized immediately, repair should be delayed for 12 weeks or more to allow for resolution of the acute inflammatory response, as evidence from the genitourinary fistula literature would indicate that attempts to repair in this window of time may lead to poor healing and early recurrence of the fistula tract [31]. In cases of early recurrent fistula, surgeons should wait a minimum of 2 months from the time of their previous repair, to similarly allow for resolution of the acute inflammatory response in the post-operative period [2, 29].

As with many surgeries requiring reconstruction of the lower urinary tract, the question of whether to perform concurrent procedures for stress urinary incontinence (SUI) needs to be addressed. In the case of UVF, it is often challenging to determine if occult SUI is present at the time of diagnosis, given the nature of the disease process. Therefore, the convention has become first completing the fistula repair and accompanying reconstruction, followed by reassessment and a delayed placement of, if necessary, an autologous fascial sling [32]. Mesh or synthetic products should not be used in this contest given the high likelihood of erosion or exposure post-operatively [3]. In cases where a continence procedure is not performed at the time of fistula repair, patients need to be counselled pre-operatively that SUI in the post-operative period is not a sign of treatment failure, and that ongoing urinary leakage that results is not necessarily a sign that the fistula has recurred. However, some surgeons argue that in cases of large fistula tracts or those arising adjacent to the EUS, post-operative SUI is a near certainty, and concurrent fascial sling placement should be strongly considered to avoid the need for a second operation, often which is challenging in patients with suboptimal tissues or prior challenging reconstructive surgeries [7, 29].

In cases of large or untenable fistula disease, such as those in the context of chronic infection, radiation, or ischemic injury, clinicians should carefully consider urinary diversion over fistula repair. In patients where recurrence is very high risk, a shared decision-making approach should be employed with the patient, and all possible reconstructive options should be reviewed, ranging from bladder neck closure or sling occlusion with suprapubic catheter or catheterizable-channel construction to simple cystectomy and continent or incontinent urinary diversion. Patients desiring fistula repair in these cases should be aware of the likelihood of failure, the need for post-operative diversion and potential for long-term suprapubic or urethral catheterization, and the need to delay definitive repair for at least 3–6 months to allow for resolution of any ongoing inflammatory or ischemic processes [33].

Surgical Principles of Repair

As with any genitourinary fistula repair, a core set of principles should be adhered to by surgeons attempting reconstruction. The most fundamental of these have been reviewed elsewhere in other chapters, but include completing a watertight, tension free, and multilayer closure of the urethra with absorbable suture, ensuring adequate debridement of any necrotic or ischemic tissue. In cases where patient or tissue factors predispose a high failure rate, surgeons are encouraged to use local tissue flaps as an interposition layer between the vagina and urethra to help prevent recurrence.

These general principles are applicable to all types of UVF repair and should be closely adhered to. However, specific elements of the surgical approach are also of great importance and will be highlighted in this section.

Positioning and Equipment

A list of typical equipment needed for most UVF repairs is listed in Table 14.3. Patients are typically positioned in lithotomy or high lithotomy, but some surgeons may approach these repairs with the patient in a prone or jackknife position. Cystoscopy should be done at the outset of the procedure, using either a short beaked rigid cystoscope or a flexible cystoscope, to allow full unincumbered surveillance of the urethra. The fistula tract should be identified and cannulated, with either a guidewire, ureteral catheter, or small caliber foley catheter if the tract is capacious (See Fig. 14.2). An incision is made on the anterior vaginal wall, most commonly in an 'inverted-U' fashion, to allow mobilization of a well-vascularized flap. Injectable saline can be used to hydro-dissect the vaginal epithelium away from the urethra and aid in initial exposure of the tract. Many surgeons advocated

Table 14.3 Equipment list for UVF repair

• High lithotomy, prone, or jackknife position
• Rigid, pediatric, or flexible cystoscope
• Guidewire ± yellow ureteral catheter ± small caliber foley (i.e. 10ch)
• Suprapubic tube (Lowsley or percutaneous access kit)
• Vaginal retractor—Lonestar or Turner-Warwick
• Injectable saline
• Fine, non-toothed forceps and fine-tip instruments
• 4-0 multifilament, absorbable suture for fistula closure
• 2-0 multifilament, absorbable suture for vaginal wall closure
• AFS harvest site access (if sling planned)
• Interposition graft donor site access (Gracilis, Martius)
• Catheter-tip syringe for testing repair
• Vaginal packing, antibiotics, Belladona-Opium suppository

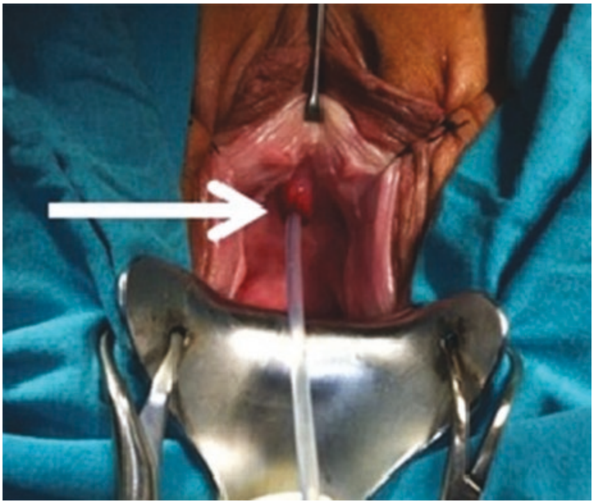

Fig. 14.2 The fistula tract (arrow) is catheterized to allow for identification during dissection. (Adapted from*: Akin Y, Yucel S, Baykara M. An extremely rare manifestation of Behcet's disease: urethrovaginal fistula. Int Urol Nephrol. 2014 Feb;46* (2)*:359–61)*

for wide mobilization of the urethra to allow for complete exposure of the fistula tract.

Following complete circumscription of the urethral side of the fistulous tract, the urethral wall should be closed with running absorbable suture, typically 4–0 multifilament suture, in a watertight fashion (See Fig. 14.3). This can be accomplished by placing stay sutures at the apices of the fistula tract to aid in exposure. The integrity of the closure can be tested through distending the urethra prior to placing a second running layer, and this is accomplished usually by injecting saline around the urethral catheter, with the urethral catheter balloon pulled back to the bladder neck. The secondary suture line can be placed either through-and-through the primary suture line or can be run in an imbricating pattern.

At this point the decision should be made regarding the use of a local tissue flap to use as an interposing layer in the repair. Surgeons should always strive to use

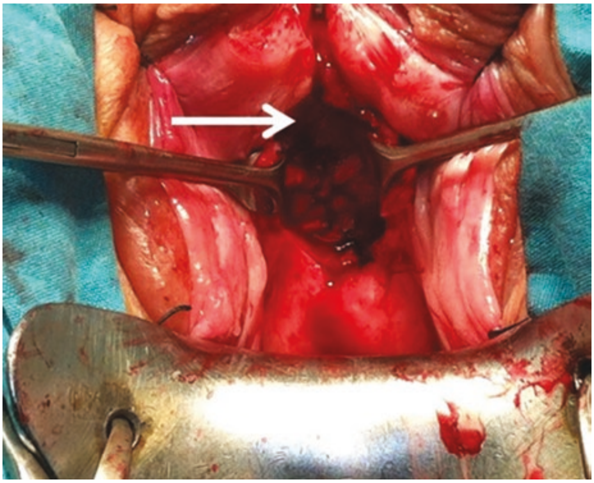

Fig. 14.3 The fistula tract arrow is closed in multiple, non-overlapping absorbable suture lines. (Adapted from*: Akin Y, Yucel S, Baykara M. An extremely rare manifestation of Behcet's disease: urethrovaginal fistula. Int Urol Nephrol. 2014 Feb;46* (2)*:359–61)*

techniques that are familiar to them, and most undertaking repair of UVF would first consider the use of a labial fibrofatty rotational flap (i.e., Martius Flap), as this provides a well vascularized and easily mobilized local tissue pedicle with minimal donor site morbidity (see Chap. 15). In cases of recurrent fistula, previous use of labial flaps, or significant vulvar inflammation or irradiation, the Gracilis muscle offers an alternative means of creating apposition between the urethra and vagina. These flaps require harvesting the muscle belly of the Gracilis, most easily accomplished by creating incisions over the muscle's origin and insertion. The distal vascular pedicle can be sacrificed to allow for the muscle belly to be rotated medially on its dominant proximal vascular pedicle. In cases of fistulae proximal to the EUS, mobilization of the bladder neck or proximal urethra may be employed as an advancement tissue flap to cover the area of defect in the urethral wall. This strategy can also be employed to reduce tension on the repair itself.

At this point, anti-incontinence procedures should be carried out, typically involving creation of a midurethral or bladder neck autologous fascial sling. This is commonly done using either fascia lata or rectus fascia. Mesh or synthetic material should not be used concurrently at the time of fistula repair due to the unacceptably high rate of mesh erosion into the urinary tract.

The vaginal wall can now be closed. The area of mucosa involved in the fistula process should be excised, and proximal and distal advancement flaps can be used to cover the urethral suture line and create non-overlapping suture lines. This can be done using an absorbable multifilament suture, usually of a larger size and with good tissue bites to facilitate a hemostatic closure.

Finally, the surgeon may wish to place a suprapubic catheter after closure of the vaginal wall, or sooner in the case if desired. While not mandatory, concurrent suprapubic catheter placement may facilitate complete urinary drainage, as well as allow an ideal set up for post-operative voiding cystourethrogram, as outlined below.

Post-Operative Management

Adequate bladder is the focus of post-surgical care after UVF repair. A urethral catheter should be maintained post-repair for 2–3 weeks even if a suprapubic catheter is placed. This ensures complete diversion of urine away from the site or repair for an adequate amount of time. Catheter flushing should be done routinely with small volumes of sterile water or saline to ensure patency. Patients should be counselled to always ensure catheter bags are placed below the level of the bladder to facilitate gravity drainage. At the clinician's discretion, medications can be used to prevent bladder spasm in the early postoperative period. These range from belladonna-opium suppositories to oral antimuscarinic or β-3 agonist.

Follow-up should include assessment of the repair, with catheter removal done in a logical and stepwise fashion. The integrity of the repair can be evaluated post-operatively with a voiding cystourethrogram, or if no suprapubic tube placed, a peri-catheter retrograde urethrogram. Patients can be counselled that the presence and degree of urinary incontinence in the post-operative period may change over time, and that urinary leakage alone does not indicate a recurrence of the fistula.

Conclusions and Recommendations

Although fortunately not a commonly presenting form of genitourinary fistula, UVF can have a significant impact on a woman's quality of life. Urologists should remain vigilant when evaluating women with UVF, as this pathology is often accompanied by concomitant genitourinary disease. Patient factors play an important role when identifying the ideal approach for repair of these fistulae, in particular previous history of radiation and prior lower urinary tract surgery. Strict principles of fistula repair should be adhered to when managing these patients in the operating room and attempts at closure should use all appropriate adjunctive surgical maneuvers such as local tissue flaps.

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Chapter 15
Rectovaginal Fistula

Carey Wickham and Christine Hsieh

Abbreviations

CT	Computed tomography
EUS	Endoanal ultrasound
IBD	Inflammatory bowel disease
LIFT	Ligation of intersphincteric fistula tract
MRI	Magnetic resonance imaging
RVF	Rectovaginal fistula

Introduction

Rectovaginal fistulas are congenital or acquired abnormal, epithelium-lined connections between the rectum and the vagina. This chapter will focus on the diagnosis and management of acquired rectovaginal fistula (RVF). These fistulas are highly distressing and can result in significantly impaired quality of life for women. Symptoms include passage of gas and stool from the vagina, which has been demonstrated to adversely impact not only the afflicted person's social interactions, and

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but their economic opportunities as well [1]. Medical management may ameliorate symptoms to some degree, but really plays only a limited role in treatment. Therefore, surgical intervention is the mainstay of therapy. Although surgical repair can be fraught with complications and recurrence, successful surgical repair can greatly improve a patient's quality of life [2]. Most of the literature on surgical repair is comprised of small retrospective studies with heterogenous populations of fistula etiologies, locations, and prior attempted repairs. It is therefore important to take an individualized approach to each patient, while applying the key principles of fistula repair.

Etiology

Rectovaginal fistula (RVF) is a relatively rare entity, accounting for only about 5% of all anorectal fistulas [3]. The term anovaginal fistula is sometimes used to describe a fistulous connection between the vagina and the anal canal distal to the dentate line. Variations in referral patterns, reporting of cases, and access to care for sufferers makes it difficult to quantify the incidence and prevalence of RVF. Etiologies include obstetrical injury, infectious or inflammatory causes, malignancy, radiation-related, or traumatic (including iatrogenic) injury.

Obstetrical Injury

The most common cause of acquired rectovaginal fistula is obstetrical injury [4]. This occurs in 0.1% of vaginal deliveries in Western countries [5]. Vaginal delivery can result in fistula formation via two mechanisms. First, perineal laceration causing injury to the rectovaginal septum, anal sphincter complex and/or perineal are typically repaired immediately after vaginal delivery, if recognized at the time. Fistulas can develop in the setting of breakdown of the repair due to infection or technical deficiencies, and this tends to occur in patients who experienced severe injury (third or fourth degree tears). Unrecognized injuries may progress to fistula formation due to inadequate healing. A large study of anorectal complications following vaginal delivery reported rectovaginal fistula in 0.5% of vaginal deliveries following episiotomy with fourth degree lacerations requiring repair [5].

Obstetric fistulas can also develop due to ischemia and pressure necrosis of the rectovaginal septum during prolonged labor. These fistulas tend to occur in the mid-portion of the vagina and distal third of the rectum. This type of injury is more common in resource limited settings, where access to medical care and surgical repair is also limited [6].

Regardless of mechanism, operative repair of obstetric RVFs should be deferred for at least 3–6 months. This allows time to address infection and allow inflammation to subside. This may be accomplished with drainage, seton placement, and fecal diversion in selected cases [7]. Some RVFs will spontaneously close during this time [8, 9]. Repair of obstetric rectovaginal fistulas tends to be more successful than those with other causes [9, 10], with as much as a fourfold increased risk of failure of transperineal repair described in patients with non-obstetric fistulas [11, 12].

Infectious Causes

Infection and resultant erosive inflammation can also result in RVF formation. Cryptoglandular disease precipitating rectovaginal fistula is very rare, but pelvic infectious processes such as diverticulitis can cause a severe inflammatory reaction that drives formation of a fistulous tract between the diseased colon and the vagina. The resultant fistula occurs in the setting of previous hysterectomy, with communication between the rectosigmoid junction and the exposed vaginal cuff. Other infectious etiologies like tuberculosis, sexually transmitted, parasitic and viral infections are increasingly rare in the setting of appropriate medical treatment of prophylaxis [6].

Inflammatory Bowel Disease

Inflammatory bowel disease (IBD), specifically Crohn's, is complicated by rectovaginal fistula in 10% of women, especially in those with colonic disease [13, 14]. Surgical management in the setting of active Crohn's proctitis has a high likelihood of failure due to ongoing inflammation and impaired tissue healing [11]. Therefore, treatment of RVF related to Crohn's disease starts with appropriate infectious source control, followed by appropriate medical management with antibiotics and immunosuppression as the mainstay of therapy.

Infliximab is considered first-line therapy for medical management of fistulizing Crohn's disease. Multiple studies have demonstrated that medical therapy with infliximab results in resolution of about 40% of Crohn's-related external fistulas in general [15–18], but data specifically for rectovaginal fistulas is less encouraging. In the ACCENT II study by Sands et al. infliximab was found to be effective in short-term closure of rectovaginal fistulas [16]. 64% of patients in the study achieved closure of the RVF during the study period. For those patients who demonstrated a response to infliximab induction therapy with closure of RVF, 72.2% of these fistulas were closed at week 14 of therapy. The study group also found that infliximab maintenance treatment was more effective than placebo in prolonging the duration that rectovaginal fistulas remained closed.

There is limited data on other immunosuppressives in management of Crohn's-related RVF. One prospective, non-randomized study of 10 patients with fistulizing Crohn's (including enterocutaneous, perianal, and rectovaginal) refractory to infliximab demonstrated a 40% complete response rate with tacrolimus, with a 33% complete response in those patients with rectovaginal fistula [19].

Unfortunately, it is difficult to predict which RVFs will respond to medical management either by closure or resolution of inflammation such that surgical repair can be done. For persistent RVF with ongoing inflammation despite medical therapies, surgical management should be undertaken cautiously, with liberal use of draining setons to allow for resolution of infection and maximal improvement of surrounding inflammation. Techniques that require disruption of the sphincter complex should be avoided. Fecal diversion in rectovaginal fistula patients with Crohn's disease is controversial, with equivocal results reported with and without proximal diversion [20]. Diversion can improve symptoms but should be considered on a case-by-case basis for technically difficult repairs, repeat repairs, and repairs in the setting of suboptimal tissue quality. Delaying surgery for 3–6 months to allow for maximal resolution of infection and inflammation is also recommended [21]. Of note, malignant transformation remains a concern in Crohn's patients with longstanding perianal disease and rectovaginal fistula, with several case reports described in the literature [22, 23].

Malignancy

Colorectal, anal and gynecologic malignancies can also give rise to rectovaginal fistula. Treatment should be dictated by the standard of care for the type of malignancy in question. Depending on symptom severity and the prescribed plan of care, fecal diversion may be beneficial for infection or symptom control pending definitive surgical management. Interposition of well-vascularized tissue such as omentum or a muscle flap may reduce the risk of recurrence [24, 25]. This is especially important if the operative field has been previously irradiated, causing impairment of normal tissue healing processes [26].

Radiation

Pelvic radiation can infrequently cause RVF formation. There are limited studies of radiation-induced rectovaginal fistula in the literature. A study of patients presenting with late colorectal complications of pelvic radiation found 22% of these patients had rectovaginal fistula [27]. Surgical management of these patients is challenging. Thorough physical exam and workup to rule out malignancy should be conducted at the outset. Fecal diversion can improve symptoms but is unlikely to result in spontaneous healing [28, 29]. High fistulas are more likely to heal [29]. Local repair is unlikely to be successful and techniques which incorporate well-vascularized tissue from outside of the radiated field have a higher chance of success [26].

Iatrogenic

Rectovaginal fistula sometimes results from iatrogenic injury to the rectovaginal septum. This most commonly occurs following transrectal procedures or instrumentation, as in proctectomy with creation of an anastomosis [30, 31], or resection of rectal tissue using stapler devices. The bulk of the literature on this complication consists of case reports [32, 33]. When using a stapling device in the rectum, rotating the stapler while palpating and visualizing the back wall of the vagina can allow the operator to ensure that no adjacent tissue will be incorporated into the staple line. Entrapment of the rectovaginal septum can be seen in these cases as dimpling on the back wall of the vagina as the stapler is manipulated.

Anastomotic leak resulting in abscess can lead to fistula if the abscess decompresses into the vagina [34]. More proximal fistulas can occur following hysterectomy or after unrecognized rectal injury in an inflamed or irradiated field [35]. Management depends largely on the underlying disease process and patient's overall health.

Classification

Rectovaginal fistulas are classified by anatomic location, size, and etiology. The location is typically described as high, medium, or low based on the proximity to the cervix, the vaginal fourchette, the anal sphincter complex, and the dentate line. Fistulas are described as complex when they are larger than 2.5 cm, high, caused by inflammatory bowel disease, or recurrent [36].

Evaluation

Symptoms

Patients most commonly report fecal soilage with the passage of stool and/or flatus per vagina. Malodorous vaginal discharge or recurrent vaginitis are also commonly reported. Obtaining a thorough patient history including the obstetric history, any prior abdominal or anorectal procedures, pelvic malignancy, prior radiation therapy, and symptoms of IBD or diverticulitis, is important for determining the etiology of the fistula, and therefore the management plan. Additional information on symptoms indicative of unresolved pelvic or perineal infection or sepsis should also be elicited.

Physical Exam

Physical examination alone can identify the location of the fistula in up to 74% of patients [37]. Focusing on localizing the fistula and assessing the quality of the surrounding tissue by palpating the rectovaginal septum and checking the anal sphincter muscle are important, as this information will impact the choice of repair. Assessment of the rectum may reveal a palpable depression anteriorly, and this may be seen as a small pit or defect on anoscopy. Vaginal examination may show a darker discoloration of the mucosa at the site of the suspected fistula opening. Stool or discharge concerning for vaginitis may also serve as clues. A "tampon test" may be done by inserting a tampon into the vagina, administering an enema with tinted fluid, and then checking the tampon for staining after retaining the enema for 15–20 min.

Thorough examination with fistula probes, transanal instillation of hydrogen peroxide or tinted fluid (commonly methylene blue), and endoscopy may aid in detection and identification of occult RVF (Fig. 15.1). Strictures, scarring, perianal fistula and other sequelae of Crohn's should be noted, and endoscopy planned if IBD is the suspected etiology. Biopsies may be necessary in patients with a history of malignancy treated with radiation to the area. Performing the exam under anesthesia may be helpful for patients with pain, anxiety, or if these potentially uncomfortable maneuvers are anticipated [36]. Very small or proximally located fistulas may not be identified on physical exam and additional diagnostics should be considered.

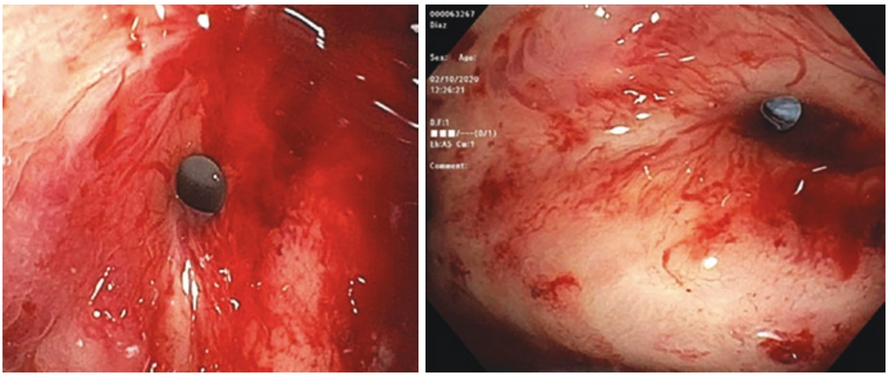

Fig. 15.1 Rectovaginal fistula on endoscopic exam: Finger inserted into vagina is visible through the fistula defect; note the irregularity of the rectal mucosa and the abnormal vascular pattern and telangiectasias associated with radiation injury. (Photo credit: Kyle Cologne, MD)

Diagnostics

Endoanal ultrasound (EUS) and magnetic resonance imaging (MRI) are the most useful modalities for delineating the fistula tract and assessing for sphincter involvement. MRI is excellent for evaluating soft tissues and the anatomical structures in the pelvis, such as the internal and external sphincter muscles, the levator ani muscles, and the puborectalis. The fistula tract can be visualized and its anatomic position clarified. Endoluminal MRI can further hone in on the rectum [38]. In one study comparing the accuracy of endoluminal ultrasound and endoluminal MRI for determining the location of a known rectovaginal fistula, both EUS and MRI were shown to have high positive predictive value (100% and 92%, respectively) [39].

Despite the high positive predictive value, EUS may not be adequate as a standalone diagnostic tool due to low sensitivity and negative predictive value. Yee et al. showed that non-contrast EUS identified only 28% of RVF already diagnosed via proctoscopy [40]. Utility of EUS may therefore depend upon available equipment and operator experience. Regardless, EUS is important for evaluating the integrity of the sphincter complex especially in patients with prior obstetric injury. The presence of air within the rectovaginal septum is a key signifier of abnormal fistulous communication, even if the tract itself is not seen (as may be the case when inflammation is minimal, or the tract is collapsed) [39].

While computed tomography (CT) is widely used to assess the intra-abdominal and pelvic organs, the presence of a fistula tract is often inferred based on findings like gas or contrast material tracking between adjacent organs, even if the fistula tract itself is not apparent or defined (Fig. 15.2). For instance, CT may show contrast or gas extravasation to an organ adjacent to a diseased segment of colon, or even show the organ wall defects themselves. While air in the bladder in the setting of diverticulitis (in the absence of ureteral instrumentation) confirms a clinical diagnosis of colovesical fistula, air in the vagina may be incidental. Therefore, clinical correlation is imperative [41] and CT alone is not adequate for ruling out presence of a fistula when the patient's symptoms are suggestive of such. CT may serve as an alternative to MRI for those with contraindications such as metallic foreign bodies or implants [42]. Even if RVF is confirmed by other modalities, CT should be done if malignancy is suspected.

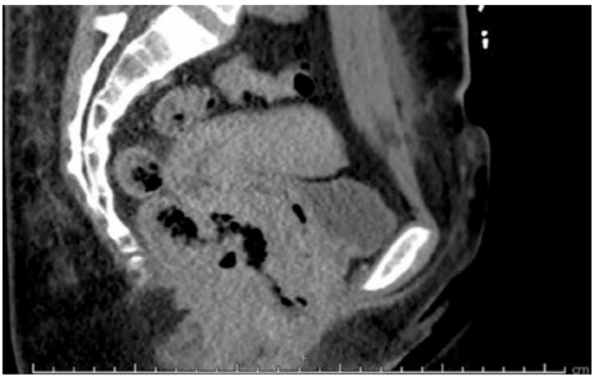

Fig. 15.2 Large rectovaginal fistula seen on CT. (Photo credit: Carey Wickham, MD)

Fig. 15.3 Hypaque enema: Fluoroscopic evaluation with contrast enema shows opacification of vagina after instillation ofdiatrizoate sodium (Hypaque) contrast medium per rectum. (Photo credit: Kyle Cologne, MD)

Endoscopy is variably reliable for showing the fistulous connection of the rectum or colon to the vagina. Large fistula tract openings are more easily identifiable than small openings, which may present endoscopically as areas of mucosal irregularity or inflammation. Colonoscopy and either CT or MRI, however, should be performed in suspected or confirmed Crohn's patients to characterize active disease and other Crohn's-related complications. Likewise, colonoscopy should be included in the evaluation of patients with suspected malignancy [6].

Contrast enema and vaginography are low yield and require balloon occlusion of the anal canal or vaginal introitus, which has the potential to also occlude the fistula tract [37]. Sensitivity of fluoroscopic vaginography has been demonstrated at 79% in one study [43] but diagnostic utility seems to vary widely in the literature, from 40% to 100% [41]. The sensitivity of proctography is low, ranging from 7.7% to 35% [43]. Although a fluoroscopic study may identify contrast filling of two organs, and variably demonstrate the fistula tract itself, it is of limited utility in providing information about the affected organs or adjacent structures (Fig. 15.3).

Medical Management

Specific subsets of RVF can be managed with medical optimization by regulating bowel function and controlling diarrhea, such as for patients with fistulas from obstetrical injury. Patients with RVF from Crohn's require appropriate medical therapy to start. The majority of patients, however, will require surgical intervention.

Surgical Management

General Principles

The general principles of surgical management of RVF include infectious source control, debridement of damaged or poor quality tissue, reconstruction of the anatomy with healthy tissue, and interposition of well-vascularized, non-radiated tissue between the vagina and the distal colon, rectum or anus. Optimal setup depends on the location of the fistula and the type of repair planned. Timing of definitive surgical repair is also crucial and should be considered only when infectious source control is achieved and inflammation resolved.

Preoperative Care and Positioning

Preoperative mechanical and antibiotic bowel preparation can be considered, as could simple enema preparation, but utilization tends to be based upon surgeon preference. Perineal approaches can be performed under local or regional anesthesia with moderate sedation, but spinal or general anesthesia are often preferable. Prone jackknife is the most versatile position for perineal approaches. Lithotomy is sometimes preferred by anesthesiologists, and better tolerated by patients with respiratory co-morbidities. Left lateral decubitus (Sims position) with gluteal tape or the Lone Star (CooperSurgical, Connecticut) self-retaining retractor for exposure can be considered but is not commonly done. Abdominal approaches should be performed in lithotomy.

Diversion

Fecal diversion should be discussed for patients with significant infection or inflammation of the surrounding tissues, as in Crohn's, or if there is concern for ongoing contamination from fecal soilage in cases of severe tissue destruction or injury. Diversion alone is unlikely to result in spontaneous healing of the fistula [28]. Creation of a diverting ileostomy or colostomy prior to fistula repair can allow for infection control and resolution of inflammation, increasing the chance of successful subsequent fistula repair. Diversion at the time of repair should also be performed in patients undergoing colorectal resection and anastomosis in the setting of a radiated field, or in those with IBD. Patients should be counseled that stoma reversal can be considered 6–12 weeks postoperatively once the fistula repair has healed.

Local Repair

Local rectovaginal tissue repairs are appropriate for low fistulas and techniques are often combined based on the level of the fistula, sphincter involvement, and the quality of the surrounding tissues. The predominate categories of local surgical repair are described below.

Fistulotomy

Fistulotomy, or laying open of the fistula tract, is the mainstay of therapy for low (minimal sphincter muscle involvement) fistula-in-ano. This technique is not appropriate for the vast majority of rectovaginal fistulas due to the thin and poorly vascularized rectovaginal septum. Anovaginal fistulas, or those situated distal to the dentate line, should be approached with caution given the risk of fecal incontinence from keyhole deformity with sphincter involvement. Only highly selected low and superficial fistulas with minimal to no sphincter muscle involvement can be laid open or excised with a simple fistulotomy with successful healing.

Fistula Plug

Limited data is available to support the use of plug repairs for rectovaginal fistulas. A tapered bioprosthetic plug with a button made from porcine intestinal submucosa (Biodesign Fistula Plug, Cook Medical, Bloomington, IN) is approved for use in both anorectal and rectovaginal fistulas. After adequate local infection control with placement of a draining seton for 6–8 weeks with or without antibiotics, the plug can be placed through the fistula tract with the button either flush against the rectal mucosa or flush with the sphincter muscle and covered by a small mucosal flap. The excess plug is trimmed at both ends, and then secured in place on the rectal end with absorbable 2–0 suture in a figure-of-eight fashion while the vaginal end is left open to drain. An early study of bioprosthetic repair showed that 1 out of 7 patients treated with the Biodesign plug device recurred, and this occurred 11 months later in a patient with Crohn's disease [44].

Mucosal Advancement Flap

Rectal and vaginal mucosal advancement flaps can be effective for the treatment of low fistulas. Endorectal mucosal advancement flaps are used with reasonably high success rates for low rectovaginal fistulas. In the presence of a sphincter defect, they are often combined with sphincteroplasty [37, 45]. Even after a prior attempted advancement flap, repeat advancement flap can be considered depending on the quality of the tissue [37].

This technique is relatively straightforward, as described by Rothenberger et al. [46]. A rectal flap is planned, with the distal aspect (apex) including the fistula opening, and the base of the flap about 4 cm proximal to the fistula. The flap is elevated off the rectal wall, including rectal mucosa, submucosa, and an underlying rim of muscle. The fistula tract is then debrided and the rectal opening is closed with absorbable suture, leaving the vaginal defect open for drainage. The distal portion of the flap is trimmed to remove any devitalized tissue, advanced distally, and sutured to the cut edge of the mucosa distal to the fistula tract with absorbable sutures. Important technical considerations include ensuring adequate blood supply with a flap base at least twice the width of the apex and making sure the flap is sufficiently mobilized to allow for tension-free anastomosis. Hemostasis is critically important to prevent hematoma formation which could lead to disruption of the wound. This technique has been used with reported success rates ranging from 43% to 86% overall [44–50].

Vaginal repair can be performed similarly to the endorectal advancement flap, or as an "inversion" type technique, in which the vaginal mucosa is elevated to expose the fistula, and the fistula inverted into the rectum with a pursestring suture [9]. The vaginal mucosa is then reapproximated.

While transanal procedures are familiar territory for colorectal surgeons, those who favor this technique over vaginal flap suggest that repair from the in-flow, high-pressure side is preferable, and that the rectal mucosa is more readily mobilized and reapproximated. On the flip side, vaginal mucosa is thought to be better vascularized and recovery may be easier for the patient [51]. Success rates for vaginal repair are quoted in the literature as at or near 100% [9, 52].

Both vaginal and rectal mucosal advancement flap repairs have acceptable and equivalent success rates in select Crohn's patients. In one systematic review of the small number of available studies, RVF closure rate after rectal advancement flap was 54.2%, and 69.4% after vaginal flap. Risk of recurrence was comparable [53]. Crohn's patients, however, have lower successful repair rates than patients with fistulas from other etiologies, with some studies suggesting techniques dependent on primary repair without significant tissue mobilization are more effective in this population [54].

Rectal Sleeve Advancement

Rectal sleeve advancement is described in the Crohn's literature for low rectovaginal fistulas [55, 56]. Success rates of 62–80% are described in the setting of Crohn's disease with some patients requiring repeat sleeve advancements to achieve healing. The procedure was first described by Parks et al., who reported a series of four patients successfully managed with this technique for rectovaginal fistula after radiation therapy [57]. Beginning at the dentate line, the mucosa is incised and the submucosal dissection continued circumferentially and cephalad into the supralevator space. Rectal mobilization is continued until there is enough length for a tension free anastomosis after debridement. The fistula tract is then cored out and closed with absorbable suture. The vaginal defect is left open for drainage. The tissue surrounding the fistula tract is then debrided and trimmed. The distal rectum is then advanced and sutured to the anoderm with absorbable suture.

Transperineal Repairs

A number of different techniques to achieve debridement and reconstruction of the perineal anatomy may be utilized via a transperineal approach. These techniques include episioproctotomy with layered closure, transperineal repair with levatorplasty, the Ligation of Intersphincteric Fistula Tract (LIFT) procedure, and sphincteroplasty. Each of these techniques begins with an incision in the perineum that may be circumlinear around the anus, transverse, or vertical. The rectum and vagina are then separated with cephalad dissection along the rectovaginal septum, resulting in the division of the fistula tract. The incision is then closed in layers, with interposition of healthy tissue, ideally muscle, between the rectum and vagina via levatorplasty or sphincteroplasty. Imbrication of the repaired areas of the vagina and/or rectum can also be performed. A rectal or vaginal advancement flap can also be added. These techniques have been described as reaching up to 70% success in Crohn's patients [54], however due to the technically challenging nature of this approach, plus higher morbidity rates, transperineal repair is typically considered after other procedures have failed [58].

Once such repair for cloaca-like deformities, essentially ultralow rectovaginal fistula with distal obliteration of the rectovaginal septum, is bilateral X-flaps with sphincteroplasty which is described with primary success rate of 75% [59]. Along with the repair, some authors advocate placement of a biologic graft to separate the vagina and rectum. The most commonly described graft in the literature is porcine intestinal submucosal graft, which has reported success rates of 64–81.5% [44, 60, 61] (Fig. 15.4).

Tissue Interposition

A number of rotational tissue flaps are available for tissue interposition for transperineal repairs. These flaps are typically performed after failed repairs, or in the setting of inflammation or radiation changes to surrounding tissues. Usage of such flaps may result in donor site pain, wound complications, poor cosmesis, and delayed healing.

The Martius flap, consisting of the labial fat pad with bulbocavernosus muscle, is one technique for flap repair. Initially used for cystovaginal or urethral-vaginal fistulas, it has been coopted for repair of low complex or complex rectovaginal fistulas. A transverse incision is made over the rectovaginal septum with the dissection carried cephalad proximal to the fistula. The fistula opening is curetted on the rectal

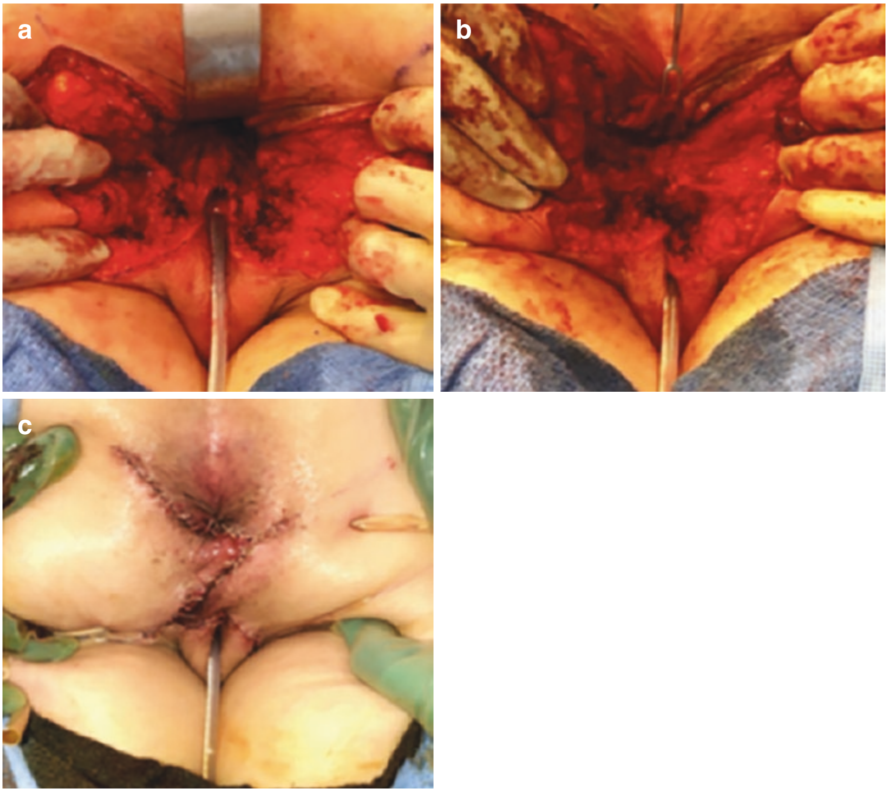

Fig. 15.4 X-Flap repair of cloaca-type deformity. (**a**) Posterior vaginal repair and flap mobilization. (**b**) Sphincteroplasty. (**c**) Closure of flaps to recreate perineal body. (Photo credit: Carey Wickham, MD)

side and closed primarily with absorbable suture. The vaginal portion of the fistula is excised from the mobilized vaginal flap leaving only healthy vaginal tissue. A vertical incision is then made over one of the labia majora. The labial fat pad and contiguous but often diminutive bulbocavernosus muscle are then dissected laterally to medially, taking care not to disrupt the blood supply from the posterior labial vessels. Adequate flap length should be ensured prior to transecting the flap superiorly.

The flap will then be tunneled through to the rectovaginal septum dissection, making sure the flap is not overly compressed, kinked or twisted to ensure adequate perfusion of the flap. The flap is then positioned across the rectovaginal septum and sewn in place. Leak testing by filling the rectum with dilute hydrogen peroxide can then be performed. The vaginal flap is then closed over the interposed Martius flap and sutured to the vaginal introitus with absorbable suture. The labia majora is closed over a drain and the vagina is packed with absorbent dressing [51].

Martius flaps have success rates ranging from 60% to 100%, however, most studies are small with short duration of follow up and focus on healing rates without describing other quality of life or patient satisfaction measures [58]. Much of the data on Martius flap repairs is in patients with fecal diversion. Complications described in the literature are rare but include dyspareunia and labial wound complications [62]. Large defects may not be amenable to repair with a Martius flap due to it generally smaller size and limited blood supply [3].

Muscle flap interposition can also be performed using gracilis, rectus abdominis, sartorius or gluteal muscle. Gracilis muscle transposition is commonly described. The location of the muscle adjacent to the perineum makes it convenient to harvest, however, transposition of this large, well-vascularized muscle portends greater morbidity. The transperineal dissection of the fistula is performed as described previously. An endorectal advancement flap can also be added. The gracilis muscle is harvested with either a long incision along the length of the muscle or smaller incisions at the origin and insertion of the gracilis. The muscle is mobilized and divided above the insertion, and tunned from the proximal aspect of the incision to the rectovaginal septum, taking care to avoid excessive compression, rotation, or kinking of the muscle and its blood supply. The muscle is then sutured to the proximal aspect of the opened rectovaginal septum and both the perineal and medial thigh incisions are closed (Fig. 15.5).

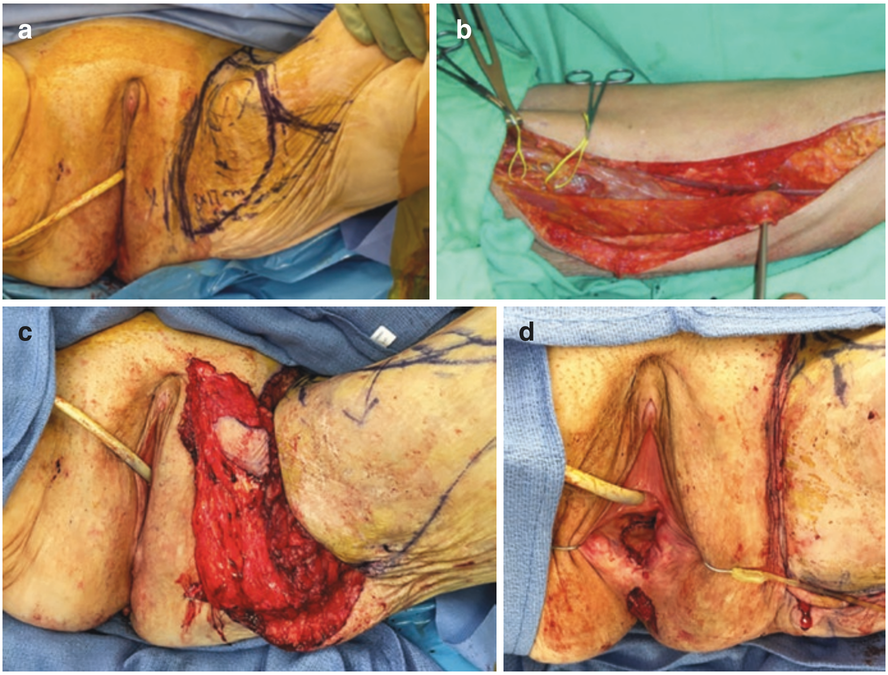

Fig. 15.5 Gracilis/fasciocutaneous flap interposition. (**a**) Marking gracilis with fasciocutaneous flap. Incision is planned along the belly of the muscle. The neurovascular bundle is typically found at the superior aspect, 8–10 cm from the pubic tubercle. (Photo credit: Joseph Carey, MD) (**b**) Preparation of gracilis with neurovascular bundle identified with vessel loops. (Photo credit: Joseph Carey, MD) (**c**) Preparation of flap for tunneling and positioning of skin paddle. (Photo credit: Joseph Carey, MD) (**d**) Completed reconstruction and closure of harvest site wound. (Photo credit: Joseph Carey, MD)

Published success rates range from 43% to 100% [58]. Pinto et al. have published the largest study with 25 patients and 60% success [63]. Fecal diversion is often performed prior to or at the time of gracilis flap transposition. Post-operative quality of life studies suggest that some patients are satisfied with their sexual activity, but there are reports of reduced libido, dyspareunia, decreased vaginal lubrication, and concern over perineal scarring which adversely affect sexual activity [64]. Some studies show a short-term decrease in function of the leg in regards to muscle strength, hypoesthesias and pain, but long-term issues are infrequent and pertain mostly to dissatisfaction with scar appearance (about 17%) [65].

Transabdominal Repairs

Transaabdominal repair with omental flap interposition is also described in the literature for management of high rectovaginal fistulas, with 90–100% success rates [66–68]. For these procedures, the abdomen is accessed either via laparotomy or minimally invasively. The rectovaginal septum is dissected to identify the fistula tract. The vaginal defect is primarily repaired, and the involved segment of bowel is resected (as with diverticular colovaginal fistula, malignancy, or radiation-induced injury) or primarily repaired. The omentum is mobilized on its vascular pedicle and placed between the vagina and rectum.

Resection

The type of surgical resection depends on the level of the fistula. The goals of resection are to remove the diseased or damaged rectal tissue around the fistula and replace it with healthy, well-vascularized tissue and intact colon or rectum. Transabdominal low or ultra-low anterior resection, transanal mucosectomy with coloanal anastomosis, and transabdominal transanal abdominoperineal pull-through (known as the Turnbull-Cutait procedure if done in two stages, first with initial pull-through of the colon conduit, followed by delayed coloanal anastomosis) have all been described in the literature with near 100% success rates [66–69]. These procedures are often combined with omental flap interposition and are discussed in detail in Chap. 19. Success rates are reportedly as high as 100% on short-term follow up [70]. As these techniques are more invasive, they are typically reserved for patients with high fistulas or those who have undergone multiple failed perineal repairs (Figs. 15.6 and 15.7).

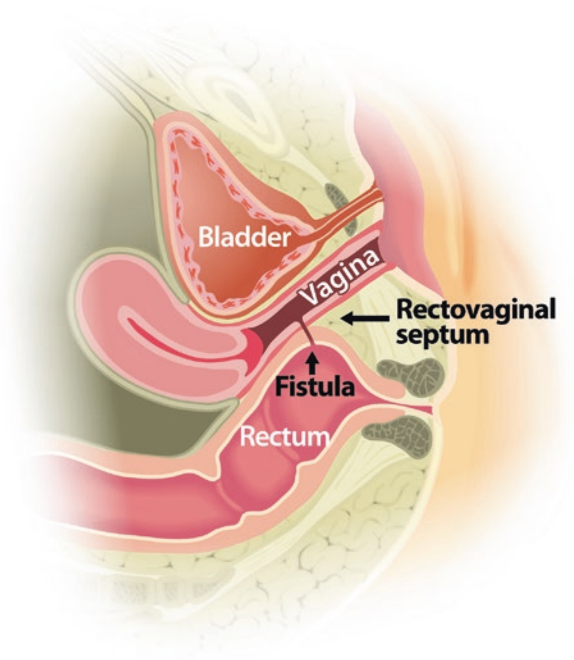

Fig. 15.6 Proximal rectovaginal fistula

Recurrent or Persistent Fistula

Recurrence rates vary widely but can approach 50% for rectovaginal fistulas. Crohn's disease and smoking are associated with a higher recurrence risk [63]. Success rates for rectovaginal fistula repairs unfortunately decrease with recurrence. Timing of repeat surgery is important, and should follow the same general principles for repair of initial RVF including allowing 3–6 months for resolution of inflammation [11]. As discussed previously, mucosal advancement flaps can be repeated several times with reasonable success. Patients with recurrence should be evaluated for adequately vascularized tissue interposition and need for fecal diversion.

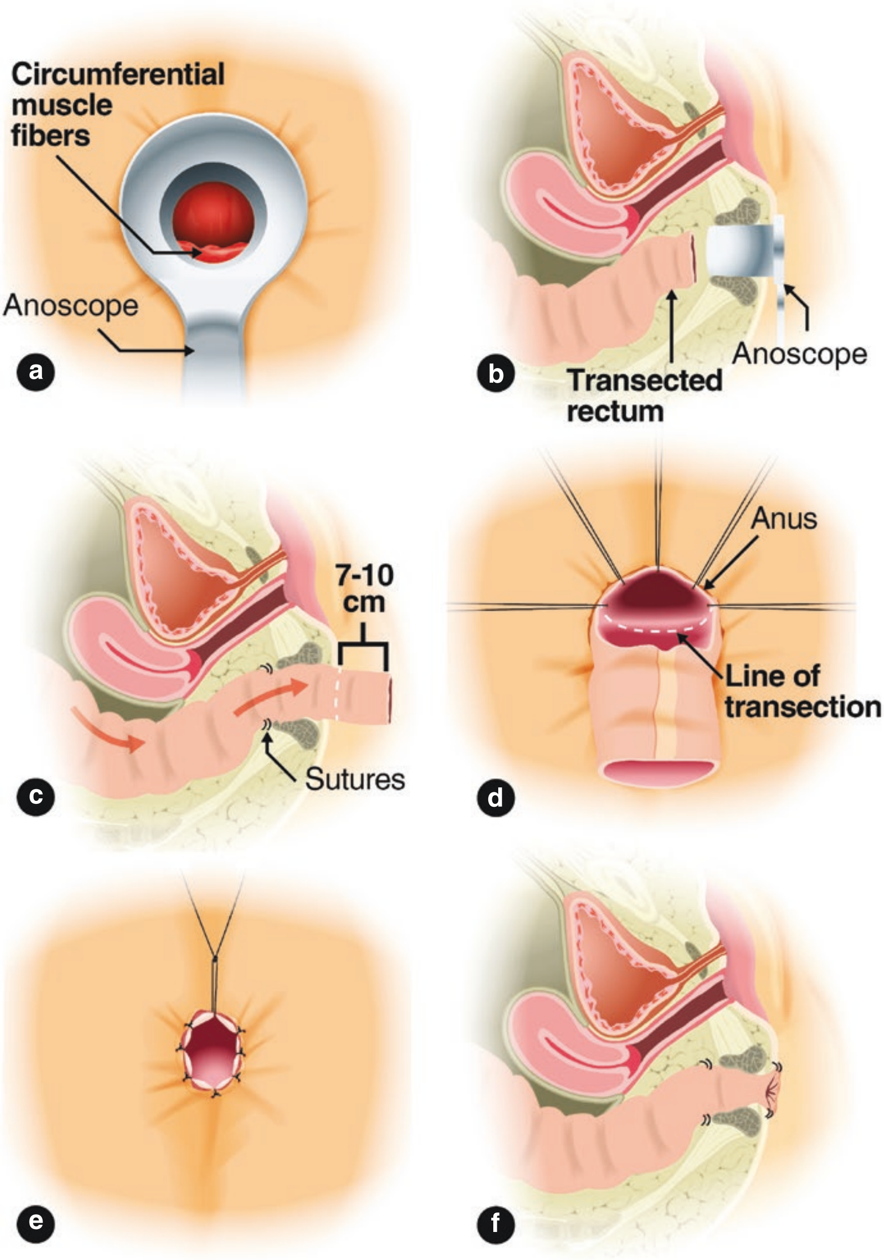

Fig. 15.7 Step-by-step approach for transabdominal transanal pull through technique

Conclusion

Rectovaginal fistulas represent a heterogenous and complex challenge for surgeons. The variety of etiologies, anatomic considerations, and therapeutic options result in a spectrum of possible outcomes. Published data are limited by their small sample size, heterogeneity, retrospective data collection, short-term follow-up, and limited measures of outcome. Although many case reports and series describe reasonable outcomes following repair, there is a vast range of published closure rates with both short and long-term follow-up. The lack of large, randomized studies make generalization difficult, Therefore, an individualized approach tailored to each patient remains the most appropriate treatment philosophy.

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Chapter 16
Obstetric Fistula

Madina Ndoye and Tamsin Greenwell

Abbreviations

CT	Computerized tomography
EUM	External urethral meatus
IVU	Intravenous urography
LHRH analogues	Luteinizing Hormone Releasing Hormone
LSCS	Lower segment Caesarean section
MRI	Magnetic resonance imaging
TB	Tuberculosis
UGF	Urogenital fistula
UTI	Urinary tract infection
UTVF	Ureterovaginal fistula
VVF	Vesicovaginal fistula
WHO	World Health Organisation

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Introduction

Obstetric urogenital fistulae are a major health issue in resource limited countries consequent to prolonged, obstructed second stage of labour [1]. In well-resourced countries obstetric urogenital fistulae are a rarity and mostly Caesarean section related [2]. The World health Organization (WHO) estimates that 50,000–100,000 women develop obstetric fistula worldwide each year [3], mainly in sub-Saharan Africa or south Asia. This is likely to be a significant underestimate as reported data is scanty and often inaccurate. Many women in resource limited settings live with their fistulae for decades without surgical repair with untreated obstetric fistulae estimated to affect approximately 3.5 million women worldwide [4].

The consequences of developing an obstetric fistula in a resource limited country include not only urinary and/or fecal incontinence but also fetal death, lower limb and pelvic girdle injuries alongside significant psychological, social, and financial adverse effects [5]. These women are often outcasts. They are considered unclean because they are soiled, stinking and continually wet. They are stigmatized by their family and communities, often divorced by their husbands, and relegated to precarious lives on the margins of society [6].

Incidence

The 2006 WHO estimated that two million women worldwide were living with VVF. This estimate was made from a countries' rapid needs assessments and physicians' reports rather than robust epidemiological studies [7]. The current figure is likely to be much higher, up to 3.5 million women worldwide [4], with high fistula prevalence rates reported in Nigeria, Kenya, Ethiopia and Bangladesh [8]. It is estimated that there are one million women living with VVF in Nigeria alone [9] and that 1/1000 deliveries in Nigeria and Kenya are complicated by obstetric fistula [9, 10] The World Health Organization estimates that 50,000–100,000 women develop obstetric fistula worldwide each year [3].

In contrast to this VVF, in particular obstetric VVF, are vanishingly rare in well-resourced settings—with a total of 74 VVF (none of which were obstetric VVF) recorded in England (population 55 million) in 2018–2019 [11].

There continues to be a paucity of accurate data regarding obstetric VVF. Most data is from relatively few countries on each continent. Studies deriving data from demographic and health surveys and questionnaires are likely to overestimate incidence [12]. Studies deriving data from local hospital and community records are likely to underestimate both incidence and prevalence of the condition by neglecting to include women living in hard to reach, rural areas [13] who are the most likely to be affected by the condition.

Types of Obstetric Urinary Tract Fistula

Whilst obstetric fistulae are primarily vesico-vaginal, obstructed second stage of labour can also result in uretero-vaginal, utero-vaginal, urethrovaginal and recto-vaginal fistula.

Uretero-Vaginal Fistulae (UTVF)

A uretero-vaginal fistula is defined as an abnormal communication between the ureter and the vagina (or the uterus or cervix). Full assessment to exclude a simultaneous VVF is essential as UTVF are associated with VVF in up to 25% of cases [14–17]. Up to 9% of women with UTVF present with acute renal failure (ARF) due to delayed presentation and diagnosis [15].

Aetiology of UTVF

The commonest cause of UTVF worldwide is injury by incision, division, crush, tie, or diathermy at time of hysterectomy [15, 18]. UTVF may also arise because of pressure from an obstructed second stage of labour [19].

Presenting Symptoms of UTVF

Most data on UTVF are on post-surgical UTVF with minimal data available on obstetric UTVF. UTVF are generally asymptomatic until the affected woman experiences sudden onset of urinary leakage from the vagina, at around 1–4 weeks post-delivery [15, 20, 21]. If symptomatic, it is generally with back or loin pain [15, 22] due to partial or complete ureteric obstruction (present in over 2/3) causing hydronephrosis. Over 10% of UTVF patients have a non-functioning kidney at time of diagnosis due to delayed presentation and diagnosis in the majority [15, 23].

Diagnosis of UTVF

CT Urogram with delayed urogram images (Fig. 16.1) provides the most accurate and rapid diagnosis along with identification of level of ureteric injury. IVU or retrograde urography can be utilized instead of CT Urogram if it is not available [15]. Ultrasound is often performed as a primary investigation, demonstrating upper tract dilatation in the majority, and should lead to further imaging as delineated above. Cystoscopy to exclude a simultaneous VVF is mandatory following the diagnosis of UTVF [20, 21].

Fig. 16.1 CTU showing right uretero-vaginal fistula

Treatment Options for UTVF and Outcomes

Immediate renal drainage, either by insertion of a ureteric stent, nephrostomy tube or formation of cutaneous ureterostomy should be performed to preserve renal function [24, 25] whilst awaiting resolution of inflammatory changes and definitive surgical repair, if required. Ureteric stent insertion may not be straight forward, and rendezvous (antegrade-retrograde) access or "cut-to-the-light" endoscopic techniques may be required to allow placement [26]. Complete healing of UTVF has been reported in 5–15% following stent placement alone [24, 25].

Classification of ureteric fistula is by:

1. Cause of the injury (cut, tie, diathermy, avulsion, ischemic (obstetric))
2. Complete or incomplete division of the ureter
3. Size of the ureteric defect.

This classification allows categorization and thence comparison of UTVF treatments and outcomes, and the prediction of the odds of success from minimally invasive management techniques. If minimally invasive management treatment fails or is not available, then open or laparoscopic/robotic options should be utilised.

Surgical treatment consists of open or laparoscopic/robotic uretero-vesical reconstruction ± VVF repair. Direct reimplantation is possible in up to 80% of cases, whilst psoas hitch, Boari flap, transureteroureterostomy and ileal chute interposition are required in up to 20% (Table 16.1, Fig. 16.2). Complete renal loss occurs in around 2% of cases. In cases having successful direct reimplantation, stabilization of the repair with a psoas hitch to prevent ureteric kinking yields best results [28].

Vesico-Vaginal Fistulae (VVF)

A vesicovaginal fistula (VVF) is defined as an abnormal communication between the vagina and the urinary bladder. It is a devastating complication of poorly managed (second stage) labour and, far less commonly, pelvic surgery and/or radiotherapy [29, 30].

Aetiology of VVF (Table 16.1)

The majority (>90%) of low resource setting VVF arise due to neglected, prolonged, obstructed labour [29, 31]. Whilst 6–13% are caused by Gishiri cutting, sexual assault, post-coital injuries, and infections such as tuberculosis (TB) [32–35].

In contrast in high resource settings the majority (>90%) of VVF are iatrogenic, following pelvic surgery for benign and malignant conditions [36, 37] or radiotherapy to treat malignancy [38]. An increase in lower segment Caesarean sections (LSCS) in both elective and emergency obstetrics has resulted in an increasing number of iatrogenic urogenital fistula (UGF), accounting for up to 12% of cases in some series [39, 40].

Table 16.1 Aetiology of fistulae in the developing and developed world. Table uses data presented in Hillary CJ Osman NI, Hilton P, Chapple CR. The aetiology, treatment, and outcome of urogenital fistulae managed in well- and low-resourced countries: a systematic review. Eur Urol. 2016 Sep;70(3):478–92 [27]

Aetiology	Low-resource settings	High-resource settings
Obstetric causes	95.2%	3.5%
Prolonged, obstructed labour	44.9%	0.1%
Surgical causes	4.4%	83.2%
Abdominal hysterectomy	1.2%	46.2%
Radical hysterectomy	0%	4.2%
Vaginal hysterectomy	0.4%	1.9%
Other pelvic surgery	1.6%	12.7%
Radiotherapy	0.2%	13%

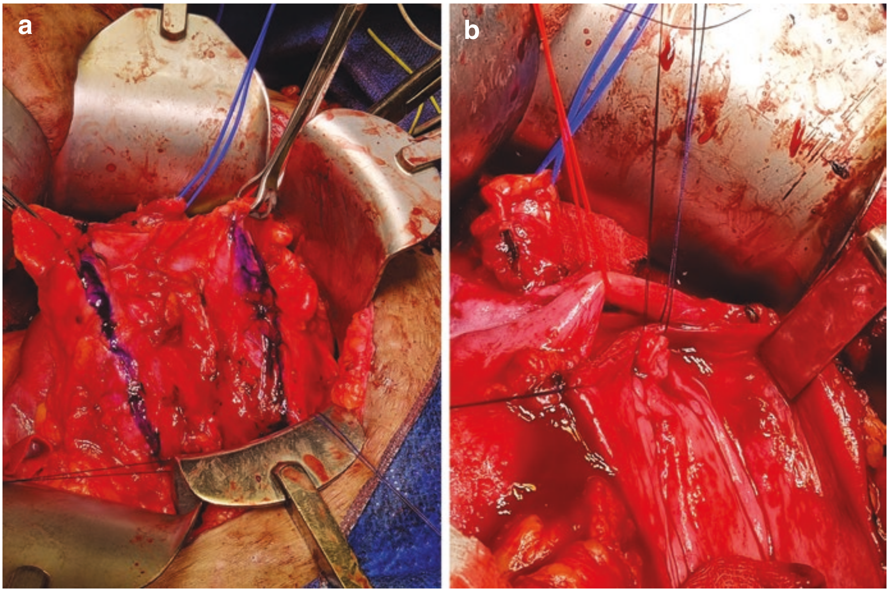


Fig. 16.2 Open abdominal ureteric reimplantation for obstetric ureterovaginal fistula. (**a**) Outline of left Boari flap on anterior bladder wall. (**b**) Left Boari flap with psoas hitch and Leadbetter-Politana tunnel for ureteric reimplant

Classification of Obstetric VVF

There have been many classification systems for obstetric VVF described over the years however none have attained universal acceptance. The two most widely used classifications are those of Goh [41] and Waaldijk [42].

The Goh Classification [41]

- Type 1—Vesico-Cervico-Vaginal Fistula

- The distal edge of the fistula is >3.5 cm from the external urethral meatus (EUM)
- Type 2
- The distal edge of fistula is between 2.5 and 3.5 cm from EUM
- Type 3
- The distal edge of the VVF is 1.5–2.5 from the EUM
- Type 4
- The distal edge of the VVF is <1.5 cm from the EUM

The Waaldijk Classification [42]

- Type I—Vesico-Cervico-Vaginal Fistula
- Does not involve the urethral closure mechanism
- Type II
- Involves the urethral closing mechanism
- Type III
- The ureteric orifices are involved

The prognosis in terms of likelihood of anatomical closure and restoration of continence worsens with grade in both classifications.

Although VVF classification offers a useful framework for describing fistulae and has some prognostic value, it has not been proven to be useful in all settings [43]. Most VVF in high resource settings are type 1/1 and neither the Goh nor the Waaldijk classification systems appear to have practical relevance in terms of outcome prediction [43].

In low resource settings critical factors for VVF outcomes are the position and size of the fistula, in particular its' proximity to the ureters and whether the urethral closure mechanism is involved. A comparative study between the Goh and Waaldijk classification systems found that the Goh system was significantly better at predicting successful fistula closure [44, 45]. However, there is a large degree of subjectivity in the application of all available classifications, with accuracy dependent upon both surgical experience and individual interpretation [46]. The goal must be the development of a simple, simple, standardised, international system (similar to that used to stage cancers) [47] which accurately predicts surgical outcomes.

Predisposing Factors

The pre-eminent risk factor for obstetric VVF is poverty, not just of wealth, but also of education and environment. Women developing obstetric VVF are commonly poor, young, illiterate, and live in rural communities [48]. The average age at marriage for "women" developing obstetric VVF is 14.7–15.9 years and at first pregnancy and delivery is 16.9 years [48–50]. Women most commonly develop their fistula during their first delivery (43.5%), and 83% develop their obstetric VVF before the age of 20 [48–50].

These unfortunate young women are also likely to be malnourished, with stunting of their overall and pelvic growth [49–51]. This stunting exacerbates cephalopelvic disproportion related to their lack of physical maturity and in many cases their underlying anatomy (for example African women have naturally narrower pelvises) [51–53]. Cephalo-pelvic disproportion is a significant causative factor for obstetric VVF—with larger male fetuses and/or malpresented fetuses of either sex more commonly involved in obstructed prolonged labour [54]. Women with obstetric VVF experience prolonged obstructed labor of on average duration of 2.3 days with fetal death from asphyxiation and subsequent still birth in 89–90% [4, 55].

The multi-level poverty that predisposes to obstetric VVF development is also associated with a reduction in the likelihood of/or ability to seek medical care. In Benin, Sierra Leone and Ghana obstetric complications are believed to be God's will, the consequence of evil spirits or inherited [49, 53, 56]. In some provinces of Nigeria woman need their husbands' permission to access emergency healthcare [53, 56] and birth injuries may be stigmatized as God's punishment for previous sexual misbehavior [4, 55]. There is also a lack of understanding in some communities that Caesarean section is life saving and a perception that failure to give birth vaginally is a form of reproductive failure [57]. The financial cost of obstetric care also presents a significant barrier for many [52, 53].

Prevention

Short-term preventative strategies for obstetric VVF are:

- Improved care during labor
- Increased access to emergency obstetric services (particularly Caesarean section)
- Improved medical care during and after obstructed labor

The long-term preventative strategies for obstetric VVF are:

- The development of specialist fistula centers to treat injured women
- Universal access to emergency obstetric care
- Universal access to family planning services
- Increased level of education for girls and women
- Community economic development
- Enhanced gender equality [58]

These are all the reasons that obstetric VVF have all but vanished from high resource settings.

Pathogenesis

When the second stage of labour is obstructed, the fetal head is compressed against the tissues of the birth canal for a prolonged period. This causes local tissue ischaemia which eventually results in necrosis [50, 52, 59, 60] and destruction of the vesicovaginal septum with consequent fistula formation. Further local tissue damage occurs secondary to the irritation and infection caused by the subsequent continuous urinary incontinence which in turn increases inflammation and scarring [49, 50]. The level at which obstruction occurs during labor determines the site at which the fistula will subsequently develop [59, 61]. For example, if labor becomes obstructed at the pelvic brim, the resulting VVF will be high in the pelvis whilst if labor becomes obstructed at the pelvic outlet, the VVF will be closer to the urethra.

VVF is only 1 part of the "Obstetric Injury Complex" formed from a combination of any or all the following: urethral damage, renal failure, vaginal stenosis, rectovaginal fistula, pubic symphysis damage and foot-drop due to compression injuries of the local nerves [49–52].

Presenting Symptoms

Up to 80% of women with obstetric VVF may never seek treatment [51, 52, 55] secondary to lack of knowledge, infrastructure, and resource ± shame [53]. Many live with their VVF for years before presenting with persistent urinary (and/or faecal) incontinence, urinary tract infection and ammoniacal dermatitis [62]. The volume of urine voided per urethra and the volume of urinary incontinence vary significantly depending upon the site and size of the VVF. Urinary incontinence can range from continuous (large and low fistulae) to intermittent and postural (small and high fistulae). Other symptoms include pelvic pain, dyspareunia due vaginal stenosis and/or incontinence and infertility [63]. Women with obstetric VVF suffer from significant depression, post-traumatic stress disorder and mental health dysfunction [51, 53], the end result of which is sadly suicide for some [64].

Diagnosis

Examination of the vagina utilizing a Sims speculum and Rampley sponge holding forceps may show pooling of urine in the vagina ± the fistula itself (Fig. 16.3) [62]. Pre-existing pelvic organ prolapse and urgency and/or stress urinary incontinence should be also noted. Cystography or methylene blue installation ± the "3 swab test" (the placement of 3 white swabs in the vagina followed by intravesical instillation of 100 mL methylene blue dye diluted 50:50 with normal saline) may allow visualisation of more subtle fistulae directly by visualisation of blue tracking into the vagina or indirectly by observation of blue staining on the innermost swab (Fig. 16.4) [52, 65, 66].

Simultaneous cystoscopy and vaginal examination remain the gold standard for diagnosis and allow classification of the fistula by determining size, location, and tissue quality (Fig. 16.5) [61, 65]. Associated inflammation, infection and tissue friability should also be recorded and may prompt postponement of fistula repair to allow them to settle. Vaginal length, mobility, vascularity and tissue quality along with width of the genital hiatus and vaginal introitus are important factors to record for classification and to determine the route of repair—vaginal or abdominal.

Up to 20% of women with VVF will have concomitant ureteral injuries (obstruction ± UTVF) [62] and all women with VVF should have a CT Urogram, IVU, retrograde ureterography or very rarely MRI to exclude this (Figs. 16.6 and 16.7) [59, 66].

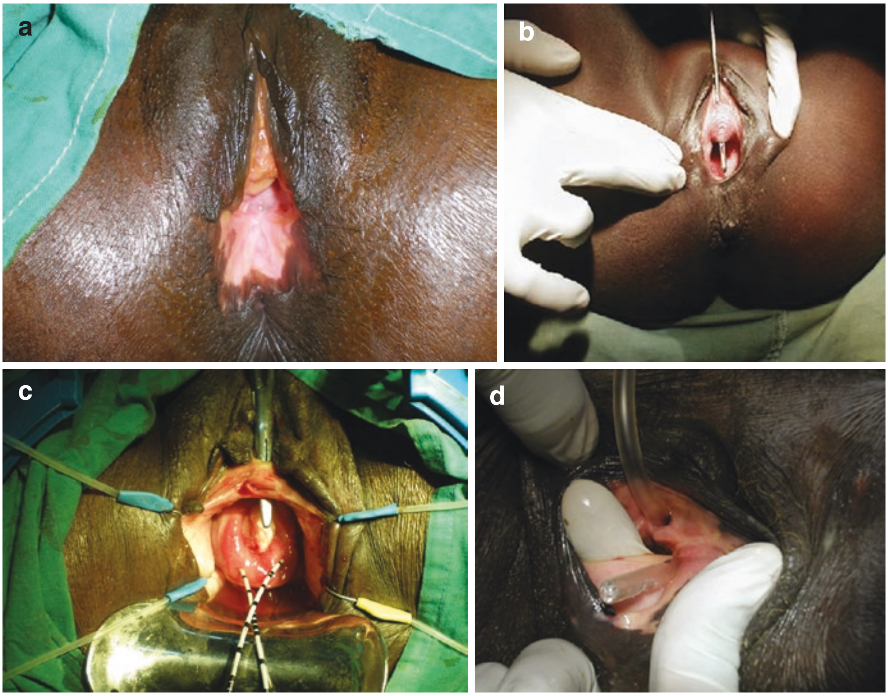
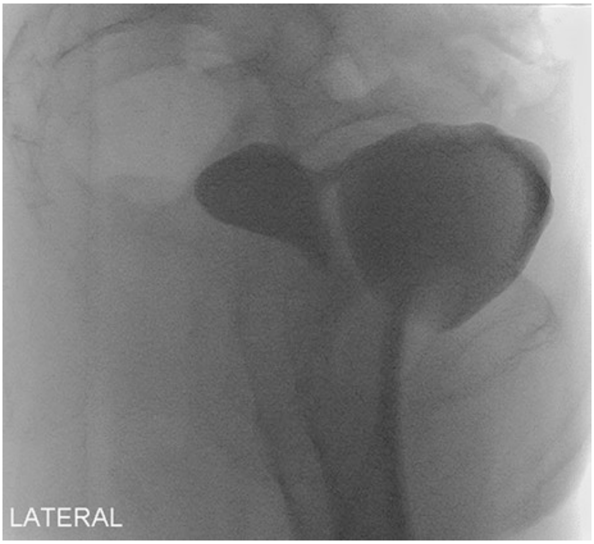


Fig. 16.3 Obstetric VVF on examination. (**a**) Perineal loss. (**b**) Proximal urethrovesicovaginal fistula. (**c**) Complete loss of urethra and bladder neck. Stents in the ureteric orifices. (**d**) Rectovaginal fistula

Fig. 16.4 Cystogram to diagnose VVF



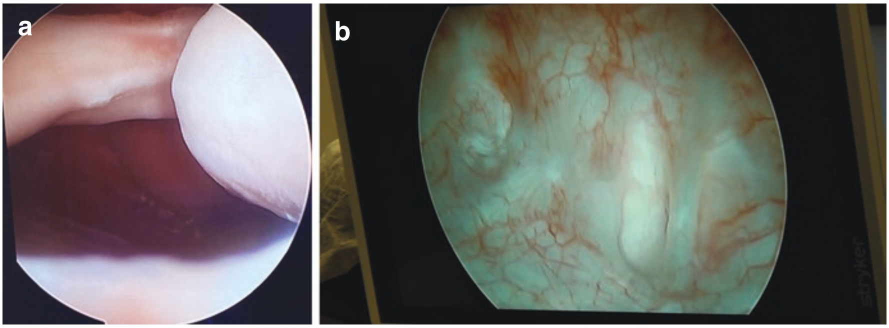


Fig. 16.5 Cystoscopic diagnosis of VVF. (**a**) Large VVF—view into bladder from the vagina. (**b**) Small VVF—at 6 O'clock in bladder

Fig. 16.6 CTU of VVF—to left of midline

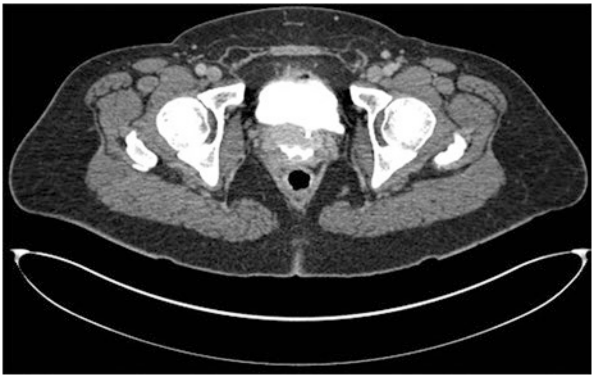


Fig. 16.7 MRI of VVF—to right of midline

It is also important to exclude other causes of urinary incontinence such as stress, urgency, mixed and overflow incontinence and vice versa. Rarely patients with long standing refractory urinary incontinence have been found to have VVF as the cause of their problems [50].

Management Options For VVF

The aims of VVF management are:

1. Anatomical closure of the VVF
2. Restoration of complete urinary continence
3. Restoration of volitional voiding
4. Diagnosis of malignancy (if indicated)

Conservative Management

Spontaneous closure occurs in up to 12% of women managed with indwelling catheters and anti-cholinergic medication for the first 3–6 weeks following the precipitating injury [67–69]. Excellent nutrition, infection control and urinary drainage (using indwelling catheters or nephrostomy tubes) are first line primary management. If this fails to result in spontaneous closure of the within primary closure of the fistula within 6 weeks, the VVF is unlikely to close with continued conservative management and surgical management will be necessary. Any indwelling urethral catheters can be removed at this stage unless they significantly reduce the volume of urinary leakage experienced. All urethral/suprapubic catheters should be removed at least 6 weeks before definitive repair to eliminate catheter related irritation and inflammation of the bladder mucosa, which may reduce the ability to visualise the fistula at the time of the repair, and to allow definitive treatment of any catheter related urinary tract infection (UTI). Incontinence pads, skin care and regular perineal review with continence nurse specialists (if available) greatly improve patient comfort and reduce distress.

Endoscopic Management

The use of diathermy fulguration or of fibrin glue has been described for small fistulae (<5 mm) [70, 71]. It would be reasonable to offer a trial of these techniques the patient presenting with a small VVF whilst awaiting the optimal time for delayed repair however there is no data for this in the setting of obstetric VVF.

Definitive Repair

The key surgical principles include [49, 50, 60, 61, 72]:

1. Incision and delineation of the fistula margins
2. Wide separation of the vaginal wall from the vesical wall (generally without debridement of the fistula margins and the tract) with sufficient mobilization of both to allow tension free closure.
3. Removal of any foreign bodies
4. Watertight closure of both bladder and vaginal side of fistula
5. Multi-layer, tension free closure without overlapping suture lines utilizing peri-vesical, paravaginal or interposition flap as a third layer
6. Excellent haemostasis
7. Appropriate anti-microbial cover as per institutional policy
8. Drainage of the urinary tract with an indwelling catheter for a minimum of 2 weeks (until healing is presumed or confirmed by leak test, dye test or cystourethrogram).
9. If healing has not occurred by 6 weeks, then the procedure is deemed to have failed [50, 67].

There are very few other areas of consensus regarding best management of VVF [49, 50]. Areas of divergence are:

Timing of Repair

Surgical repair is indicated if spontaneous healing has not occurred following 6 weeks of urinary catheter drainage. Traditionally obstetric VVF repair has been delayed for 6–12 months from the time of the precipitating delivery, to allow resolution of tissue inflammation and infection [4, 12, 73, 74]. This has been challenged recently and, with careful patient selection, it has been proven possible to achieve successful repair within 12 weeks of the precipitating delivery [75] with one Nigerian series reporting success in 87.8% of VVF repaired within 12 weeks of injury versus 87.2% in those having delayed repair. Early repair if successful benefits the patient's physical, psychological and social wellbeing [61]. It should be noted that the most likely chance of successful VVF closure is following the first repair attempt [50] and shortening the waiting period must not compromise overall surgical success [59]. Taking this into account, most experts continue to recommend a period of delay to treat infection, let inflammation settle and allow the fistula margins to mature before attempting definitive repair [8, 10, 27, 45].

Antibiotic Usage

The use of antibiotics is a further area of controversy [8, 10, 49, 50]. Some centres give all patients a course of peri-operative antibiotic therapy [60], some use only one prophylactic dose [8, 10, 76] whilst others do not use any [59, 77, 78]. One randomized controlled trial in West Africa found no benefit at all from antimicrobial therapy [8]. In view of the lack of evidence antibiotic use remains an individual and institutional decision.

Route of Repair

There continues to be a debate about the best surgical approach to VVF repair. It should be possible to close VVF vaginally at least 70% of the time [8, 79] and this is the route of choice for the majority of obstetric VVF repairs. The chosen route of repair is mainly dependent upon the training and surgical preference of the operating surgeon—with a tendency for gynecologists to perform transvaginal repairs, and for urologists to perform transabdominal repairs [27, 37] in well-resourced settings. This is not however always the case with 85% of VVF repairs performed transvaginally by urologists in my institution [43]. Anatomical closure rates are similar for both routes of repair however the open abdominal route has significantly higher morbidity [77, 80–82]. In the case of fistulae that are particularly large, complex, or high in the vagina, a transabdominal approach may offer the best chance of success [6, 9].

Trans-Vaginal VVF Repair (Fig. 16.8)

Transvaginal VVF repair was first reported by Sims in 1838 [78].

Absolute Indications

1. The VVF is physically accessible via the vagina—the VVF is low enough, the vagina mobile enough and vaginal width versus depth ratio sufficient to allow visualisation and instrumentation
2. There is no absolute indication for abdominal repair (ureteric injury ± small capacity bladder requiring clam cystoplasty)

Relative Indications

1. Previous failed abdominal repair

Advantages

Vaginal repair avoids a laparotomy and its associated morbidities and the need to bivalve the bladder with its associated longer-term functional morbidities. Vaginal repair is also associated with reduced post-operative pain, more rapid recovery, a

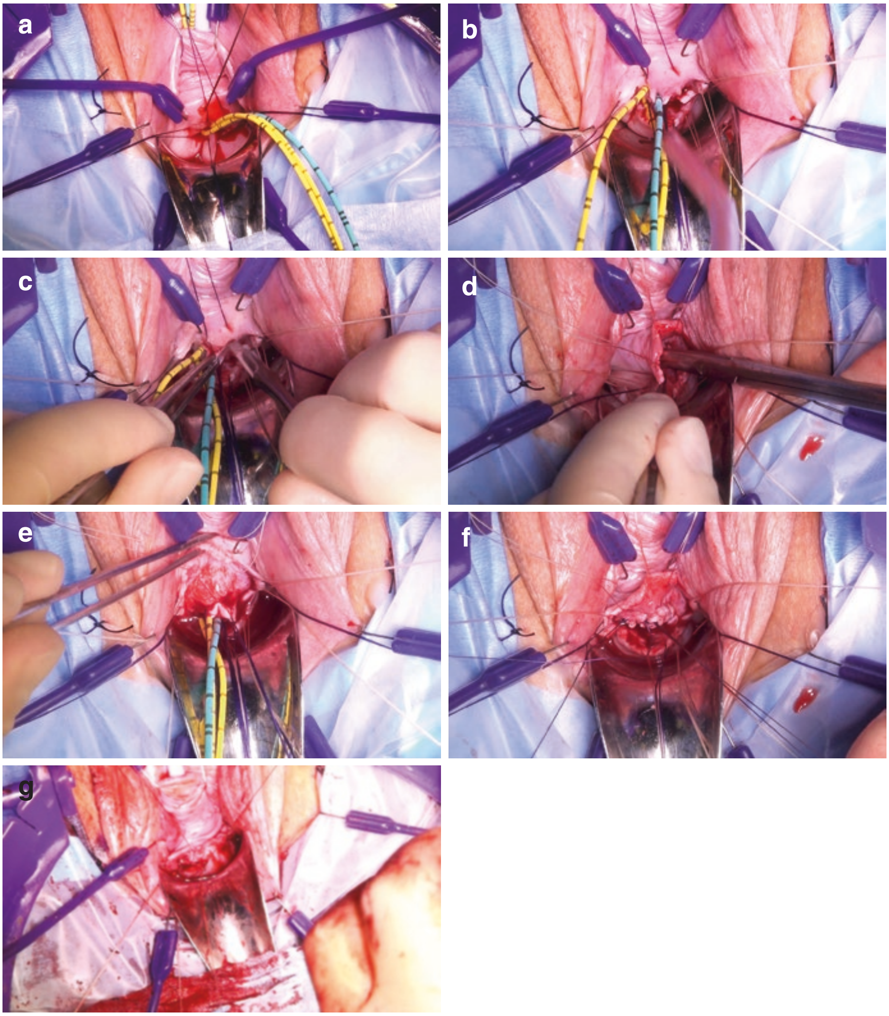


Fig. 16.8 Vaginal repair of VVF. (**a**) Stay sutures to pull fistula into operative field. (**b**) Fistula is circumscribed and white monocryl stays on vaginal free edges. (**c**) Fistula circumscription is completed and purple Vicryl stay sutures are places on vesical free edges. (**d**) The plane between the vagina and bladder is widely mobilized. (**e**) The wide mobilisation of the vagina off the underlying bladder is completed to allow a tension free closure. (**f**) The bladder aspect of the fistula is closed with continuous Vicryl. (**g**) The vaginal aspect of the fistula is closed with continuous Monocryl

shorter hospital stay and an earlier return to normal activities [77, 80–83]. Local paravaginal interposition flaps (e.g., Martius fat pad) are immediately adjacent and readily available and it is relatively simple to perform simultaneous anti-incontinence or prolapse surgery if indicated. There may also be a putative reduction in medico-legal litigation costs in high resource settings because of these advantages.

The complications associated with the transvaginal approach include a longer operative time, vaginal shortening and potential dyspareunia [77, 80–83].

Trans-Abdominal VVF Repair

The O'Connor technique is considered the gold standard for transabdominal VVF repair [84] and follows the principle of omental flap interposition as described by Turner-Warwick in 1967 [85, 86]. The fistula is approached via a long anterior wall and bladder dome cystostomy. Fistula can also be repaired extra peritoneally with dissection along the back wall of the bladder minimizing bladder trauma and allowing easy access for omental interposition through a small peritoneal window [87].

Indications for Trans Abdominal VVF Repair (Fig. 16.9)

Absolute Indications

1. Ureteric involvement requiring concomitant ureteric reimplantation
2. Small capacity bladder requiring augmentation cystoplasty,

Relative Indications

1. high fistula in a deep narrow or a floppy capacious vagina making surgical access impossible
2. previously irradiated tissues
3. complex fistulae (commonly fistulae over >2 cm)
4. previous failed transvaginal approach [85, 87].

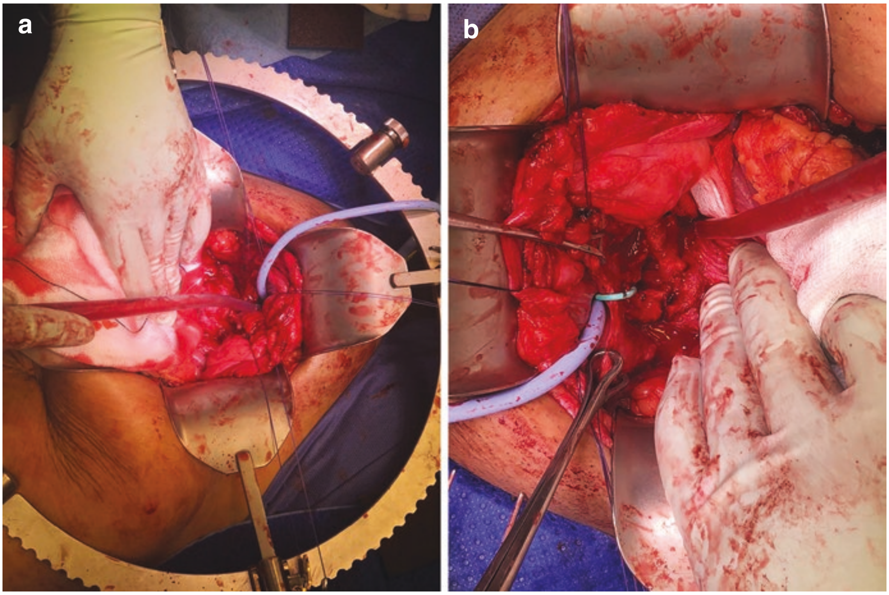


Fig. 16.9 Abdominal repair of vesico-utero-cervico fistula. (**a**) Pfannenstiel incision, dome and posterior wall of bladder opened to level of fistula. (**b**) Plane between posterior aspect of bladder and cervico-uterine fistula developed with stent traversing fistula

Advantages

Abdominal repair of VVF allows for simultaneous reimplantation of ureter(s) and/or clam cystoplasty if required. Omentum can also be easily harvested in most patients without additional morbidity or incision.

The complications associated with the transabdominal approach include the morbidity associated with a laparotomy, greater post-operative pain, longer recovery time and hospital stay and a marginally higher risk of failure.

Excision of the Fistula Tract

Complete excision of the fistula tract can compromise the outcome of the repair [88–91] by creating a much larger tissue defect and may convert a simple fistula suitable for transvaginal repair to a more complex fistula requiring a transabdominal approach, especially if the VVF is adjacent to a ureteric orifice. The exception to this edict is for post radiotherapy fistulae when the fistula margins need to be debrided back to healthy bleeding tissue (if possible). This often creates a large fistula as the area of non-viable tissue requiring debridement is often substantially larger than suggested on preoperative radiological or examination appearances.

Tissue Interposition

The reason for tissue interposition is to promote healing (via improved blood supply and, venous and lymphatic drainage) and avoid overlapping suture lines [8, 91–93]. Those most used during transvaginal repair are paravaginal fascia, peritoneal flaps (for proximal fistulae) and Martius (labial) fat pad flaps [10, 30, 92]. A recent single centre study indicated excellent success rates over 10 years in a cohort of 83 patients with tissue flap interposition regardless of flap type [90]. Many surgeons regard the use of interposition tissue flaps as another core principle of vesicovaginal fistula repair whilst others feel they are not indicated for all VVF repair [90, 91, 93, 94]. Most authors whether proponents of routine interposition flap usage or not would agree that they are indicated in (1) irradiated tissue, (2) previous failed repairs, (3) large fistulae >3 cm.

Omentum is widely regarded as the interposition flap tissue of choice for transabdominal repair (open, laparoscopic, or robotic). Evans et al. found a higher success rate (100% for both benign and malignant aetiology) for transabdominal repairs performed using an omental flap than without (63% for benign aetiology and 67% for malignant aetiology) [94].

There is, however, more ambiguity with regards the use of tissue flaps for transvaginal repair, particularly Martius labial fat pad flaps. Success rates over 95% have been reported with Martius interposition compared to 75–80% rates with simple repair alone [95–98]. Tissue interposition flaps appear to make a significant difference in salvage repair outcomes [98], although good results from simple transvaginal repair have been reported in single series [43, 83]. The arguments against Martius fat pad flap interposition are related to the purported difficulty and morbidity of its harvest. Reported complications include bleeding and haematoma from the

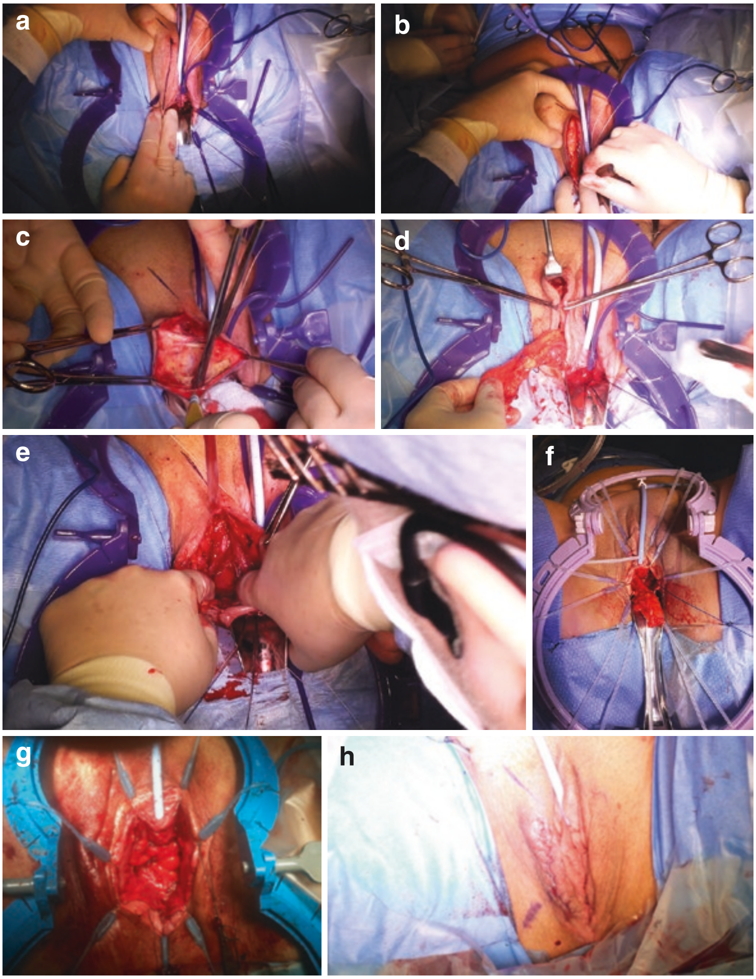


Fig. 16.10 Martius fat pad flap harvest and interposition. (**a**) Skin incision marked on right labium majora. (**b**) Skin and superficial fascia excised to deep fasia. (**c**) Lateral aspect of fat pad is mobilized. (**d**) Superior pedicle is divided and fat pad is completely mobilized on all aspects apart from inferolateral pedicle. (**e**) Tunnel is made along lateral wall of vagina. (**f**) Fat pad flap is transposed into vagina. (**g**) Fat pad flap is sutured to vaginal fascia to reinforce the underlying bladder repair. (**h**) Final appearance

harvest site, labial wound infections, altered and distorted labial cosmesis, reduced and absent labial sensation and labial pain [97, 99, 100], although most complications are mild and self-limiting. Cosmetic disfigurement and reduced sexual function do not seem to be significant factors, although protracted paresthesia and pain [97, 100] may occur in <10%. An alternative technique utilised in the resource limited setting is excision of the fistula tract and vaginal cuff scar with layered tissue closure [101]. We have used a modified fibroadipose Martius flap with minimal cosmetic or functional morbidity in all transvaginal repairs since 2002 (Fig. 16.10).

Other surgeons reserve the use of tissue interposition only for complex (urethral and bladder neck fistulae) and have found that there was no significant difference in success rates between those cases where a graft had been used and those where it had not [102]. We are currently reliant on evidence primarily from cases studies and this is inevitably subject to the bias of individual surgeons. Randomized trials are needed to standardize practice and establish when and which tissue interposition is most appropriate.

Who Should Repair VVV and UVF?

Overall, there is 10–30% of failure to close obstetric VVF and a 30–55% failure to achieve urinary continence [8, 10, 32, 33, 41]. Successful fistula closure is significantly more likely in women who had not had previous failed attempts at closure [8, 95] in other words the best opportunity to repair a VVF is at the first operation. Failed attempts at repair create further inflammation, scarring, anatomical distortion, and compromise potential reconstructive flaps. Whilst it is possible to achieve repair after several failed operations, each failed repair adversely effects the likelihood of success of the subsequent repair [103, 104]. Surgeons involved in fistula repair should be skilled in both abdominal and vaginal approaches and should have experience and versatility to decide the most appropriate procedure for each individual patient including urinary diversion and continence procedures. Repair by experts in centres of significant experience is the best option for all patients [105] and produces the best results.

Techniques for Complex Fistulae

Complex fistulae are defined as those that are greater than 2 cm in diameter, radiation induced (rare in low resource settings), involving the trigone or involving the urethrovesical junction [89, 106]. Although vaginal repair is possible in most of such cases [106], a modified approach may be required [107].

When repairing vault or juxta-cervical fistulae it is advisable to perform this transversely [8] to reconstruct the underlying trigone. When there has been substantial urethral loss, a flap of anterior vaginal wall can be used to form a neourethral tube over a catheter [8]. Tissue interposition is almost always required to provide additional bladder neck and/or neourethral support [8, 79]. Because of the severity of injury these fistulae have a poorer prognosis both in terms of anatomical closure and urinary continence [8].

Some complex fistulae will necessitate a transabdominal approach, particularly those that are extensive and/or close to the ureteric orifices. Preliminary catheterisation of the ureters to prevent ureteric injury [8, 10, 92] is essential when repairing such fistulae.

Outcomes

Anatomical Closure

Successful anatomical fistula closure has been reported in 58–98% have been reported [32, 73, 75, 108–111] depending on whether the fistula is simple or complex, obstetric or iatrogenic and whether the procedure a primary or secondary (or more) procedure. Obstetric VVF primary anatomical closure rates vary from 72.9% in Zambia [109] to 91.8% in Nigeria [111].

Anatomical closure of a simple VVF has been reported in more than 85% with either the transvaginal or transabdominal approach in many series. VVF that are complex, secondary to obstetric causes, large or those associated with radiation therapy, generally have lower success rates of between 60% and 70% [8, 38, 108–111]. At our institution we have found that up to 85% can be performed transvaginally, with a 95% first time repair success rate, and 100% success rate overall. Modified Martius fat pad flap interpositions are used for all transvaginal repairs.

Although there are no randomized controlled trials to compare outcomes of vaginal and abdominal repair, series have consistently reported lower primary closure rates for abdominal repair [14, 43]. A recent systematic review of VVF repair cites a success rate for a vaginal closure of 91% versus 84% for abdominal repairs [112].

Continence Rates

Stress urinary incontinence in up to 55% of women following successful anatomical closure of their obstetric VVF [113–115]. Continence rates are higher after primary successful anatomical VVF closure compared with after successful anatomical closure of persistent VVF (previous failed anatomical closure). Continence rates are also higher following successful anatomical closure of simple VVF compared with successful anatomical closure of complex VVF. The Danja centre in Nigeria reported closure and continence in 80% of all women after primary fistula closure; when subgroups were analysed 92% of women with primary simple VVF had closure and continence compared with only 57% of women with complex and/or recurrent VVF cases [32]. Success decreased with increasing numbers of previous attempts at surgical repair [32]. Stress incontinence following successful closure of obstetric VVF may be secondary to “tethered vagina syndrome” and the use of a Singapore skin flap may prevent this [116]. Many try to prevent the development of post closure stress urinary incontinence by performing a bulbocavernosus muscle sling at time of VVF repair [117].

Other Complications

Acute Complications

Peri operatively women are at risk of wound and urinary tract infection [8, 12], blood loss and pain. In low resource settings access to blood products and analgesia is often limited. Many VVF repairs are performed under spinal anaesthetic alone and in some cases local anaesthetic alone [75]. Despite this, most studies report a very low short-term complication rate especially for the transvaginal route [12, 75, 108–111].

Long Term Complications

Long term complications are much more prevalent and can have a profound effect on quality of life. The most common long-term complications include frequency, urgency, urge incontinence, stress incontinence (detailed above), vaginal stenosis, recurrence, ureteric obstruction and bowel obstruction [79]. Voiding dysfunction either preexistent or as a consequence of VVF and its repair is found in up to 83% [72, 118–120]. Types of voiding dysfunction include detrusor overactivity, loss of compliance and detrusor hypocontractility in order of frequency. USUI and IDO are most commonly associated with bladder neck VVF [121]. Urethral stricture causing bladder outflow obstruction occurs in 4–6% of those with urethral involvement and has generally been managed by urethral dilation or urethrotomy ± ISC [122] although urethroplasty can be considered in recurrent cases.

Female sexual function is barely reported. No difference in sexual function has been reported in 1/3 of women having their VVF repaired by transabdominal or transvaginal approach with or without a modified Martius fat pad flap interposition [99]. Sexual function was significantly improved in 64% patients and overall sexual function was significantly improved following both operative approaches. Neither surgical intervention was superior to the other regarding sexual function or quality of life scale [72].

Irreparable Fistula

There is no universal agreement on what constitutes an “irreparable” fistula [123]. Typically, they are defined by multiple failed repair attempts or such significant obstetric injury that the tissue defects are simply too large to close (complete destruction of the urethra or bladder, defects involving the ureters or severe vaginal scarring) [7, 10, 12, 123]. Urinary diversion, most commonly by ileal conduit [124] but also ureterosigmoidostomy [125] and neobladder and Mitrofanoff [126], may be offered to women with irreparable fistulae. These represent a small proportion of the total number of women with obstetric VVF—<1% in most series [7, 32, 123]. However, they are both a technical and ethical challenge.

Urinary diversion surgery requires extensive pre-operative counseling, a reliable supply of stoma equipment and long-term follow up [123, 124]. Unfortunately, this is not often available low resource settings. It is imperative that the pros and cons of diversion are carefully considered in light of the above in low resource settings [123].

Ureterosigmoidostomy is an alternative form of urinary diversion [123, 125] which eliminates the need for stoma equipment. It requires a well vascularised portion of sigmoid colon and an intact anal continence mechanism for success whilst neobladder and Mitrofanoff channel necessitates ISC [126]. Long term follow up is still requires due to risks of acute and chronic pyelonephritis, hyperchloraemic metabolic acidosis and colonic cancer [123–126].

Vesico-Uterine Fistula

A vesicouterine fistula (VUF) is defined as an abnormal communication between the uterus and the urinary bladder. It most commonly occurs following difficult Caesarean section and rarely following obstructed vaginal delivery, pelvic surgery and/or radiotherapy. There is an increasing in incidence in VUF consequent to increasing Caesarean section rates in both high and low resource settings [127–131].

Presentation

VUF presents with cyclical haematuria (menouria), amenorrhea, infertility or first trimester spontaneous abortion [127–132]. Rarely it presents with haematuria, urinary incontinence (in the presence of cervical incompetence), dysfunctional voiding, and urosepsis [128–133]. Bladder injury during Caesarean section should be repaired immediately with tissue interposition to prevent fistula development [134].

Treatment

Spontaneous closure of small VUF occurs in up to 5% and is more likely if menstruation is prevented by hormonal manipulation with LHRH (Luteinizing Hormone Releasing Hormone) analogues [127, 132, 135].

Those failing conservative management require surgical repair. If access is amenable, vaginal repair may be possible [127]. Alternatively, an open, laparoscopic, or robotic repair using omentum as an interposition is employed [127–133]. Hysterectomy may be necessary to ensure cure however uterine preservation is preferred if possible.

Urethro-Vaginal Fistula (UVF)

An urethrovaginal fistula (UVF) is as an abnormal communication between the urethra and the vagina. In low resource settings, UVF primarily occurs because of obstructed second stage of labour and is a consequence of pressure necrosis of the pelvic floor including the bladder base, bladder neck and proximal urethra, often with loss of the sphincter control mechanism [136]. Catastrophic loss such as this is rarely seen in well-resourced settings with only 3–6 UVF repairs are performed annually in England [11]. UVF are mostly iatrogenic in well-resourced settings, occurring as a consequence of stress urinary incontinence surgery, anterior prolapse surgery and urethral surgery in particular diverticulectomy [122, 137, 138]. Other reported causes have included severe trauma [139], forgotten foreign bodies [140], catheterisation during labour [141] and rare inflammatory conditions such as Bechet's disease and Churg Strauss disease [142].

Signs and Symptoms

Size and location of the fistula with respect to the urethral sphincter determine symptoms. Proximal urethral fistula present with continuous or stress incontinence (70%). Distal urethral fistula (beyond the sphincter) may be asymptomatic or may present with a urinary divergence or vaginal voiding [143] Frequency, urgency, nocturia, pelvic pain and obstructive or painful voiding symptoms have been reported in 20–40% of cases [143, 144].

Diagnosis

The diagnosis of UVF is mainly made on clinical examination—with voiding cystogram and cysto-urethroscopy required in a small number. As a significant number of patients with a UVF also have a VVF, examination or imaging to exclude VVF is essential [144, 145].

Classification

There is no current classification system for isolated UVF, but position relative to the urethral sphincter (proximal/through or distal), size of defect in relation to urethral length and circumference, the presence of obstruction distal to the fistula, local infection, fibrosis, degree of tissue vascularization, malignancy, or dermatological pathology should be documented.

Management

UVF Repair

There is no conservative management for UVF. Surgical repair can be technically challenging if there is an extensive tissue loss and or a lack of local viable tissue for a multi-layered repair [136].

Distal fistulae that are asymptomatic may be observed or managed via an external meatotomy [122, 143, 144, 146], although the patient must be warned about divergent urinary stream. Most fistulae can then be repaired by direct suture and tissue interposition using similar principles described for VVF repair. In UVF where there is significant urethral loss urethral reconstruction may be required. Rotational vaginal flaps [147] and buccal mucosa inlay grafts [148–152] have been utilized in this situation. In very severe cases, urethral substitution using ileum also has been described [153].

Anatomical closure rates for simple UVF after one surgery are 90% and up to 99% after a second or more operations [154–156]. For complex UVF anatomical closure rates vary between 25% and 80% depending on aetiology of the UVF and the complexity of the reconstruction required [122, 136, 143, 148–153, 155, 156].

Bladder neck and proximal urethra involvement with consequent sphincter incompetence in the UVF result in high rates of stress urinary incontinence—(up to 50% in some series) following successful anatomical closure [122, 143, 154]. In obstetric UVF, the bulbocavernosus muscles have been utilized as an anti-incontinence flap/wrap in these situations with reasonable success [117, 157].

Rectovaginal Fistula

Given the obstetric aetiology of most fistulae in resource limited countries, it is likely that a fistula surgeon operating in this setting will encounter more extensive fistulae involving the urethra and quite possibly the rectum. Rectovaginal fistulae can be repaired via a transanal, transvaginal or transabdominal approach—the latter being reserved for high recto-vaginal fistula. A diverting colostomy may be needed in extreme cases, and this should ideally be done in conjunction with a colorectal surgical team.

Future Surgical Developments

There is an increasing interest in laparoscopic/robotics in VVF repair and there have been recent studies showing an overall high success rate comparable with open abdominal repair [158] in experienced hands. However, the current data is derived largely from case reports and small series with generally short term follow up, thus more extensive trials are needed in this area. Laparoscopic/robotic repair if found to be equivalent to open abdominal repair should remain second line to vaginal repair whenever vaginal repair is possible—as this will remain the most cost effective [83] and patient friendly mode of repair especially within the financial constraints of a resource poor setting.

Additionally, the advent of bioglues may presented new options for the minimally invasive management of small fistulae [159]. However, their use at present must be considered experimental and they are highly unlikely to be of great utility in the management of the average obstetric fistula.

Holistic Care

It is also important to consider the setting in which surgical repair of obstetric VVF takes place. Most women will have travelled a significant distance and may have been ostracised from their families and communities. In addition to closing their fistula and rendering them continent again, rehabilitation must occur to ensure sufficient education, economic skills and social support to function independently [123]. These women have been born into a society where their worth is all too often determined by their ability to bear children and have sex with their husband. It is therefore unsurprising that many have been divorced or abandoned by their husbands [4, 29, 30, 160] by the time of their fistula repair. In Niger, fistula accounts for 63% of all divorces [30, 161] whilst in Ethiopia 100% of women having fistula repair had been abandoned by their husbands [30, 55]. In the long term a shift in mindset and culture is required at both a community and national level.

There is little evidence available on the success and best mode of delivery for pregnancy following successful VVF repair. Much of the literature on successful outcomes focuses on the technicalities of anatomical closure, and there is little on woman's quality of life post repair. This is no doubt a consequence of the difficulties in long term follow-up of patients living in remote, rural areas who do not have easy access to transport, telephone or postal services [111]. Many women are left childless following the development of an obstetric fistula—their first baby is stillborn following their fistula inducing delivery [9] and they subsequently become amenorrhoeic secondary to dysfunction of the gonadotrophin hormonal axis although the reasons behind this are undefined [9, 12]. This compounds their cultural worthlessness [64].

For those women who recover their fertility the socioeconomic and healthcare factors that predisposed these women to developing obstetric fistulae initially are still in place and family planning is of paramount importance following fistula repair. In Burundi, a comprehensive programme of fistula care is offered, and all women are discharged with family planning advice and a contraceptive method [108]. This should be an integral part of any fistula repair centre. However, contraception is often limited to condoms or the rhythm method, both of which rely on male compliance and consequently many women are simply advised to remain abstinent for at least 6 months following their VVF repair [9, 75]. They are also informed to attend the nearest healthcare facility once labour commence for any subsequent pregnancy for delivery by Caesarean section [9, 12, 162]. There have been reports of successful vaginal deliveries under medical supervision without incurring damage to the repair in women whose initial fistula was the result of a non-recurring cause (malpresentation rather than pelvic disproportion) and where tissue interposition had been used in the repair [12].

Conclusion

Obstetric fistulae affect more than 3.5 million women worldwide. These women are all too often left wet, childless, poor and alone. There must be a concerted and coordinated effort at national and international level to prevent VVF or, treat all VVF in a timely and effective manner. To do this, it is necessary to obtain accurate data on incidence and prevalence of obstetric VVF from a wide range of settings. Funding must be diverted to antenatal and obstetric care and fistula centres. Governments and academics must strive to improve the status of women in the most affected countries. A widely recognised and utilised classification of obstetric fistulae needs to be developed to determine best practice for anatomical closure with urinary continence,

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Part IV
Fistulas in Males

Chapter 17
Rectovesical Fistula

Laura C. Perez, Anibal La Riva, Luis G. Medina, Charles F. Polotti, and René Sotelo

Abbreviations

C-section	Cesarean section
CT	Computed tomography
IBD	Inflammatory bowel disease
MIS	Minimally Invasive Surgery
MRI	Magnetic resonance imaging
RP	radical prostatectomy
RVF	Rectovesical fistula
VUA	Vesicourethral anastomosis

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Introduction

Rectovesical fistula (RVF) is an epithelized connection between the lumen of the rectum and the bladder [1]. RVF are generally seen after conditions that result in inflammation involving both organs and/or iatrogenic injuries.

Diseases of the enteric system such as inflammatory bowel disease (IBD) are closely related to RVF [2]. Colon cancer causing an RVF can occur in up to 20% of the cases [3], and urologists, in treating prostatic conditions either open, laparoscopically, or robotically can inadvertently injure the rectum and cause an RVF (Fig. 17.1). After radical prostatectomy (RP), the rate is up to 1% [4]. Other etiologies such as trauma and radiotherapy have been described. However, the exact incidence has not been reported in the literature [5, 6].

RVF located in the dome of the bladder may occur due to colon cancer or IBD. On the other hand, those involving the bladder neck are typically seen after unrecognized intraoperative rectal injuries [2, 3]. Studies comparing open vs. robotic approaches have shown lower incidence of unintentional rectal injuries with the robotic platform [7, 8]. Of note, it is worth mentioning that immediate repair is highly encouraged after a rectal injury is recognized as subsequent RVF development is less likely to occur [4, 9].

Physicians sometimes mislabel RVF as a rectourethral fistula when they occur after RP. However, most of the time, the fistula originates in the bladder neck at the level of the vesicourethral anastomosis and not within the true urethra as it occurs in rectourethral fistulae. The bladder neck is considered the anatomical landmark for correct identification of the fistula. When the fistulous tract is located proximally to the bladder neck it is classified as RVF. On the other hand, a rectourethral fistula occurs when the fistulous tract is located distally to the bladder neck [3, 10]. This clarification is important as the surgical approaches may vary.

RVF has been a recognized medical condition for centuries. However, its management has remained challenging [11]. Many surgical approaches have been

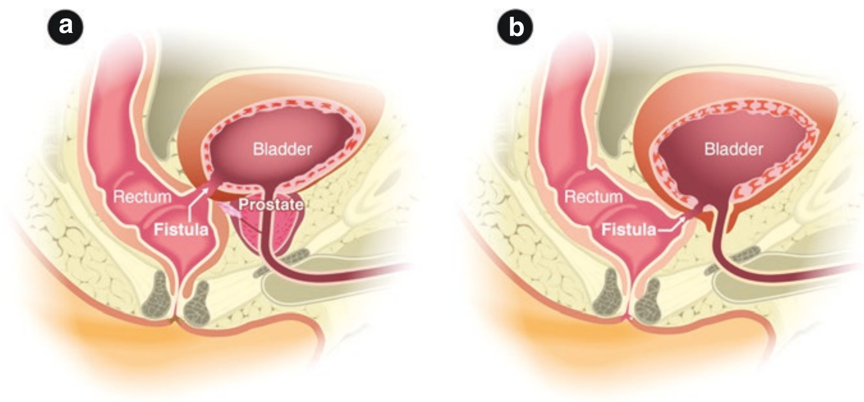

Fig. 17.1 Schematic depiction of RVF types. (**a**) RVF with prostate (**b**) RVF without prostate

proposed to treat RVF (transperineal, trans-sphincteric, transrectal, transanal, trans-sacral, transabdominal). No agreement on standardized management has been reached, and the surgeon's experience and preference still guides the approach [12]. The scope of this chapter is to review this entity, with special emphasis on the robotic surgical technique, as these, from our standpoint, provide the best chance for a successful repair in selected patients.

Clinical Features and Diagnosis

Recurrent urinary tract infections are a typical clinical manifestation of RVF, which can be seen in up to 88% of the patients. Also, depending on the disease severity, fecaluria, pneumaturia, and urinary leakage per rectum can be present [2].

Evaluation and diagnostic workup start with an adequate history including underlying diseases, past medical history of radiotherapy, and surgical procedures. Moreover, a pelvic examination can reveal important findings such as erythema around fistula orifice or a palpable rectal defect on digital examination.

Different imaging techniques are used for the appropriate identification and classification of the suspected fistula. Among the techniques, cystoscopy, colonoscopy, barium enema, and computed tomography (CT) urogram are used to further investigate the location, size, tissue characteristics, presence of other types of fistulae, concomitant injury/stricture, and relation to its surrounding structures [13]. In those cases where pelvic malignancy is part of the history or suspected, a biopsy is warranted.

Classification

Clinically, we classify RVF as simple and complex based on specific characteristics.

Simple fistula:

- Unique tract
- Size <2 cm
- Not associated with previous repair attempts
- Not associated with energy treatments

Complex fistula (one or more or the following criteria):

- Multiple tracts
- Size ≥2 cm
- Associated with previous failed repair attempts
- Associated with energy treatments
- Associated with bladder neck strictures

Treatment Approaches

Conservative Treatment

Conservative treatment, which includes urinary and fecal diversion, is considered the first intervention of treatment for most surgeons. This approach is based on continuous bladder drainage and bowel diversion using a transurethral foley catheter or a suprapubic tube, and a colostomy. These diversions will promote a decrease in inflammatory tissue and edema, which is essential for healing [14]. There is not a standardized pathway for conservative treatment and not enough data is available. Its duration is normally surgeon-driven and thus, further studies are warranted.

Surgical Treatment

Surgical standardization of RVF repair is nonexistent. We recommend a transabdominal approach which offers several advantages. It allows the surgeon to repair the fistula while being able to place an interposed tissue at the repair site. It also provides access to the rectum allowing for easier closure of the rectal defect without tension and/or to create a fecal or a urinary diversion at the time of surgery, if necessary [15]. However, transperineal, trans-sphincteric transrectal (York-Mason), transanal (such as the Parks and Latzko procedures), and trans-sacral (Kraske procedure) approaches have also been described with positive outcomes reported. However, technical difficulties due to the limited space, and high rate of complications could make these techniques more challenging [16–20].

Improvements in the surgical management of RVF by using minimally invasive techniques is constantly evolving. Therefore, surgeons are increasingly performing reconstructive procedures laparoscopically or robotically.

Laparoscopic procedures to repair RVF were initially proposed to decrease the morbidity associated with open abdominal incisions, with similar success rates, lesser morbidity, and minimal surgical trauma, thus allowing more rapid convalescence. However, laparoscopy requires advanced expertise and mastery of complex maneuvers such as intracorporeal suturing [1, 3].

Moreover, robotic assistance in complex laparoscopic procedures has overcome the initial laparoscopic steep learning curve, yet maintains the surgical principles of broad exposure of the fistula tract 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 for successful fistula repair, even in challenging cases of recurrent RVF [21].

Herein, we will describe the step-by-step robotic-assisted transabdominal approach for RVF repair.

Transabdominal Robotic-Assisted, Laparoscopic Repair Step-by-Step

Patient Preparation

The patient receives mechanical bowel preparation the day before surgery and preoperative antibiotic prophylaxis [14]. General anesthesia with endotracheal intubation is used.

Patient Positioning

The patient is placed in low lithotomy and steep Trendelenburg position.

Cystoscopy

Initially, a cystourethroscopy is performed, and both ureters are catheterized. This will facilitate later identification and will add protection during excision and closure of the fistula. The fistulous tract is cannulated with a different color open-ended ureteral catheter, pulled through the fistula into the rectum, and retrieved through the anus to facilitate intraoperative identification.

Port Placement

The Da Vinci® Xi Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) is employed using the 4-arms in a six-port transperitoneal approach with a port configuration identical to a robotic RP. The configuration must be appropriately shifted to the right in case of fecal diversion (Fig. 17.2). Open laparoscopic access is obtained following the Hasson technique [22], pneumoperitoneum is established to 15 mmHg, and subsequent trocars are placed under direct visualization.

Omental Harvesting

If it is long enough, intact omentum can be brought down to serve as interposition tissue. Otherwise, an omental flap based on the right gastroepiploic artery can be created replicating the open omentoplasty technique [23]. The initial step involves the coloepiploic detachment followed by careful dissection along the gastrocolic

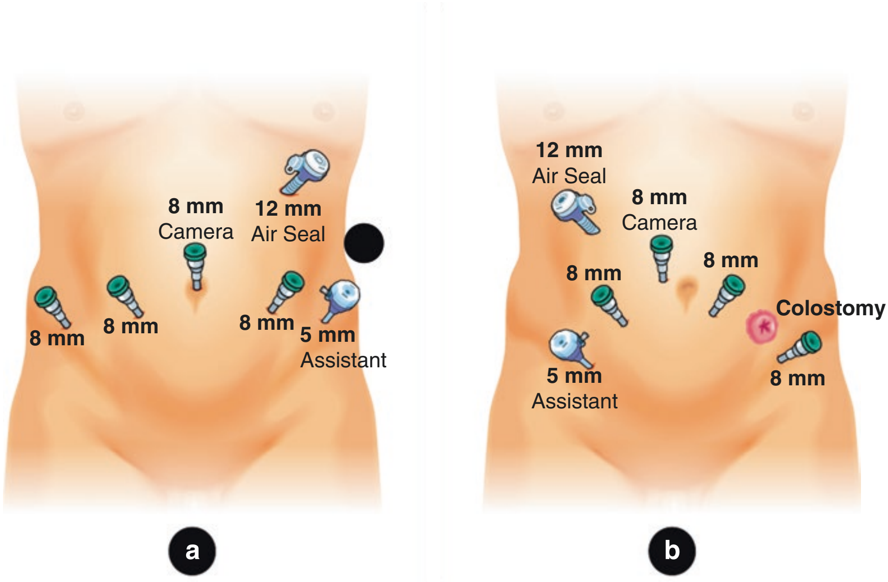

Fig. 17.2 Schematic drawing represents the robotic six-port transperitoneal configuration for RVF repair. (**a**) Robotic port-placement configuration without colostomy (**b**) Robotic port-placement configuration with colostomy

ligament using the laparoscopic Harmonic ACE® curved shears (Ethicon Endo-Surgery, Inc. Cincinnati, OH, USA) or the robotic Vessel Sealer Extend (Intuitive Surgical, Sunnyvale, CA, USA) to create a longer flap. If the flap is still not long enough, a longitudinal perpendicular incision through the omentum, carefully avoiding vascular structures, can be performed. Once the omentum harvesting is completed, the patient is placed in Trendelenburg for RVF repair.

Dissection of the Fistulous Tract

In male patients, the repair of the fistulous tract will depend on the presence or absence of the prostate. In the absence of the prostate, the recto-vesical space is localized and dissected. After this, a downward and vertically oriented posterior cystotomy (bladder bivalving) is undertaken. The incision must be advanced until it reaches the fistulous tract (Fig. 17.3a, b). If concomitant bladder neck contracture is present, anterior dissection through the Retzius space will allow for a reconstruction of the bladder neck and a new vesicourethral anastomosis.

In patients with the prostate in situ, salvage prostatectomy is performed. Removing the prostate will facilitate the mobilization of the bladder neck. First, a retro-vesical incision is performed. The dissection is advanced distally using monopolar scissors until the fistulous tract's proximal border is encountered. Then, an

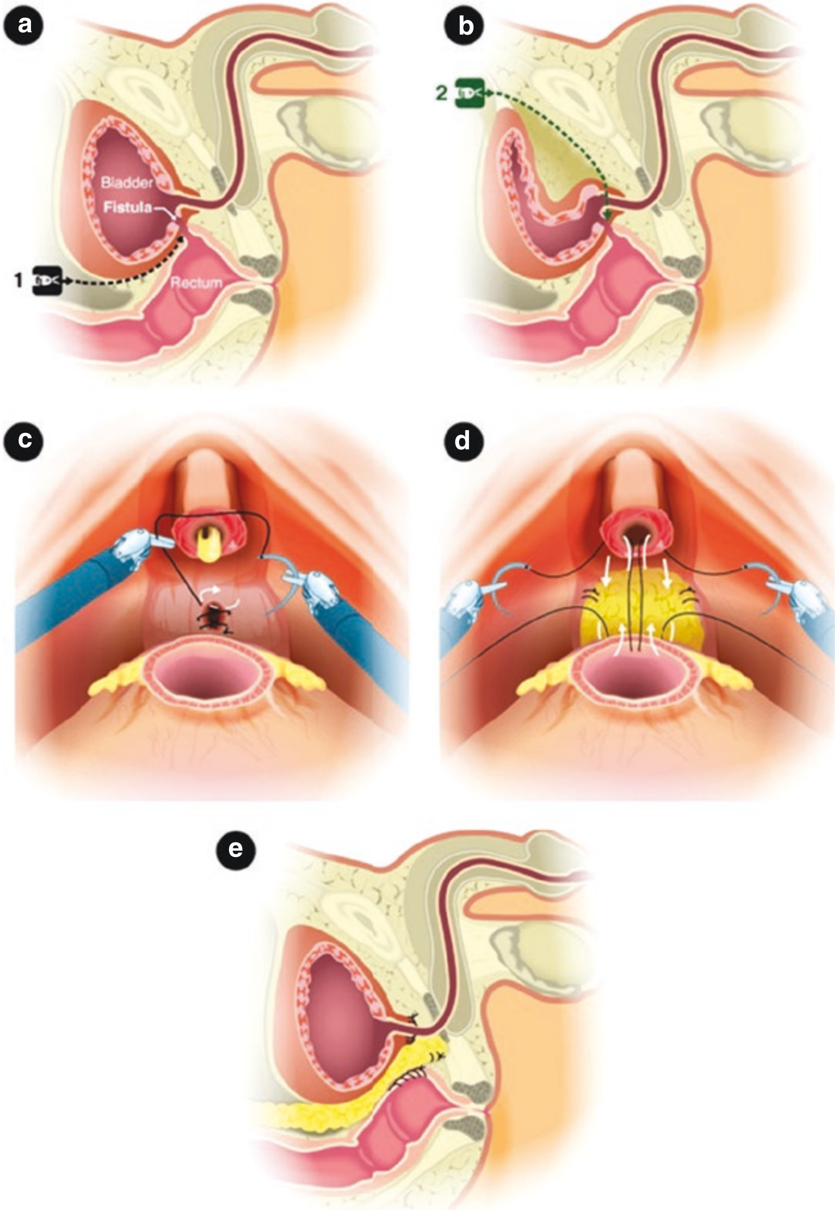

Fig. 17.3 Step-by-Step robotic surgical repair of RVF in the absence of the prostate. (**a**) *Rectovesical space dissection*: dissection at the cul-de-sac until the proximal border of the fistulous tract is encountered. (**b**) *Anterior bladder release and bladder neck dissection*: dissection through Retzius space until the bladder is fully separated, followed by meticulous bladder neck dissection until continuous with the cul-de-sac. (**c**) *Rectal closure*: rectal closure is performed in two layers with UR-6 3–0 Vicryl suture in a running fashion. (**d**) *Omentum interposition and neo-VUA*: previously harvested omentum is interposed between the bladder and the rectum. The neo-VUA is performed with 3-0 V-Loc suture in a running single knot anastomosis. (**e**) Lateral view of RVF robotic-assisted post-surgical repair is depicted

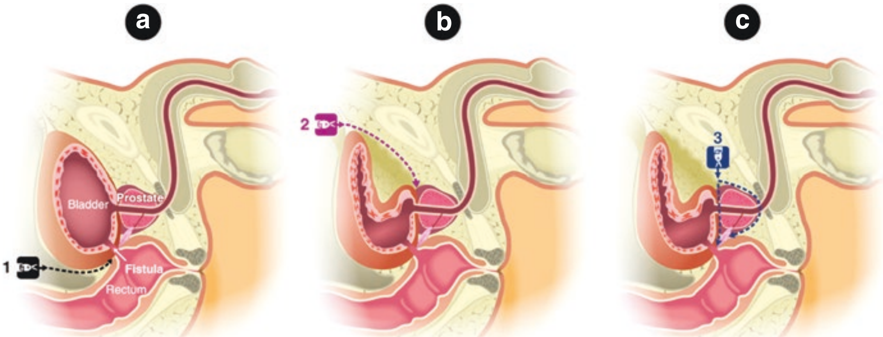

Fig. 17.4 Step-by-Step robotic surgical repair of RVF in the presence of prostate. (**a**) *Rectovesical space dissection*: dissection at the cul-de-sac until the proximal border of the fistulous tract is encountered. (**b**) *Anterior bladder release*: dissection through Retzius space until the bladder is fully separated. (**c**) *Salvage prostatectomy* is performed, followed by dissection toward the distal border of the fistulous tract

anterior dissection through the Retzius space is made, exposing the prostatic anterior capsule. The prostatic apex is dissected, and the bladder neck dissection is carried out. Lastly, the prostatectomy is completed, and the posterior bladder neck plane is dissected until it meets the distal end of the fistulous tract (Fig. 17.4). If needed, further dissection of the recto-vesical space is carried out to ensure proper separation of the rectum from the bladder using a combination of hook cautery and robotic monopolar scissors.

Rectum Closure

The fistulous tract is debrided using cold scissors removing approximately 2 mm of nonviable tissue. Rectal closure is achieved in two layers with an initial knot on the rectum's outer surface and outside the defect area (Fig. 17.3c). Laparoscopic closure is performed in an interrupted fashion using UR-6 3–0 poliglecaprone (Monocryl®; Ethicon Inc., Somerset, NJ, USA). When done robotically, 3–0 V-Loc™ (Covidien, Dublin, Ireland) is used in a running fashion. Finally, indocyanine green (ICG) (Akorn, Lake Forest, IL, USA) and fluorescence imaging ensure an adequate blood supply. Anorectoscopy, including a bubble test, can verify the appropriate rectal caliber and confirm watertight closure.

Tissue Interposition

After rectal wall repair, the harvested omental flap is advanced through the recto-vesical space to serve as an interposition tissue layer and will be anchored down on the pelvic cavity distal to the rectum's suture line using 3–0 V-Loc™ (Covidien, Dublin, Ireland) (Fig. 17.3d). If omentum is unavailable or cannot be adequately harvested, the gracilis muscle, rectus muscle, or a peritoneal flap from the nearest anatomical location can be used [24].

Bladder Closure

A bladder trigone reconstruction is carried out in two layers using 3–0 V-Loc™ (Covidien, Dublin, Ireland) suture, ensuring non-overlapping suture lines. Lastly, a tension-free vesicourethral anastomosis (VUA) is performed with a running single knot anastomosis [25] (Fig. 17.3d, e).

Postoperative Care

Urethral catheter patency must be closely monitored. Ambulation is encouraged, and appropriate prophylactic antibiotics are given. The urethral catheter and Blake drain are removed on the third postoperative day if no concern for urine leak and low drain output.

Patients require close monitoring of the Foley catheter as acute urinary retention due to a blood clots can occur. The urethral catheter or suprapubic tube is removed 3 weeks post-surgery after confirmation of no urinary leakage via cystogram. In cases of fecal diversion, laparoscopic Hartmann procedure reversal is performed around 4 months after confirmed successful repair.

A follow-up visit should be performed at 1, 3, and 6 months postoperatively. A detailed patient interview assessing for RVF recurrence symptoms and physical examination should be performed. At 12-months post-op, an imaging study such as cystoscopy and/or CT urogram will help to confirm successful repair.

Surgical Outcomes

Our approach has demonstrated promising results in patients after open RP with recognized rectal injury resulting in RVF [1] and after Hartmann's reversal resulting in a posterior bladder injury with subsequent development of a large RVF in a patient with prostate [26]. Other groups have described modified approaches with the robotic platform that been successful as well [27]. However, the data that has been published on this subject its mostly comprised by initial experiences or case reports. In addition, most of the repairs are done at tertiary referral centers by highly experienced surgeons, raising concerns for bias and ability to generalize repair techniques. Another limiting factor to assess surgical outcomes of robotic repairs of RVF is that they are frequently mislabeled as rectourethral fistula when they occur after RP.

There is not enough data to compare outcomes from robotic techniques against other procedures. Hence, the significance of robotic surgery in the spectrum of surgical choices for RVF remains unclear. Given the advantages of the robotic platform and the understanding that the first repair provides the best opportunity for success, we hypothesize that the robotic technique is a useful choice for to avoid recurrence in complex fistula repairs.

In our opinion, there is an impending need to increase the number of cases reported in the literature in a standardized manner that would allow reconstructive surgeons to have enough data to solidify a treatment algorithm or at least to provide patients with clear prospects of their outcomes for all the available surgical options.

We expect these initial descriptions to be the start point of more studies to shed some light into the surgical management of this rare, yet emotionally catastrophic condition.

Conclusion and Recommendations

Minimally invasive surgery may represent a safe and effective way to manage RVF. Although there is no current standardized approach for RVF, robotic-assisted surgical repair for these types of fistulae is rising in popularity among surgeons. Thus far, it has shown a safe and feasible treatment modality in terms of improved visibility, dexterity, dissection precision, decreased blood loss, and reduced length of stay. However, further prospective and randomized studies are needed to define the role of MIS in RVF management.

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Chapter 18
Rectourethral Fistula: Transanal, Transperineal, and Posterior Approaches

Jordan Wlodarczyk and Christine Hsieh

Abbreviations

AIDS	Acquired immune deficiency syndrome
BMI	Body mass index
CT	Computed tomography
ERAF	Endorectal advancement flap
GI	Gastrointestinal
HIFU	High-Intensity Focused Ultrasound
HIV	Human immunodeficiency virus
MRI	Magnetic resonance imaging
RUF	Rectourethral fistula
TAMIS	Transanal minimally invasive surgery
TEM	Transanal endoscopic microsurgery

Introduction

Rectourethral fistula (RUF) is an uncommon congenital or acquired entity in which an abnormal connection forms between the rectum and the urethra. Numerous repair strategies have been described in the colorectal, urologic and pediatric surgical

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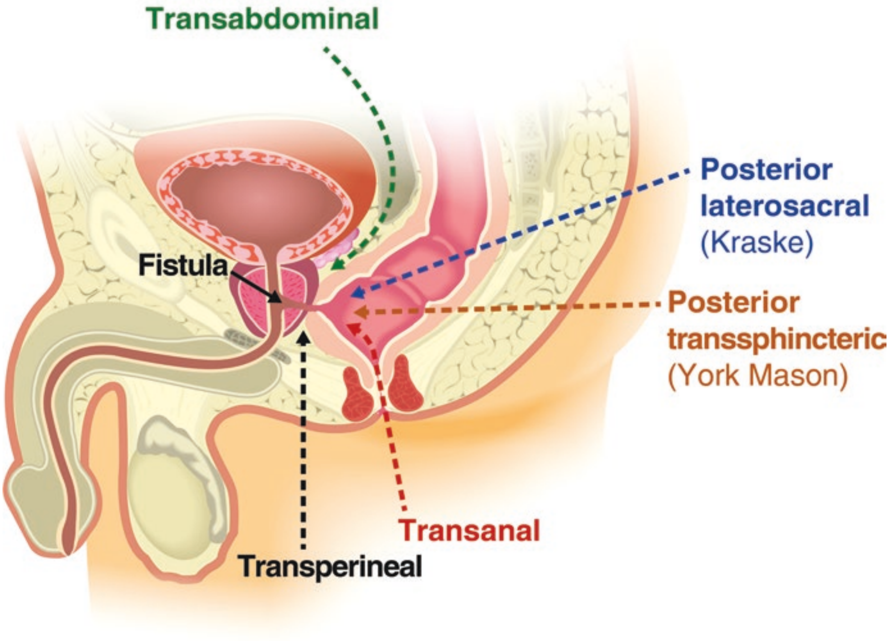

Fig. 18.1 Surgical approaches for RUF repair

literature, however, a standard surgical approach has yet to be established. Repair methods can be simplified as working from above, requiring an anterior or transabdominal approach, or from below, meaning the transanal, transperineal, and posterior techniques. This chapter will focus on the repair of acquired rectourethral fistula via transanal, transperineal, and posterior exposures (Fig. 18.1).

Etiology

Prostate cancer treatment is the most common cause of RUF [1]. RUF is well-described in the literature as a rare surgical complication, which in one large series occurred in 13 of 2447 (0.53%) of patients after radical proctectomy [2]. With increasing refinement and utilization of ablative therapies such as external beam radiation therapy, brachytherapy, cryoablation, and high-intensity focused ultrasound (HIFU), RUF is reported in several studies to affect 1–3% of patients [3–6], but the risk can reach 16% for patients undergoing HIFU [7]. Some small studies reported RUF development in as many as 60% of patients who received a combination of ablative procedures for salvage therapy [8].

Clinical Features

Symptoms of rectourethral fistula range from subtle to lifestyle limiting. Urinary symptoms include pneumaturia, hematuria, and fecaluria, which suggests a large defect and therefore carries a worse prognosis [2]. Some patients may complain of frequent watery diarrhea, unaware that this actually represents recturia. Smoldering infection may manifest as recurrent UTIs, or severe rectal or pelvic pain. Rectal bleeding may variably occur, indicative of rectal inflammation.

Diagnosis

When RUF is suspected clinically, a number of studies can be pursued to define and characterize the fistula. Typically, RUFs are located within 5–6 cm of the anal verge, an area palpable by the average examiner's index finger. On exam, the fistula may feel like an irregular thickening or nodularity in the anterior rectal wall, if no overt defect is palpated.

The location of the fistula relative to the anal verge should be recorded. Anoscopy is readily performed in the clinic setting, improving exposure of the distal rectal wall so that biopsy could be performed if recurrent malignancy is suspected. Flexible endoscopy allows for detailed assessment of the rectal mucosa under magnification. Biopsy and photodocumentation of the fistula can be done, and the size of the defect, vascularity of the mucosa, degree of inflammation, and distensibility of the rectum can be noted (Fig. 18.2). Full colonoscopy may be pursued for colorectal cancer screening purposes or to assess for any other suspected pathology in the lower GI tract. Cystoscopy is routinely performed to assess the urinary tract. This provides useful preoperative information about the morphology of the fistula, any urethral stricture, and also bladder capacity [9].

Cross-sectional imaging such as CT or MRI can be performed to rule out any other nearby pathology and to orient the fistula tract in relation to nearby anatomic structures and landmarks. Such imaging is especially helpful in cases of suspected abscess or soft tissue inflammation. Fluoroscopy studies such as contrast enema or cystourethrogram are variably helpful for defining the tract morphology, as contrast instillation may not provide enough pressure to force the contrast through the fistula.

Fig. 18.2 A large rectourethral fistula on the anterior wall of the rectum is visualized endoscopically, with the tip of the flexible endoscope located at the dentate line. The opening measured 4 cm in maximum dimension. Copious fibrinous exudate was seen in the rectoprostatic space, representative of a large associated abscess cavity. (Photo credit: Christine Hsieh, MD)

Management

The management of RUFs requires a tailored approach specific to each patient. Important factors to consider include the fistula etiology, size, and location in relation to anatomical structures. Other variables include the expected degree of urethral stricture after surgical closure, the previous attempts at surgical repair, and the local tissue quality. Previous surgeries in the area have the potential to replace healthy tissue with non-compliant, poorly vascularized scar tissue. Previously irradiated tissue often exhibits delayed or impaired healing, while epithelialized tracts, once debrided down to healthy tissue, may leave a significantly larger defect to repair. Simple fistulas—those with smaller defects and minimal associated symptoms, and without associated urethral stricture or local tissue ischemia from prior ablative therapies—are more likely to close spontaneously with conservative measures compared to complex RUF [10].

The decision to perform proximal urinary or fecal diversion should be made on a case-to-case basis. Urinary drainage can be accomplished with a transurethral or percutaneously placed catheter, being mindful that a suprapubic catheter may cause scarring or inflammation in the bladder which could complicate mobilization at the time of a future operation. Fecal diversion is beneficial in cases of pelvic sepsis, but can also be considered in those with chronic, smoldering infection related to constant stool soilage of the fistula tract. Diverting the fecal stream allows for a decrease in the local inflammatory response which may improve tissue healing potential. Other indications for proximal diversion include large defects (>1 cm), highly symptomatic fistulas, and persistent gross fecaluria despite bowel rest. While proximal diversion helps to controls symptoms of the fistula, spontaneous fistula closure after diversion is variable, with higher success rates in simple fistulas [11–13].

Preparation for surgery varies widely across institutions, but tends to follow general surgical principles. Typically, patients will undergo preoperative bowel preparation with cathartics if no fecal diversion is in place. Preoperative antibiotics may be prescribed as well. Broad spectrum prophylactic antibiotics are given at the start of surgery. Urinary drainage is usually established by the time of surgery, otherwise this may be done after induction of anesthesia. General anesthesia is favored, though spinal anesthesia may be considered if the patient's co-morbidities are prohibitive. A small catheter or stent may be passed through the urethra into the fistula tract, and out the rectum to help with identification of the fistula during the dissection. Post-operatively, antibiotics may be continued. Drains are kept in place per surgeon preference. Urinary catheters are generally maintained throughout the first several weeks or even months of recovery, then removed when study of the urinary system shows no leak. Fecal diversion is similarly maintained, and reversed only when radiographic studies confirm complete healing of the rectum.

Transanal Repairs

Accessing the fistula via the rectum can potentially reduce operative morbidity by limiting the field of dissection, sparing neurovascular bundles, and avoiding division of soft tissues or sphincter muscle. Because of the relatively restricted working space and use of local tissue for these repairs, the transanal approaches are best reserved for simple fistulas. Endorectal advancement flap (ERAF), a procedure commonly done for management of cryptoglandular anal fistula, can be adapted to the repair of low RUF. Likewise, transanal operating platforms like TEM (transanal endoscopic microsurgery) and TAMIS (transanal minimally invasive surgery) have been used with reported success, and allow access to fistulas higher in the rectum.

Endorectal Advancement Flap

Transanal local flap repair consists of endorectal advancement flap with or without adjunctive biological mesh. This approach offers the benefit of minimal postoperative pain and does not require a skin incision or muscle division.

This procedure was described for repair of RUF by A.G. Parks in 1983 [14], and has since undergone a multitude of refinements and variations. The patient may be positioned in lithotomy (as described by Parks) or more commonly in prone jackknife. The area of the planned flap is marked out and elevated with saline for septation from the underlying muscularis propria to enhance the plane of dissection between the submucosa and muscular layers. Adding local anesthetic with dilute epinephrine may aid with hemostasis. The shape of the flap should be trapezoidal, with a broad base of 3–4 cm wide and narrowing gradually towards the fistula in order to ensure adequate perfusion as the flap is mobilized. Generally, a length to width ratio of 5:1 helps to ensure mobility and diminish tension across the suture line. The thickness of the flap should be consistent throughout and include both mucosa and submucosa for optimal tissue perfusion and integrity.

With the flap elevated, the fistula is exposed, debrided, and closed primarily if tissue laxity allows. The distal tip of the flap containing the fistula tract opening is trimmed to remove additional granulation tissue [15]. In the case of larger fistula tracts where closure of the fistula tract under the advancement flap is not possible without undue tension, a small piece of biological mesh can be parachuted into the wound bed and sutured down to promote tissue in-growth [16]. The advancement flap is secured laterally and distally with absorbable suture, and great care should be taken to minimize flap manipulation and trauma lest this cause damage to the delicate blood supply (Fig. 18.3).

With success rates reported in the range of 75–100%, ERAF is an appealing option for treatment of rectourethral fistulas [15, 17, 18] and is particularly suited for small fistulas in the distal rectum. However, this procedure may be of limited utility in patients with a deep gluteal cleft or long anal canal, due to inadequate exposure and reach of standard anorectal retractors and instruments. Access to the urethra is limited and may affect the integrity of a urethral repair, if done.

Identified demographic factors predictive of failure of the endorectal advancement flap are increased age, high BMI, presence of Crohn's disease, immunosuppression, active smoking, and a previously irradiated surgical field [19]. Identified technical factors predictive of flap failure include inadequate flap thickness, increased flap tension, inadequate width of the flap, and ongoing presence of infection and inflammation at the repair site. If the attempt at closure with endorectal advancement flap fails, an additional endorectal flap can be attempted before considering fecal diversion, if not already done, or an alternative approach to repair.

Minimally Invasive Transanal Repair

Minimally invasive surgical platforms are increasingly applied to the treatment of an expanding assortment of rectal pathologies, including RUF. Although these platforms require specialized equipment, such as for transanal endoscopic microsurgery (TEM; Richard Wolf GMBH, Knittlingen, Germany), some are already be available in many institutions. Transanal minimally invasive surgery (TAMIS) utilizes standard laparoscopic equipment, and the DaVinci Xi Surgical System (Intuitive Surgical, Sunnyvale, California, USA) is broadly used across surgical specialties.

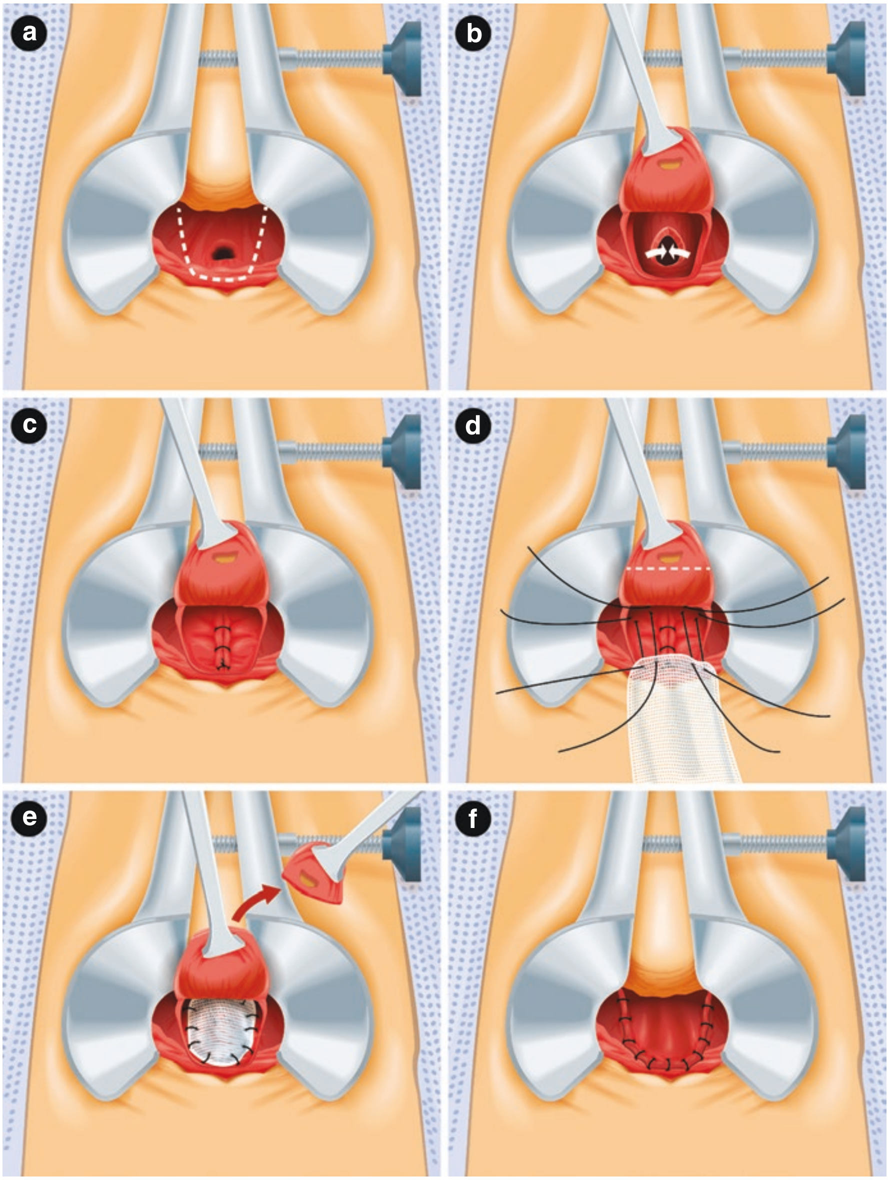

Fig. 18.3 (**a–f**) Technique for endorectal advancement flap RUF repair

TEM was pioneered by Gerhard Buess in 1983 for the management of benign and early malignant rectal lesions. This technique utilizes a flat or beveled operating proctoscope of 4 cm diameter and available in varying lengths which is mounted to the operating table to create a stable platform. A faceplate contains ports for camera and instrument insertion. Insufflation with carbon dioxide is established and a camera inserted for visualization under magnification. Dissection is carried out with instruments similar to those used in laparoscopy, but with angulated tips to facilitate dissection in the confines of the rectum. Compared to the traditional transanal approach, which is limited to pathologies within 4–5 cm of the anal verge, TEMS allows for significantly improved access to and visualization of mid- to upper rectal lesions for precise dissection and suturing.

Over time, use of TEM expanded to other rectal pathologies, including RUF. As with standard transanal repair, the fistula is first identified and the rectal wall debrided, then a flap is mobilized for closure. The urethra can be difficult to address with this technique but additional interventions may be accomplished via cystoscopy [20]. Results for this type of repair have been mixed, with numerous case reports describing complete resolution with TEM repair [20–23], but the few limited case series in the literature demonstrate only modest success rates of 50–66% [24, 25]. A major hurdle to widespread adoption of TEM is the need for upfront purchase of expensive equipment, and an acknowledged steep learning curve for mastery of this technique [26, 27].

TAMIS builds upon the concept of TEMS and uses a multiport access system (e.g. GelPOINT Path, Applied Medical, Rancho Santa Margarita, CA; SILS Port, Covidien, Mansfield MA) to seal the rectum and establish pneumorectum. This allows for use of a standard laparoscope and instruments. As with TEM, the fistula is identified, debrided, and rectal wall repaired after mobilization of a partial or full thickness flap. The full range of available laparoscopic scopes and instruments may be used with the TAMIS platform. Data for success rates and complications are so far limited to case reports and small series [28].

Robotic TAMIS is a novel application of the robotic surgical platform to transanal surgery. This application takes advantage of the enhanced visualization and wristed instruments of the DaVinci Xi Surgical System. With the patient in prone jackknife position, the rectum is accessed similarly to the TAMIS set up with a Lone Star Retractor (Cooper Surgical, Inc., Trumbull, Connecticut, USA) for anal effacement and a transanal access platform such as the GelPOINT Path for the camera and instrument ports. The AirSeal insufflation system (ConMed Corporation, Milford, Connecticut, USA) helps to maintain stabile pneumorectum. The robot is docked, then the fistula is identified and debrided. The rectoprostatic space is dissected to expose the urethra. The urethra and the rectum are then repaired primarily in a transverse direction to prevent luminal stricturing, or by raising a full-thickness flap. Adjuncts like biologic mesh or fibrin solutions can be used to promote healing and to separate the suture lines. The increasing number of case reports in the literature suggest excellent results with less morbidity and short length of stay [29–34] in carefully selected patients—i.e., those without prior ablative therapies and resultant local tissue damage (Fig. 18.4).

Fig. 18.4 DaVinci Xi robot docked for robotic TAMIS procedure using standard robotic trocars placed into the GelPOINT Path transanal access platform, with the patient in prone jackknife position for exposure and visualization of the anterior rectal wall. (Credit photo: Sarah Koller, MD)

Transperineal Repairs

One strategy for repair of complex RUF is to approach the fistula by dissecting via a perineal incision in order to interpose healthy, well-vascularized tissue harvested from an adjacent area unaffected by inflammation or radiation. Such tissue adds bulk to the damaged area and acts as a natural barrier to fistula recurrence. This approach is particularly suited to RUF with openings in the distal rectum, and presents a clean plane of dissection which is especially useful in patients who have undergone previous abdominopelvic surgery. The perineal incision allows for wide exposure of the rectum and the urethra, which facilitates urethral reconstruction [35]. The two most commonly employed techniques for perineal repair are the gracilis muscle interposition flap and the dartos musculocutaneous interposition flap, though many other native tissue flaps have been described.

Gracilis Muscle Interposition Flap

Of the described perineal interposition flaps, the gracilis muscle flap is used more frequently than the dartos flap due to its vascularity, location remote from local tissue damage, and ease of access [36]. Morbidity from gracilis muscle harvest is overall minimal and includes wound complications, inner thigh numbness, and scarring [37] (Fig. 18.5).

This repair is done in lithotomy position to allow for exposure of the inner thigh, where the gracilis muscle lies in its anatomical position, and its recipient site in the perineum. If extensive work on the urethra is anticipated, some surgeons will first harvest the gracilis muscle in lithotomy, then flip the patient into prone jackknife for

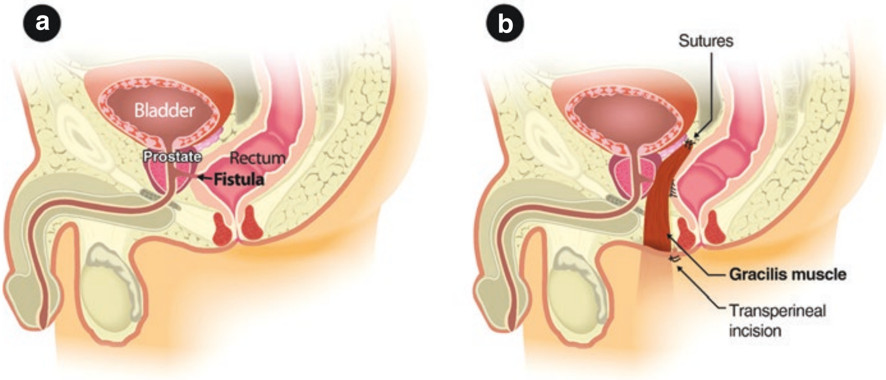

Fig. 18.5 (**a**, **b**) Gracilis muscle interposition. (**a**) depiction of RUF, (**b**) completed repair with interposed gracilis flap

urethral reconstruction. The muscle is marked by tracing its course about 4 cm posterior to the palpable adductor muscle. Three incisions are made over the length of the muscle, which is isolated and disconnected from its distal attachment point at the pes anserinus. The gracilis muscle is dissected bluntly off the surrounding tissue from distal to proximal, gradually rotating it medially. Blood supply of the gracilis muscle is from the dominant vascular pedicle medially and several minor vascular pedicles laterally, so the laterally based minor pedicles can be divided without compromising perfusion. The major vascular pedicle is typically located within 10 cm of the pubic symphysis and care must be taken to avoid twisting the base of this pedicle when rotating the graft to the fistula site [38]. A subcutaneous passage is created by tunneling under colles fascia and fascia lata to reach the perineum, and the gracilis muscle is maneuvered through this space into the perineal wound bed.

The rectoprostatic space is accessed by making a curvilinear incision in the perineum, outside of the external anal sphincter and extending laterally towards the ischial tuberosity on both sides. The subcutaneous tissue and colles fascia is incised to develop the rectoprostatic space, dissecting cephalad along the anterior rectal wall until the fistula is identified. Care must be taken to preserve the anal sphincter complex and to dissect far enough laterally to allow for a tension-free closure of the rectum. Rectal repair is typically done in two layers, taking care to imbricate the rectal mucosa. The urethra may be repaired primarily with absorbable suture, or buttressed with a graft as needed. After repairing the urethra and rectum, the gracilis flap is secured to the wound bed using absorbable suture, ensuring full coverage of the repairs by pulling the apex of the muscle beyond the suture lines and securing it to the rectal wall and base of the bladder. The wound is then closed in layers over a drain, and skin is closed [13, 35] (Fig. 18.6).

Assessment of outcomes after gracilis muscle interposition flap for RUFs are limited by the power and design of the studies available in the literature. Reported success rates range from 78% in a 36 patient study [39] to 100% in numerous

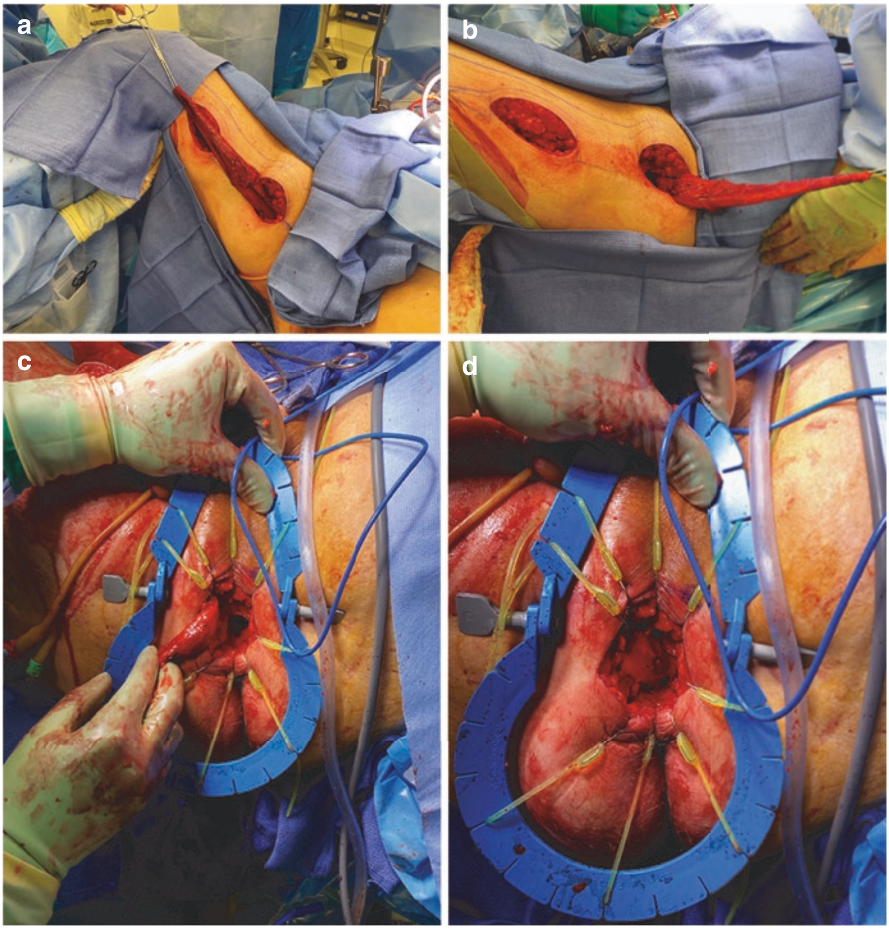

Fig. 18.6 (**a**) The gracilis muscle is dissected free of its surroundings and disconnected from its distal attachment at the medial aspect of the knee (photo credit: Joseph Carey, MD). (**b**) Length and bulk of the gracilis muscle is assessed in preparation for tunneling towards the perineal wound (photo credit: Joseph Carey, MD). (**c**) Care must be taken to avoid tension on the gracilis muscle or twisting of the vascular pedicle as it is placed into the rectoprostatic space (photo credit: Joongho Shin, MD). (**d**) The gracilis muscle is sutured into place to cover the urethral and rectal repairs. (Photo credit: Joongho Shin, MD)

smaller series [38, 40, 41]. Lower rates of successful closure and higher post-operative complications were reported in patients with pre-existing Crohn's disease, large fistulas, and previous radiation to the area. A common complication of this repair includes urinary incontinence, which may affect up to 75% of patients [42]. Initial failure of surgical repair can be managed initially with prolonged urinary catheterization and in some cases this may allow for spontaneous closure. Otherwise, reoperation may be done with the contralateral gracilis muscle.

Dartos Musculocutaneous Interposition Flap

More commonly performed for hypospadias repair, this musculocutaneous flap was first described in the treatment of RUF in 1989 as a combined procedure with endorectal advancement flap [43]. Its use remains uncommon in RUF repair but the few small case series in the literature report success rates of 75–100% [44–46]. The patients in the series from Yousseff et al. [45] and Varma et al. [44] had all undergone preoperative urinary and fecal diversion.

The dartos muscle is thin layer of smooth muscle that is closely associated with the scrotal skin, and can be harvested as a musculocutaneous flap based on the anterior scrotal branches of the deep external pudendal artery extending anteriorly. With the patient in lithotomy, an inverted U-shaped incision is marked on the perineum to the posterior aspect of the scrotum. The incision is made through the dermis and the dartos muscle is dissected free. The rectoprostatic space is developed via a transperineal incision until the fistula is identified, often with the aid of a urinary catheter placed into the fistula tract. The fistula tract is excised and the rectal and urethral defects repaired.

To prepare the dartos flap, the skin is removed from the tip of the flap to the transperineal incision. The dermal island flap is then completely de-epithelialized using scissors, then rotated inward. It is then tacked to the undersurface of the urethra and parachuted into the rectoprostatic plane to cover the urethral closure and buttress the repair. The perineal skin is reapproximated over a drain (Fig. 18.7).

The morbidity from this procedure is less severe when compared to the gracilis muscle flap due to the smaller incision and avoidance of a separate surgical incision in the inner thigh. In the series of eight patients published by Varma et al. two patients developed recurrent fistulas. One had a history of radiation for prostate cancer, and the other had a history of HIV and developed a post-operative wound infection and dehiscence [44]. The largest series to date was published by Youssef et al., with 12 patients, all of whom had complete healing. Four of these patients developed urinary incontinence, but erectile function was not affected [45].

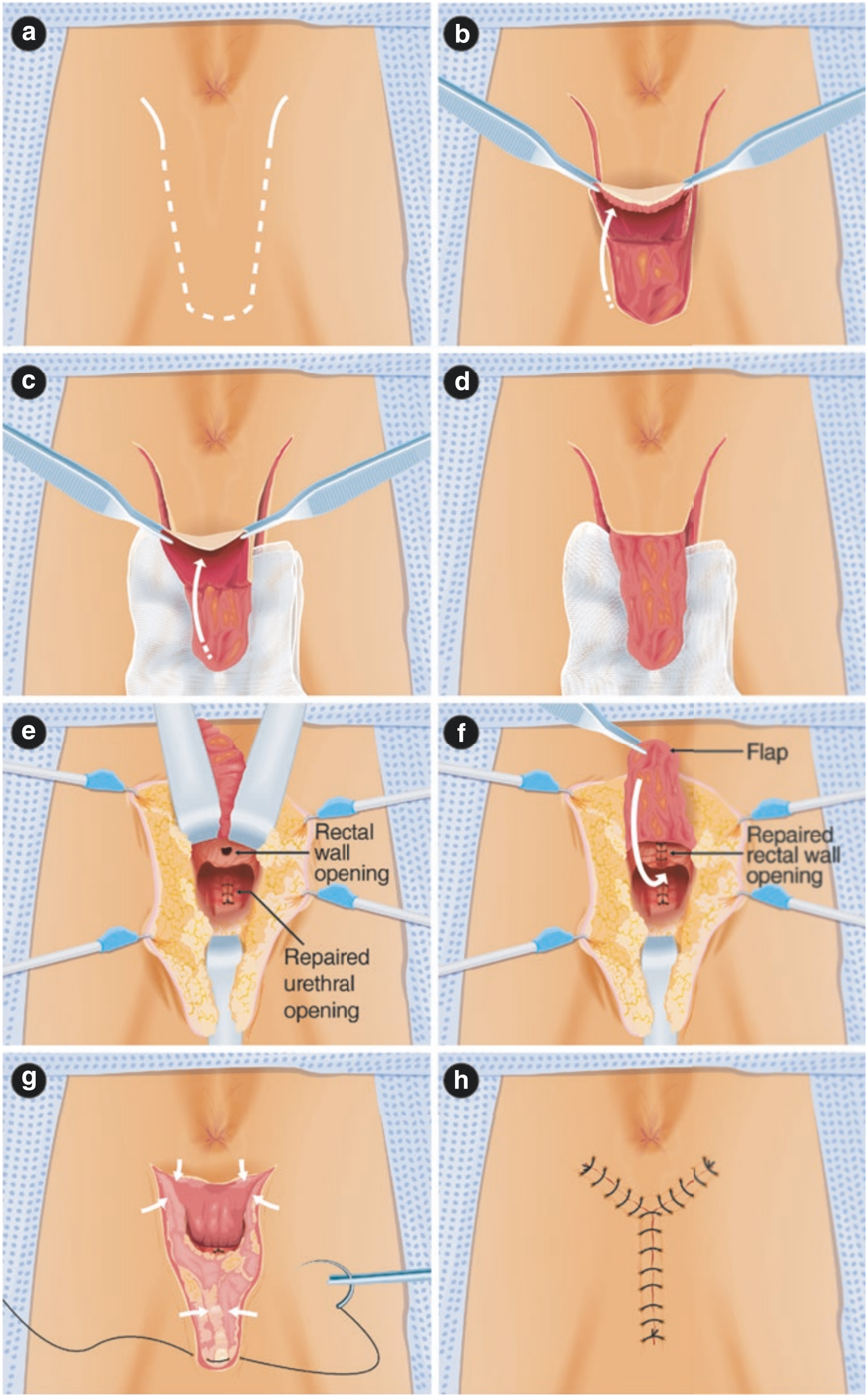

Fig. 18.7 (**a–i**) Step-by-step technique for dartos interposition flap

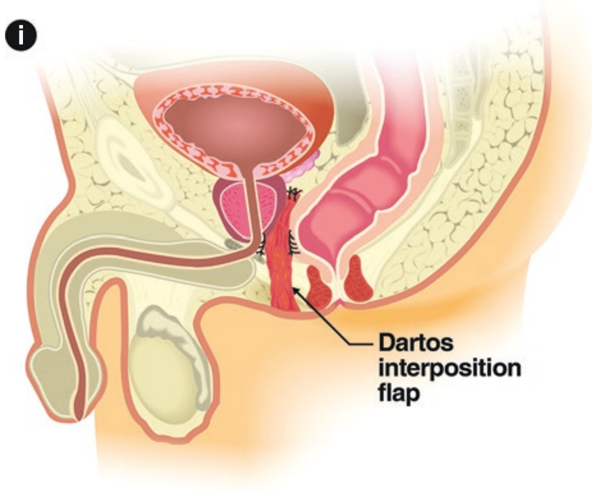

Fig. 18.7 (continued)

Posterior Repairs

Although advantages of the posterior approaches include quick surgical access with avoidance of neurovascular structures for ejaculatory function, urinary continence, and rectal innervation, plus excellent exposure of pathology in the mid rectum, they are now uncommonly used for RUF repair. Two posterior repair techniques have been described: the posterior laterosacral (Kraske) and posterior transsphincteric (York Mason) procedures.

Posterior Laterosacral Repair (Kraske)

The posterior laterosacral approach to the rectum was first described by the German surgeon, Paul Kraske, in 1885, as a means of excising rectal tumors. While initially an appealing option for rectal cancer resection due to preservation of the sphincter complex, this procedure led to rectocutaneous fistula in 70% of patients and had unacceptable oncologic outcomes, with recurrence as high as 90% [47]. In 1908, abdominoperineal resection of rectal cancer was introduced by the British surgeon William Ernest Miles [48], and from there, the Kraske procedure fell out of favor.

Interest in the Kraske procedure was revived in more recent years as a means of accessing mid-rectal pathologies, such as early tumors amenable to local excision, and for repair of RUF. With the patient in prone jackknife position, modern modifications describe an incision from the coccyx to the anus in the midline, then encircling the anus in a "racket" shape [49], or making a paracoccygeal incision starting halfway between the anus and coccyx then extending superiorly along the left side of the sacrum [47]. This exposure requires resection of the coccyx and segments of the sacrum, usually S5 and part of S4. The coccyx can be removed with cautery, and the sacral segments removed with a bone cutter. Sharp corners can be addressed with a rongeur or file. The puborectalis and levator ani muscles are divided, but the sphincter complex is left intact. The rectum is mobilized posteriorly and laterally, then a proctotomy is made to expose the anterior wall of the rectum. From here, the fistula tract is resected and the urethra and anterior wall of the rectum repaired. The posterior wall of the rectum is then closed in layers and muscles carefully reapproximated. The skin and subcutaneous fatty tissues are closed over a drain.

Despite patient selection and refined techniques in more modern series, the morbidity of the Kraske approach is still high. With 15–25% of patients developing rectocutaneous fistulae, and nearly 10% left with urinary dysfunction, plus oncologic results that do not hold up to modern day standards [47], this technique has been largely abandoned for both benign and neoplastic disease, and is now of primarily historical significance.

Posterior Transsphincteric Repair (York Mason)

The posterior transsphincteric approach, commonly known as the York Mason procedure by the surgeon who first described this in 1970, also entails making an incision from the anus towards the coccyx, but offsets this from the midline to the left side and continues obliquely along the left side of the sacrum [50]. After dividing the soft tissues, the muscular structures are identified and divided, tagging the ends carefully (usually with different colored suture material) to ensure accurate reapproximation at the end of the case. In this manner, the puborectalis, levator ani, and external sphincter muscles are completely transected. If necessary for exposure of high fistulas, the lower fibers of the gluteus maximus are also divided, and the coccyx may need to be removed. Finally, the posterior wall of the rectum and sphincter complex is completely opened.

With the fistula entirely exposed from the rectal side, full mobilization and debridement can be accomplished. The urethra is repaired and can be buttressed with adjacent perirectal fat, however exposure of the urethra and bladder neck is limited [44]. The anterior and posterior rectal walls are closed in two layers. The previously tagged muscles are reapproximated and the incision is closed over a drain. Urinary catheters are left in place for the initial post-operative period (timing of which varies across the literature), then contrast studies performed to ensure resolution of the fistula [51] (Fig. 18.8).

Success rates for the York Mason procedure are generally high, with several smaller series producing complete fistula resolution rates of 90–100% [52–55]. The largest study to date aggregates data from 51 patients over the course of 40 years,

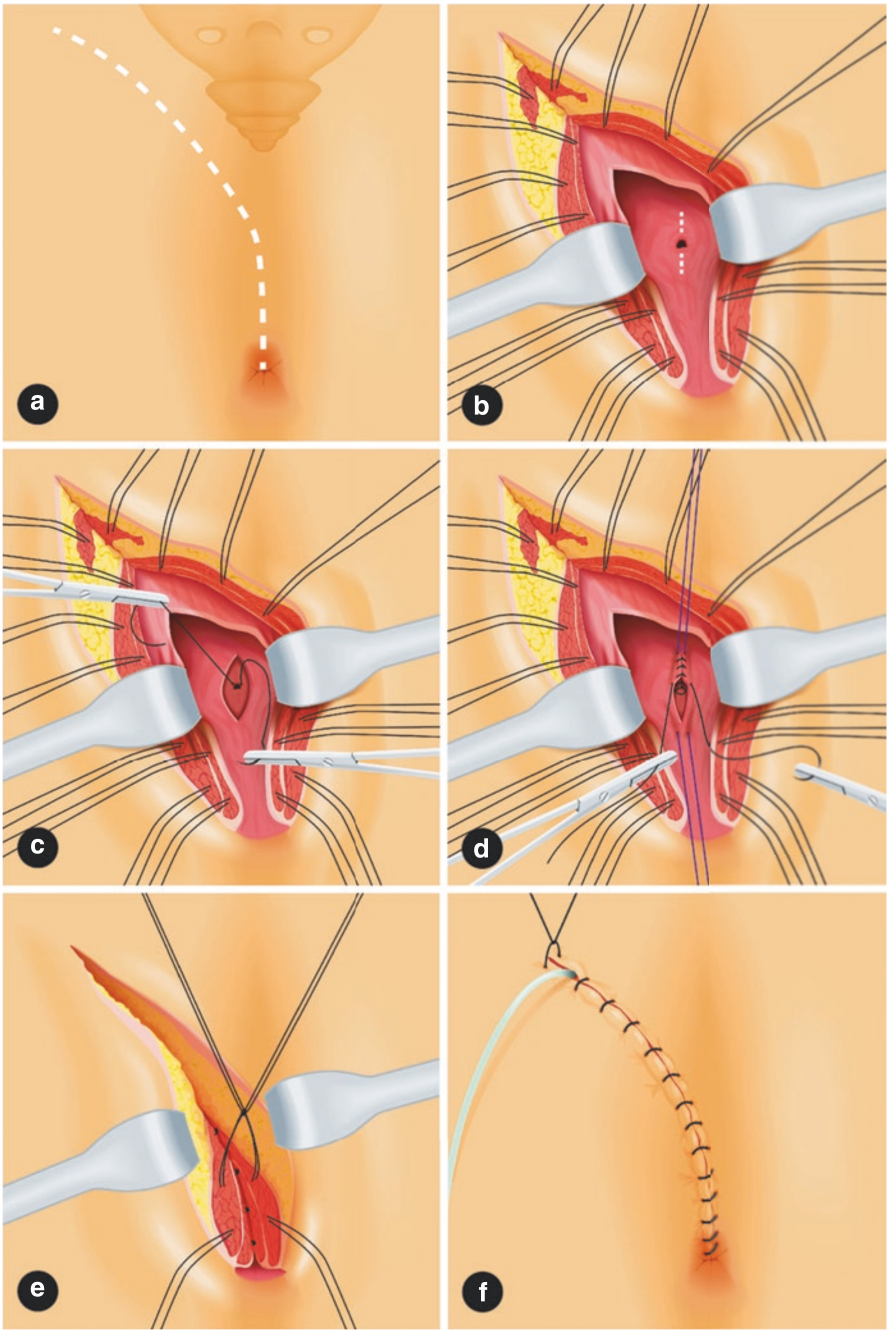

Fig. 18.8 (**a**–**f**) Step-by-step depiction of posterior transsphincteric (York Mason) repair

with closure in 47 patients (92%) [56]. Failure was generally associated with previous radiation or systemic disease like HIV/AIDS or Crohn's disease.

However, like the Kraske procedure, the York Mason procedure is now uncommonly performed due to wound healing and continence concerns. This is especially relevant for patients with previous radiation treatment or ongoing severe proctitis. Although Dr. York Mason himself published a series of 24 patients who had no alteration in continence or defecation post-operatively [50], rectocutaneous fistula development has been reported at 5–7% in the literature [55], and fecal incontinence rates vary significantly across studies from as low as 1% to as high as 40% [55, 57–59]. The cited complication rates for fecal and urinary incontinence is generally lower than with the Kraske procedure, but when compared with the transanal and transperineal approaches, the York Mason is now reserved for only select circumstances.

Recommendations

Successful repair of RUF starts with thorough work-up and consideration of patient co-morbidities and causative factors for fistula formation. Small (<2 cm) fistulas with otherwise healthy local tissue, and without associated urethral stricture or surrounding infection, heal more readily regardless of the technique used. Complex fistulas, especially those in patients with a history of pelvic radiation, heal nicely with interposition of healthy, well-vascularized tissue. In those patients with recurrent RUF after attempt at repair, repeating the same technique has proven successful in some cases (notably with ERAF and the York Mason procedure) [18, 56], however caution may dictate attempting an alternative route via undisturbed tissue planes. Combining approaches may be effective and reduce risk of recurrence, such as performing an ERAF with dartos interposition flap [43] or York Mason procedure [60].

Conclusion

Many operations exist for the surgical correction of RUF, which speaks to the complexity of the problem and the affected patients. Due to the rarity of the disease process and the lack of robust high-quality evidence, no generalizations can be made as to the ideal repair technique. Preoperative evaluation is of critical importance, as is patient counseling regarding complications and options in the face of possible recurrence. Familiarity with the above described techniques, plus options for abdominal approaches to repair, will help the treating surgeon to guide patients towards recovery from this difficult and distressing condition.

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Chapter 19
Transanal, Transperineal, and Combined Abdominoperineal Approaches (Turnbull-Cutait) to Repair of Rectourethral Fistula

Marjun Philip N. Duldulao

Abbreviations

CT	Computed Tomography
MRI	Magnetic Resonance Imaging
RUF	Rectourethral fistula
TAMIS	Transanal Minimally Invasive Surgery

Introduction

Rectourethral fistulas (RUFs) are classified as congenital or acquired. Overall, RUFs are uncommon but a majority of cases are acquired [1]. Acquired RUFs can be the result of surgical complications, pelvic radiation or ablative treatments, trauma, chronic infection, inflammatory bowel disease, or malignancy. Historically, RUFs were mostly reported from complications related to treatment of prostate cancer. However, with the development of new transanal approaches to other conditions, such as transanal total mesorectal excision for rectal cancer, more occurrences of RUFs can be associated with the management of non-urologic conditions. Although the overall occurrences of RUFs is rare, numerous surgical subspecialties are impacted by this condition (i.e. Urologic, Colorectal, Gynecologic, etc.) [2]. Frequently, RUFs are managed in a multidisciplinary manner and there are

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numerous methods for repair. Furthermore very few randomized controlled trials exist for the management of RUFs and thus choice of operative interventions depend mostly on specific patient/anatomic factors and surgeon experience.

Evaluation of RUFs for Transanal or Transperineal Repair

An in-depth focused history and physical combined with radiologic testing is necessary for the diagnosis of RUFs. In consideration of a transanal or transperineal repair one must consider the operative limitations of each approach. The limited exposure either a transanal or transperineal approach provide contributes to the case complexity. Thus a thorough assessment is warranted. Often, a transanal or transperineal repair may be the first step in a series of procedures to repair RUFs. Not infrequently, injury to the urethra can be identified intra-operatively during transrectal procedures and vice versa injury to the rectum can be visualized during urologic procedures. If injuries to these closely approximated structures are identified then an attempted repair should be performed at that time. Patients who present with RUFs may develop pneumaturia, fecaluria or frequent loose stools [3, 4]. Additional history such as prior history of urologic, gynecologic, or colorectal malignancy, inflammatory bowel disease, prior radiation, or prior transanal or transperineal operations (episiotomies, anorectal fistula repairs, hemorrhoidectomy, sphincteroplasty, perianal or perineal incision and drainages) should be obtained.

The operative reach of a transanal or transperineal technique is limited and thus a thorough perineal physical examination will aid in determining the feasibility of either approach. A digital rectal exam can help determine the distance of the RUF from the level of the levators and anal verge. Furthermore, it may also identify additional fistula tracts or abscesses. Anoscopy can be performed readily in a clinic setting and is a simple diagnostic procedure to aid the initial physical exam. Prior perineal incisions should be noted. Anal sphincter dysfunction that can be visualized on a physical exam such as a patulous anus or the presence of an anal stricture may further aid in the decision to pursue a transanal or transperineal repair. Transperineal techniques can reach up to about 8 cm from the perineum. However, in obese patients the depth in which a transperineal approach can afford may be shortened secondary to the presence of additional subcutaneous fat. Transanal approaches provide for a deeper reach depending on the apparatus utilized for exposure but can limited by internal anatomic features such as angulation and curve of the rectum or the valves of Houston (Fig. 19.1). These features can be identified with a flexible sigmoidoscopy or colonoscopy during the evaluation of patients with RUF.

Pertinent radiologic evaluation such as CT scan and/or MRI paired with diagnostic procedures (voiding cystourethrogram, retrograde urethrography, cystoscopy, colonoscopy, endorectal ultrasound, gastrograffin enema) help delineate pelvic anatomy. Cystoscopy and/or colonoscopy with biopsy can further diagnose if there

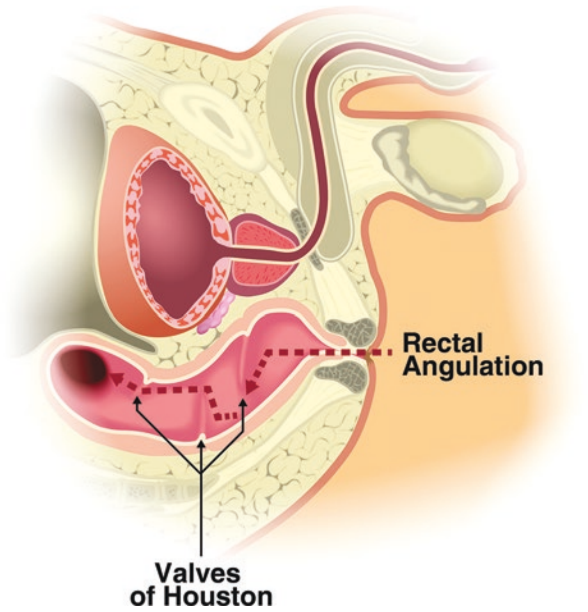

Fig. 19.1 Angulation of the rectum - sagittal anatomy

is an underlying malignancy, or can identify RUFs related to chronic inflammation (radiation, inflammatory bowel disease, or infection). The consideration for biopsy should be carefully considered as this may enlarge or exacerbate the RUF. Additionally, functional studies (urodynamics, anal manometry) to determine urinary and fecal function may help guide treatment decisions.

Initial Management and Preparation of Patients Prior to Transanal or Transperineal Repair of RUF

Conservative management with fecal and urinary diversion for small RUFs (less than 2 cm) can be attempted, especially in patients who have not received radiation and without any signs of underlying sepsis. However, most RUFs do not respond to conservative management and require surgical repair [4–6]. Patients should be considered for at least fecal diversion (diverting ileostomy or colostomy) as this may decrease the incidence of septic events prior to definitive repair. Furthermore, fecal and/or urinary diversion may diminish the degree of inflammation related to radiation. Patients with inflammatory bowel disease, such as Crohn's disease, should be well controlled on maintenance biologic therapy prior to repair. In preparation for transanal or transperineal repair patients should receive a full bowel prep in order to decrease stool burden but also to improve visualization during a transanal approach. In patients who have received a prior fecal diversion bowel preparation can be performed with a series of cleansing enemas.

Transanal Techniques for Repair of RUFs

Transanal Approach

The transanal approach may be sufficient in managing most cases of RUFs and commonly the initial approach. When considering the transanal approach, the surgeon must pay attention to the relevant anatomy which may contribute to poor visibility and adequate access. If any limitations do exist it may be advisable to pair a transanal approach with adjunctive exposures such as with transperineal or transabdominal techniques. For instance, most anoscopes or transanal retractors provide adequate visualization up to 8 cm which is the common length of most index fingers. However, in obese patients the overlying perineal and gluteal fat may shorten or narrow the visual field. Effacing the anus by gently retracting the buttocks with tape may assist in visualization. Furthermore, the reach of a transanal approach can be supplemented with laparoscopic instruments via transanal or single port platforms. The choice of instrumentation is mainly guided by surgeon preference and prior experience.

A bowel prep with rectal enemas is advisable to improve visibility within the rectum from retained mucous or stool. Rectal irrigation within the operating room may also be performed. Patients can be positioned in jack-knife prone or lithotomy. Prone positioning has several advantages in that the fistula is visualized within the dependent aspect of the surgical field, in contrast to lithotomy position where the fistula is positioned on the roof or overhead aspect of the surgical field. The main disadvantage of prone positioning is the limited access provided to the urethra or Foley catheter. In multidisciplinary care with Urology and Colorectal teams, a cystoscope may need to be performed in tandem, or adjunctive exposures such as performed with a transperineal or transabdominal technique are mainly performed with the patient in lithotomy. Additionally, if there is thought for reconstruction with a Gracilis flap or other tissue interposition, this is best approached with the patient in lithotomy.

Latzko: Primary Closure

The Latzko technique can be utilized for fistulas up to 2 cm in size. The description of this technique is described with the patient in the prone position but can be applied to a patient positioned in lithotomy. After exposure with an anoscope and elliptical incision is made around the fistula in a longitudinal fashion. The ellipse is typically about 3 times the length of the diameter of the fistula tract, and is a full thickness excision (Fig. 19.2a). This may also provide exposure to the underlying urethra which can also be primarily repaired over a Foley catheter. The rectal defect is closed longitudinally and can be performed in layers (Fig. 19.2b). Prior to closure, additional dissection within rectoprostatic plane may be necessary to obtain

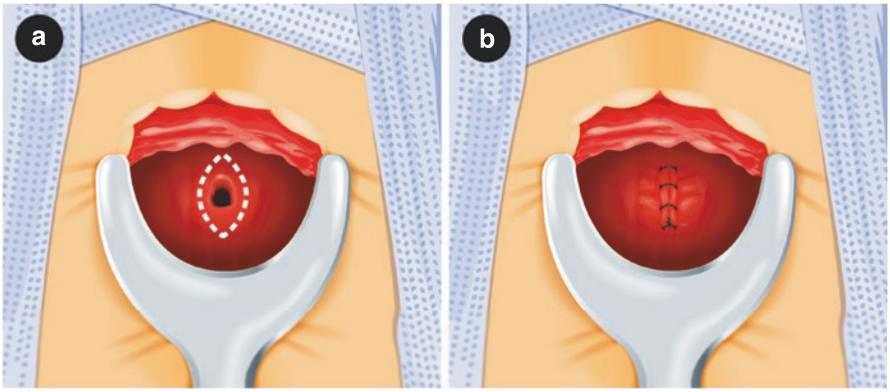

Fig. 19.2 Latzko: primary closure - transanal view (patient prone position)

closure without tension. Frequently, there is enough pliability within the rectal wall to allow for full thickness closure, however, this could be limited especially in previously irradiated tissue. A leak test is not commonly performed as the Foley catheter is often used to stent the urethral repair. The addition of biologic mesh within the exposed rectoprostatic space is not well described or studied with the Latzko technique [7]. Postoperatively, patient should remain on stool softeners if the patient is not diverted. If proximal bowel diversion is present, an assessment with flexible sigmoidoscopy or proctoscopy can be performed about 2–3 months to assess the repair before restoration of continuity. These patients should still remain on a bowel regimen as this repair may result in some narrowing and decreased compliance of the rectum which can impact bowel function.

Park: Rectal Advancement Flap

In contrast to the Latzko technique, the excision of the fistula tract is mainly limited to around the fistula itself. Often, the fistulous opening within the rectum is excised with a rim of healthy mucosa (~1–2 mm). A full thickness excision is performed of the fistula tract, but because the overall defect in the rectal wall is smaller it may limit visualization of the fistulous opening within the urethra. A tongue shaped full thickness rectal flap is mobilized by dissecting within the rectoprostatic plane in the cephalad direction (Fig. 19.3a). Dissection should be sufficient to mobilize the flap and allow for complete coverage of the fistula tract. With good apposition the flap can be closed in layers (perirectal fat/serosal and submucosal/mucosal layers) in a transverse fashion. A transverse closure prevents narrowing of the rectal vault but can be difficult to perform in the limited operating space provided by a transanal approach (Fig. 19.3b). It is important to maintain hemostasis as an underlying hematoma from injury to perforating vessels within he rectoprosthatic space or

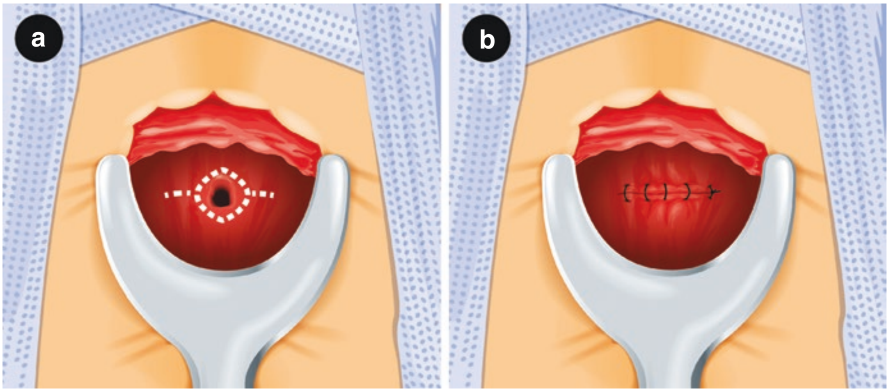

Fig. 19.3 Park: rectal advancement flap - transanal view (patient prone position)

fascia will compromise the repair. Supplementation of the Park technique with a biologic mesh is not well described or studied. A perceived advantage of the Park technique compared to Latzko is the limited dissection and smaller size of wound within the rectum. This may also be associated with better compliance of the rectum or any resultant wound dehiscence would be smaller in comparison to the Latzko technique.

Transanal Minimally Invasive Surgery (TAMIS)

Transanal platforms and single incision ports with laparoscopic instruments allow for greater reach within the rectum via the transanal approach. In particular, obese patients with deep crevices within the perineum can best be approached utilizing these devices. Patients are positioned in lithotomy with legs in stirrups. The anus can be effaced further with four quadrant sutures placed at the anal verge or with the assistance of the LoneStar retractor. Transanal laparoscopic surgery can be mitigated with the use of the GelPoint PATH transanal device from Applied Medical or single incision port systems (Fig. 19.4). The anus is dilated utilizing Hill Ferguson or Fansler retractors or with digital rectal exam and a transanal laparoscopic platform is inserted (Fig. 19.5). This can be secured to the anal verge with suture. The rectourethral fistula is then approached using either the principles discussed in the Latzko or Park procedures. In order to facilitate approximation of tissue, a barbed absorbable suture can be utilized thus minimizing laparoscopic knot tying performed within the limited confines of the rectal vault.

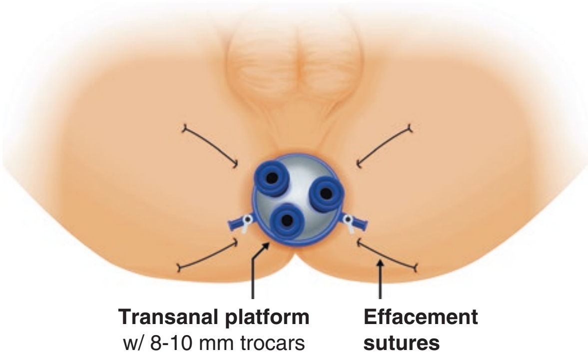

Fig. 19.4 Transanal Minimally Invasive Surgery (TAMIS) platform (Patient in lithotomy position)

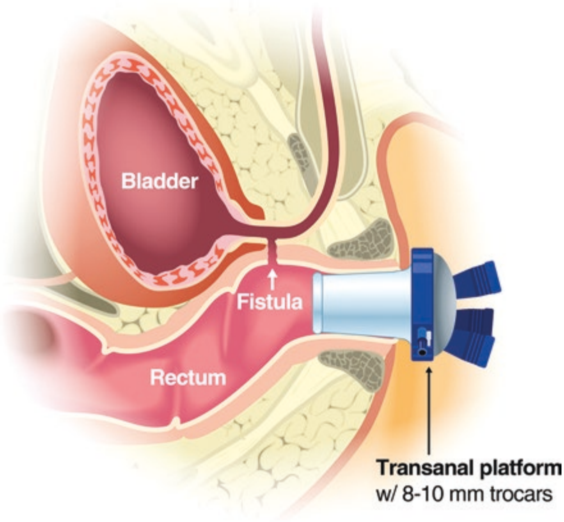

Fig. 19.5 TAMIS Platform - Sagittal Anatomic Viewpoint

Transperineal Techniques for Repair of RUFs

Transperineal Approach

The main disadvantage to a transanal approach is the limitation in operating within the confined space of the rectum. The transperineal approach does not afford significant additional exposure but has the advantage of additional adjuncts to bolster the repair. Through a transperineal incision the repair of RUFs can be supplemented by placement of a biologic mesh or tissue advancement flap, such as a gracilis muscle flap. The choice of a tissue advancement flap is often performed in a multidisciplinary fashion with participation from Urology, Colorectal Surgery and Plastic surgery.

Similar to the transanal approach, patients receive a full bowel prep and careful consideration to proximal diversion is discussed depending on whether there were prior failed attempts at repair. Furthermore, a proximal diversion should be considered in order to avoid further complications associated with the perineal wound (i.e. recto-perineal or urethra-perineal fistulas, or dehiscence). The patient is positioned in lithotomy, which also facilitates placement of a gracilis muscle flap. A foley is placed by Urology and the rectum is irrigated out to evacuate any residual stool.

Several choices are afforded in regards to shape of incision within the perineum, but an "X" or "H" shaped incision will generally be adequate for exposure in comparison to a transverse or curvilinear incision alone (Fig. 19.6a, b). The incision is made within the perineal body about 1 cm anterior from the anal verge and posterior to the base of the scrotum. Dissection within the perineal space is guided with gentle palpation for the foley and finger within the rectum. Care should be taken not to dissect too far laterally on each side as this corresponds of entry of the distal branches of the pudendal nerve. The anorectal shelf can be palpated manually which corresponds to the top of the levators ani and pelvic floor musculature. Within the perineal dissection, the anorectal shelf will likely correspond to the region of the RUF and area of most scarring which will prompt more careful dissection. The fistula tract is excised and the defect within the urethra and rectum are repaired primarily. Devascularized tissue will need further debridement on the rectum, and the rectal wall is mobilized with more proximal dissection within the rectoprostatic fascia plane to assist with primary closure. In general, a potential space about 8–10 cm in length can be dissected through the perineal approach. After repair of the urethra and rectum, the space closed in layers and either penrose or Malekot drains placed within the perineum to prevent formation of a seroma, hematoma or abscess.

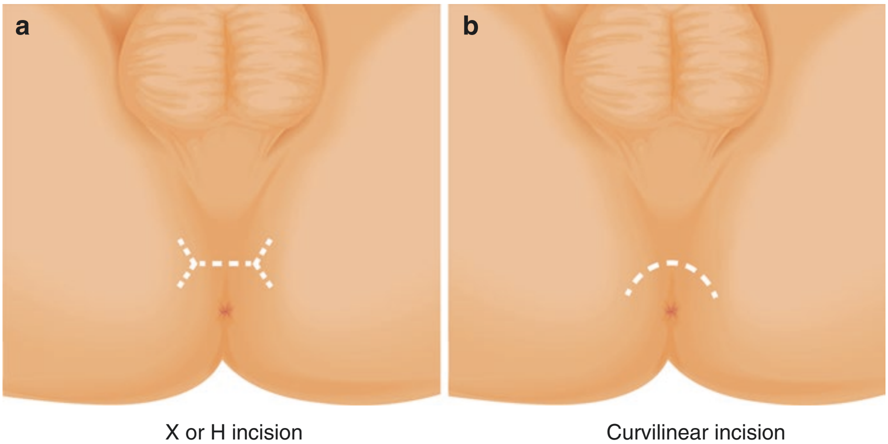

Fig. 19.6 Types of transperineal incisions

Choice of Tissue Apposition

After the potential space is created within the perineum the urethral and rectal repair can be bolstered with placement of biologic mesh or non-irradiated tissue advancement flap. A variety of biologic mesh materials can be utilized for placement between the rectal and urethral repairs. In general, an overlap of at least 1 cm on the proximal and distal side of the rectal repair is advised for biologic meshes. In regards to tissue advancement, a gracilis muscle flap is often harvested with assistance from Plastic surgery from the neighboring medial thigh and tunneled subcutaneously into the perineal space [8]. The flap should be robust and well vascularized but not too bulky. The flap is secured gently with carefully placed stay sutures, and overlapped on the rectal and urethral repairs. The advantage of a tissue advancement flap is that this may introduce healthy non-irradiated tissue into a previously irradiated region which may encourage better healing. The perineal incision is then closed over penrose or Malekot drains to evacuate any remnant seromas. These drains are subsequently removed in clinic in 2 weeks.

Transacral Techniques

Transacral techniques are another approach to RUFs but are associated with additional morbidity in comparison to other techniques. In consideration of patients for a transacral approach, one must prepare patients for the associated risk of fecal incontinence and wound complications. Frequently, patients are proximally diverted before performing these techniques [9]. However, in specific circumstances a transacral technique may be appropriate such as complicated RUFs repairs associated with a corresponding presacral mass.

Kraske

The Kraske technique is performed with the patient in jack-knife prone position. The buttock is effaced with tape. A paramedian incision is made just lateral to the sacrum from the natal cleft to about 1 cm distal from the anal verge. The coccyx is excised along with the anococcygeal ligament to allow for improved exposure. The dissection around the rectum is facilitated with a finger within the rectum. The RUF is approached by performing a posterior rectotomy and exposing the anteriorly located RUF. This is then repaired primarily utilizing Park or Latzko technique. Alternatively, the rectum can be mobilized laterally to one side and exposing the fistula but visualization may be difficult. The incision is then closed in layers with drains placed to avoid development of a hematoma or seroma (Fig. 19.7a).

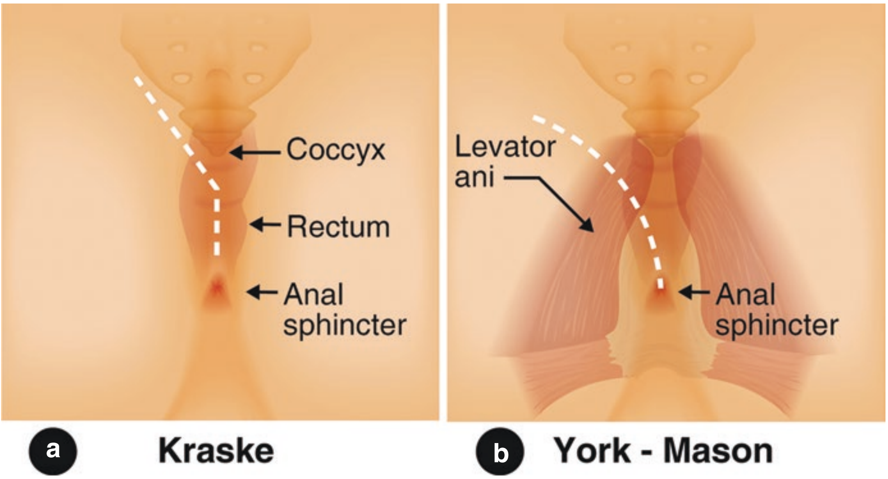

Fig. 19.7 Kraske - Paramedian incision provides access through posterior rectum. York-Mason - Paramedian incision which incises through entire anal sphincter complex to provide exposure

York-Mason

In comparison to the Kraske technique, the York-Mason technique further divides the pelvic floor and carries the incision through the posterior aspect of the anal sphincter complex [9]. This provides added exposure in order to approach the RUFs, but as expected has the added morbidity associated with anal sphincter transection. After repair of the RUF, the rectotomy and internal sphincter incision is closed primarily. The external sphincter muscle is repaired via an overlapping sphincteroplasty. The transacral wound is closed and layers over drains (Fig. 19.7b).

Abdominoperineal Techniques

Turnbull-Cutait

The Turnbull-Cutait technique is often utilized after failed primary. Similar to standard proctectomy in repair of RUFs or rectovaginal fistulas, Turnbull-Cutait involves complete mobilization of the rectum or neorectum, proximal sigmoid, descending colon and splenic flexure. Successful performance involves full circumferential dissection down to the pelvic floor within the mesorectal plane. In comparison to the standard proctectomy for the management of RUFs, the Turnbull-Cutait technique involves delayed creation of the coloanal anastomosis. In cases of recurrent rectovaginal or rectouretheral fistulas after initial repair, the fistulous connection recurs between the urethral and coloanal anastomosis. The etiology of the recurrence in this setting arises because the uretheral anastomosis and rectal anastomosis are undergoing the same inflammatory and healing processes. The confinement of the pelvis places both of these anastomosis within close proximity, and because of poor healing potential from prior radiation or a chronic inflammatory state the primary repairs of the urethra and rectum can potentially heal to each other and result in a recurrent fistula. The advantage of a proctectomy and mobilization of the proximal rectum into the pelvis is that it brings in non-irradiated tissue within the field which may allow for improved healing. The delayed creation of the coloanal anastomosis offers the added advantage of staggering the processes of repair and healing of the urethra from that of the rectum. The coloanal anastomosis is created 1–2 weeks afterwards, thus giving the urethral repair adequate time to establish sufficient healing. The main disadvantage is the frequent development of low anterior resection syndrome which is a sequelae of changes in bowel function which results from a loss of stool capacity and coordinated evacuation. As well, the management of the exteriorized colon through the anus adds to the morbidity and discomfort of the patient. As a result, the Turnbull-Cutait technique is often offered in scenarios when all else has failed and rarely offered as the primary technique for repair of complex rectovaginal or rectourethral fistulas [5].

In selecting patients for Turnbull-Cutait, one must consider remnant anatomy. Patients who have had prior segmental colectomies may not be prime candidates for this procedure depending on remnant vascular supply. The vascular supply to the colon conduit is based on the middle colic artery and its left branch distribution, and thus any compromise to the middle colic artery may be a contraindication for this procedure. Proximal diversion with a loop ileostomy is a required step in patients who undergo this procedure and management should be discussed with the patient. As this is an approach that utilizes an abdominal and transperineal approach, reconstructive techniques with tissue advancement flaps may also be utilized at the same time. Patients receive a complete bowel prep with antibiotics. Additionally, a multidisciplinary team involving Urology, Colorectal Surgery, and occasionally Plastic Surgery may contribute to improved success.

Patients are positioned in lithotomy with adjustable stirrups. The abdomen and perineum are prepped. A foley catheter is placed, which my require assistance with cystoscopy, and ureteral stents may be necessary especially in patients with prior pelvic dissection. The abdominal dissection may be approached utilizing minimally invasive techniques, but essentially, complete mobilization of the splenic flexure to the rectum should be performed. Appropriate dissection around the rectum has been discussed in prior chapters but at best should be performed within the mesorectal plane circumferentially in order to preserve the pelvic splanchnic nerves. The dissection within the abdomen and pelvis continues down to the level of the pelvic floor. At this time the rectum may be separated from the urethra. The urethra may be repaired utilizing previously discussed abdominal techniques. Additionally, a flap of omentum may be mobilized and positioned within the pelvis in order to facilitate placement during the transperineal portion of the case. A segment of small bowel approximately 20–25 cm from the ileocecal valve is brought up for creation of a diverting loop ileostomy.

After completing the abdominal portion of the case, the legs are positioned up within the stirrups to allow exposure of the perineum. Effacement sutures placed in four quadrants may facilitate exposure of the anal verge. Further exposure can be obtained with utilization of a LoneStar retractor. A Hill Ferguson or Fansler retractor is placed within the anus and the dentate line is identified. A full thickness incision is created within the anal canal circumferentially. Quite often the circumferential fibers of the external sphincter muscle can be identified signifying the incision has gone through to the appropriate depth within the intersphincteric plane. This plane is contiguous with the mesorectal plane proximally and will lead you to the region or prior dissection performed during the abdominal dissection. Care should be taken during the anterior dissection as this plane may scarred and the rectoprostatic fascia may be thin and careless dissection may result in further injury to the urethra. Once freed, the rectum can be extracted through the anus with gentle traction. Before extracting the rectum, four quadrant sutures can be placed within the top of the sphincter complex, at the top of the anorectal shelf, or at the incision made within the anus. These will function as stay sutures for the exteriorized rectum, and from 4 to 8 sutures may be positioned. A tongue of omentum can also be secured to the anorectal shelf anteriorly and trimmed through the transanal exposure. After sutures are placed the rectum is extracted and the rectosigmoid junction is identified at the point where the tenia splay on the antimesenteric portion. At this point up to 15 cm of rectum and additionally more sigmoid colon may be extracted. However, care must be made not to place the exteriorized colon on stretch, and furthermore, attention should be made to avoid twisting to maintain a straight mesentery. The mesentery is divided up to the rectosigmoid junction and the stay sutures are secured to the corresponding quadrant within the exteriorized colon (Fig. 19.8a–d). An additional adjunct to the repair can utilize the colon mesentery mobilized within the pelvis, especially if no omentum is available to bolster the repair. The mesentery of the colon can be rotated anteriorly and tacked to the anterior anorectal shelf. The exteriorized rectum is trimmed to 4–6 cm stump utilizing a GIA stapler as it is unnecessary to have a 15–20 cm conduit hanging through the anus. Additional sutures can be placed within the incision at the dentate line and tucked away within a padded carrier wrapped in Xeroform gauze. These sutures are then preserved for creation of the coloanal anastomosis which will occur in 1–2 weeks afterwards. However, it is the author's preference not to have hanging sutures around the perineum as this complicates postoperative perineal care for additional care providers. The remnant exteriorized rectal stump is wrapped in Xeroform gauze secured with umbilical tape. A barrier cream is placed on the patient's perineum along with sterile dressings. The patient is taken out of lithotomy and brought to the recovery room and surgical floor after extubation and awakening from anesthesia.

Postoperatively, patients are restricted to standing and laying down within their hospital bed. Patients are permitted to be in a seated position within a padded hospital bed only while eating for at most an hour at a time. It is encouraged that patient

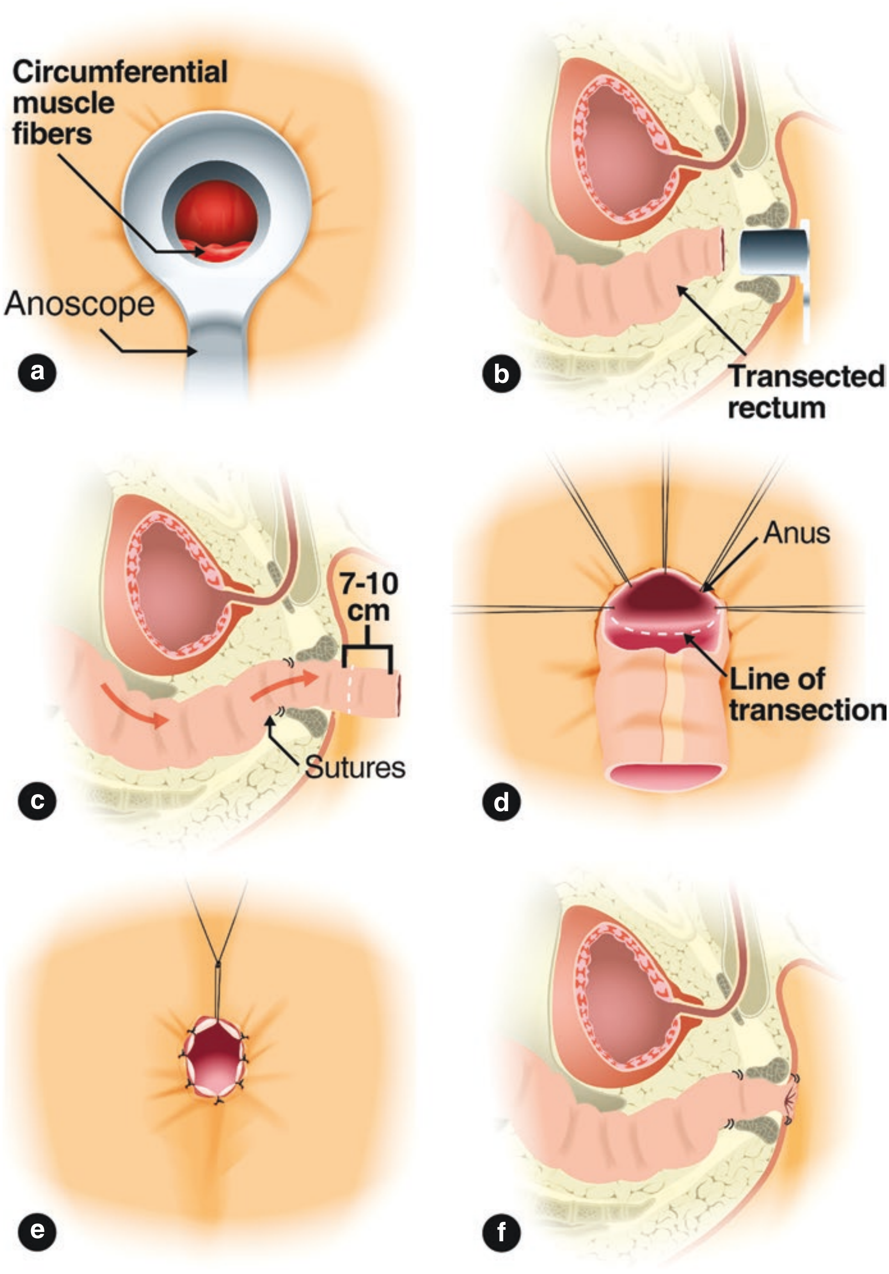

Fig. 19.8 Turnbull-Cutait - Sequence of steps

Image 19.1 Exteriorized colon through the anus after 7 days maturation utilizing Turnbull-Cutait technique

attempt to ambulate as much as possible. The Xeroform gauze can be maintained for up to 24 h and will need to be changed on a daily basis. An iodine impregnated gauze is chosen as this also suppresses the odor of the exteriorized rectum (Image 19.1). Additionally, barrier cream should be placed around the perineum to avoid moisture excoriation and chronic irritation. The patient is then taken back in 1–2 weeks for creation of the coloanal anastomosis. This is usually performed in lithotomy under monitored anesthesia care or general anesthesia. The stump is excised sharply at the anal verge and sutures placed circumferentially at the level of the prior incision at the dentate line to create a hand-sewn coloanal anastomosis. Once the stump is excised the patient can placed in a sitting position with the same precautions as for any patients with a new coloanal anastomosis. The ileostomy may be reversed in 3 months after careful evaluation such as with a gastrograffin enema study, flexible sigmoidoscopy, and possibly urethrogram or cystoscopy.

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Chapter 20
Robotic Approach for Rectourethral Fistula

Anibal La Riva, Luis G. Medina, and René Sotelo

Abbreviations

BPH	Benign prostatic hyperplasia
ICG	Indocynanine green
PCa	Prostate cancer
RP	Radical prostatectomy
RUF	Rectourethral fistula
RVF	Rectovesical fistula
VUA	Vesicourethral anastomosis

Introduction

Fistulas, by definition, are epithelized communications between organs. Rectourethral fistulas (RUF), as the name implies, are those localized between the rectum and the urethra [1].

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Over the last 20 years RUF were commonly caused by iatrogenic injuries of the prostatic capsule during procedures to treat benign prostatic hyperplasia (BPH) [2–7]. Nowadays, the etiology, incidence, and the complexity of RUF shifted due to an increased usage of energy treatments for prostate cancer (PCa) and BPH together with the standardization of neoadjuvant chemoradiotherapy in colorectal cancers [8].

Different energy modalities are frequently encountered in patients who require RUF repair. In fact, series reporting RUF repair through different approaches have described some history of energy in more than 50% of the cases [9, 10]. The incidence of RUF after some procedures is reported in recent series as follows:

- Brachytherapy for the treatment of PCa 3% [5]
- Cryotherapy for the treatment of PCa 2% [11]
- High-intensity focused ultrasound for the treatment of PCa 2% [12]
- External beam radiotherapy for the treatment of PCa 1% [6, 13]
- Radical prostatectomy 0.5% [2]
- Incidental prostatic injury during low anterior resection of the rectum for malignancy <1% [14–16]
- Transurethral resection of the prostate for the treatment of BPH <1%
- Urethral dilatation perforating the prostatic urethra <1%

Of note, the term RUF is frequently used to characterize fistulas when occurring after radical prostatectomy (RP). However, this is often inaccurate as fistulas after RP occurs mainly at the bladder neck, proximal to the urethra [17].

RUF is an extremely distressing condition for patients that can result in severe complications such as urinary tract infection, sepsis, and even death. RUF represent a higher challenge to surgeons when repairing these fistulas, as frequently the anatomy is distorted.

The surgical treatment of RUF has been always a controversial issue given that there is not a standardized pathway for its treatment. This chapter aims to review the general aspects of RUF and to provide better insight of the pathology and the technical aspects of robotic repair.

Clinical Features and Diagnosis

Signs and Symptoms

Sometimes, the severity of the RUF symptoms varies depending on the fistula size. However, three out of four patients will suffer from urinary tract infections, pneumaturia is seen in 67–85% of the cases, fecaluria is seen in 53% of the cases, and leakage of urine per rectum is only seen in 40% of the cases [6, 18]. If RUF is left untreated, severe complications such as renal failure, sepsis, and even death can occur.

Diagnosis

On physical exam, rectal examination can demonstrate a hard area in the anterior wall of the low-middle rectum. Anoscopy can demonstrate an area of defect with surrounding erythema. The patient can be instructed to urinate inside a cup of water, this in some cases may demonstrate pneumaturia.

Once a patient is suspected of having a rectourinary fistula, imaging studies will help to identify what type of fistula is present. In most cases, the urologist selects cystoscopy to evaluate for fistula complexity and surgical planning. This procedure is easy to perform, and extremely familiar among most urologists.

Retrograde cystography can help delineate fistulas, especially when there are multiple tracts. In other cases, computerized tomography (CT), CT cystogram, and magnetic resonance can be helpful to confirm the presence of RUF [9].

Classification

RUF are classified as simple or complex. Complex RUF include the following associations [17]:

- Size equal or greater than 2 cm
- Concomitant urethral strictures
- Concomitant bladder neck contracture
- Previous external radiotherapy or focal therapies

Malignancy

Treatment Approaches

Conservative treatment

The conservative treatment for RUF consists of urinary diversion (urethral catheterization, suprapubic tube, or nephrostomy) and fecal diversion (ileostomy or colostomy). This is the first-line treatment for simple fistulas. However, the rate of success varies from 14% to 100% [6, 8, 19–21]. The conservative treatments should be tried for no more than three months as after this timeframe a fistulous tract is more likely to persist due to its epithelization.

In a series presented by Nyam et al., the role of fecal diversion was not beneficial. They reported a fistula recurrence rate of 85.7% after initial management with colostomy [22].

In a series presented by Thomas et al., 13 patients were retrospectively reviewed. The group managed with Foley catheter and fully absorbable diet for 4 weeks had 100% spontaneous closure rate. The group managed with colostomy and fully absorbable diet had a 33% spontaneous closure rate [8].

These series support the use of transurethral catheter and colostomy; however, each case should be individually evaluated.

Surgical treatment

The surgical treatment of RUF consists of the excision of the epithelized tract with repair of the affected structures. This is the first-line treatment of complex fistula or simple fistula after failed conservative management.

During the repair of these fistulas, it is imperative to follow the principles of urinary fistula repair of adequate exposure of the fistula tract, excision of non-viable tissue from fistula edges, well-vascularized, healthy tissue for repair, watertight closure of each layer, the interposition of well-vascularized tissue between the organs, tension-free, non-overlapping suture lines, adequate urinary drainage after repair, prevention of infection (use of prophylactic antibiotics), being aware of possible malignant etiology of fistula (biopsy fistula tract if known history of malignancy), follow-up retrograde cystogram and nutritional optimization with a low-residue diet.

Several surgical approaches have been proposed, and there is still no consensus regarding superiority of one over another. Of the most common surgical approaches, the transsphincteric technique avoids pelvic manipulation, providing advantages such as sexual potency preservation and urinary continence. However, this procedure involves only removal of the tissue surrounding the fistula, therefore, for complex cases that involve radiotherapy or cancer recurrence, extended excisions cannot be performed. Also, this technique has been associated with fecal incontinence and wound dehiscence [17]. The open transperineal approach has the advantage of better distal urethral and rectal exposure; in the case of urethral stenosis, this can be repaired simultaneously. However, the disadvantages rely on the limited space to work, possible stress incontinence due to pelvic floor muscle trauma, and bladder neck contracture. The open transanal approach has the advantages of decreased surgical site infection rate and short convalescence. However, lack of access to the fistulous tract prevents its excision.

The transabdominal approach can be open, laparoscopic, or robotic-assisted laparoscopic repair. Open transabdominal permits using omentum as interposition tissue and the possibility of performing a urinary and fecal diversion simultaneously—however, high morbidity and a more extended recovery period may limit its use. The laparoscopic transabdominal technique improved morbidity, but a high level of laparoscopic skill was required for intracorporeal suturing, the learning curve is steep, and the range of movement was limited. The robotic-assisted approach brings all the advantages of the minimally invasive approach with greater dexterity, tridimensional view, and a shorter surgical learning curve. Of note, as complex fistula incidence is increasing, the transabdominal approach offers the highest chance for a successful repair, as all the structures can be well dissected, interposition tissue can be placed, simultaneous diversion can be performed, and concomitant pathologies such as bladder neck contracture can be repaired; however, technique selection is still up to the preference of the surgeon [1, 17].

Transabdominal Robotic-assisted Laparoscopic Repair Step-by-Step Surgical Technique

Preoperatively

All patients should undergo mechanical bowel preparation with polyethylene glycol and receive prophylactic antibiotics with second generation cephalosporin (e.g., cefoxitin, cefotetan). Alternatively, ampicillin/sulbactam and aminoglycoside or aztreonam in cases of renal insufficiency and metronidazole or aztreonam and clindamycin or clindamycin alone as indicated by the Best Practice Statement of Urologic Procedures and Antimicrobial Prophylaxis [23].

Intraoperatively

The following surgical technique is performed:

Patient Positioning, Port Placement and Cystoscopy

The patient is placed under general, endotracheal anesthesia, prepped, and draped in usual sterile fashion and positioned in dorsal lithotomy.

First, laparoscopic access is achieved using open Hasson technique [24]. Pneumoperitoneum is established up to 15 mmHg. After this, trocars are placed under direct visualization in a six-port transperitoneal configuration (Fig. 20.1). Of note, some patients will have fecal diversion, which will require a shift of the trocars (to the left, usually). Simultaneously, another surgeon performs a cystoscopy to stent both ureters with open-ended ureteral catheters in a retrograde fashion. Then, a different catheter (this catheter needs to have a different color from the ureteral stents) is passed through the fistula and retrieved through the anus for future intra-operative identification.

After the cystoscopy and trocar placement is done, the robotic system is docked. For the Si da Vinci System® (Intuitive Surgical, Sunnyvale, CA, USA), the docking occurs from between the legs of the patient whilst for the Xi System (Intuitive Surgical, Sunnyvale, CA, USA), the robotic cart can be docked from the side (Fig. 20.1).

Fig. 20.1 Six-port transperitoneal configuration, Patient Positioning and Cystoscopy. Left: Patient without fecal diversion. Right: Patient with fecal diversion

Omental Harvesting

Ideally, an omental flap is used as interposition tissue between the rectum repair and the vesicourethral anastomosis, if salvage prostatectomy is performed to excise the fistulous tract. The omentum is harvested replicating the open omentoplasty technique with either standard laparoscopy or the da Vinci Surgical System platform (Intuitive Surgical, Sunnyvale, CA, USA) in cephalic view [25]. For this specific step, the patient must be repositioned to reverse Trendelenburg to allow for better anatomic exposure. The colo-epiploic detachment, followed by dissection along the gastrocolic ligament, gives most surgeons a proper omental length to reach the cul-de-sac. Rarely, omentum cannot be used as interposition tissue. In those cases, peritoneum, endorectal advancement flap and implantation of biologic mesh [26], rectal advancement flap plus adipose lipofilling [27], neurovascular bundles, or rectus muscle [28] have been described in different series with variable rates of success.

Salvage Prostatectomy

The patient is placed back in Trendelenburg position to perform the salvage prostatectomy as described by Guillonneau et al. [29]. The rationale behind prostatectomy is normally, the fistula is located between the prostatic capsule and the rectum; therefore, removal of the prostate will excise most of the fistulous tract and will promote easier dissection/mobilization of the tissue planes.

After initial adhesiolysis, a posterior approach through the cul-de-sac takes place. The dissection is advanced towards the Denonvilliers' fascia until the proximal border of the fistulous tract is reached. Then, the anterior dissection takes place, starting with the bladder drop. The dissection is advanced through the Retzius space until the prostatic capsule plane is encountered. Sometimes, especially in patients with a history of energy treatment, it is hard to locate this plane, however, careful dissection will allow the plane's development. After this, the plane above the prostate capsule is dissected. The distal prostate is then dissected, and the urethra is incised (Fig. 20.2). The dissection is continued until the distal aspect of the fistulous tract is reached to complete the prostatectomy.

Rectal Defect Closure

The fistula edges in the rectal defect are freshened approximately 2 mm with scissors to leave enough healthy tissue for the rectal suturing. Some degree of distal and lateral dissection is needed to release the rectum, which will also help to plan where the omentum will be anchored. An essential point of rectal defect closure is that the blood supply of the rectum needs to be sufficient. Otherwise, a recurrent fistula may occur. This can be ensured using indocyanine green (ICG) (Akorn, Lake Forest, IL, USA). Also, another critical point in the rectal closure is to make sure that the rectum diameter is appropriate, this can be ensured by inserting a Hegar dilator into the rectum. Figure 20.3 demonstrates a longitudinal closure performed in one layer in a

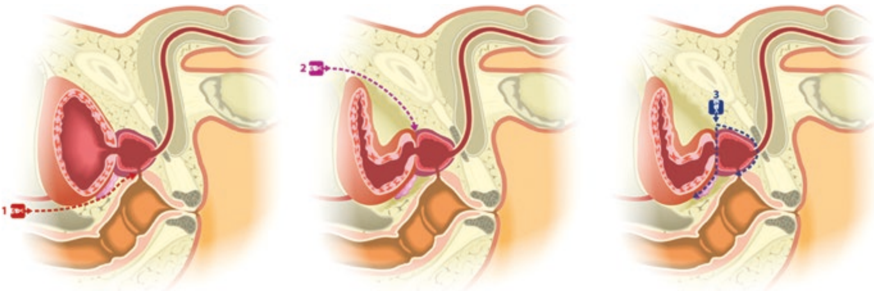

Fig. 20.2 Salvage prostatectomy: (*1*) Posterior dissection until proximal border of fistulous tract. (*2*) Anterior dissection. (*3*) Dissection of the rest of the prostatic capsule, urethral incision and fistulectomy

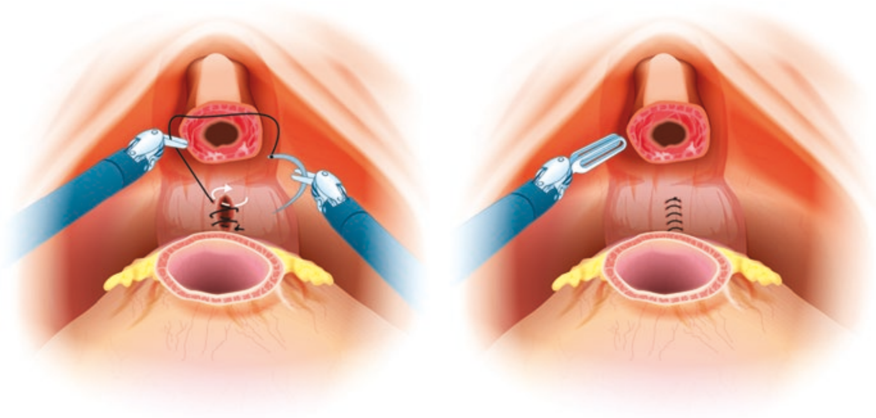

Fig. 20.3 Rectal defect closure. Left: longitudinal one layer running suture. Right: healthy watertight closure

running fashion, starting on the apical side with a 3–0 V-Loc suture (Covidien, Dublin, Ireland). A confirmatory rectoscopy, if possible, is recommended to assess for proper rectal caliber and closure.

Omental Flap Interposition

The omental flap is advanced through the opening at the cul-de-sac, and anchored distal to the suture lines of the rectal closure. The anchoring is performed with 3–0 V-Loc suture (Covidien, Dublin, Ireland) to the peri-rectal fat (Fig. 20.4).

Vesicourethral Anastomosis (VUA)

The VUA is one of the most critical steps. It is essential to resect the urethral stump until a healthy margin of the urethra is encountered, especially in concomitant bladder neck contracture cases, as this scarred tissue will likely fail to heal, and a new RUF can develop [30]. Consequently, a tension-free and water-tight VUA is a must to avoid urinary leak.

If a healthy urethral margin is easily encountered and a tension-free anastomosis is feasible, a running single knot anastomosis following the technique described by Van Velthoven et al. is performed [31] (Fig. 20.5).

If a tension-free VUA cannot be performed due to extensive tissue destruction and atrophy of the residual urethra the following maneuvers can be attempted in a sequential manner:

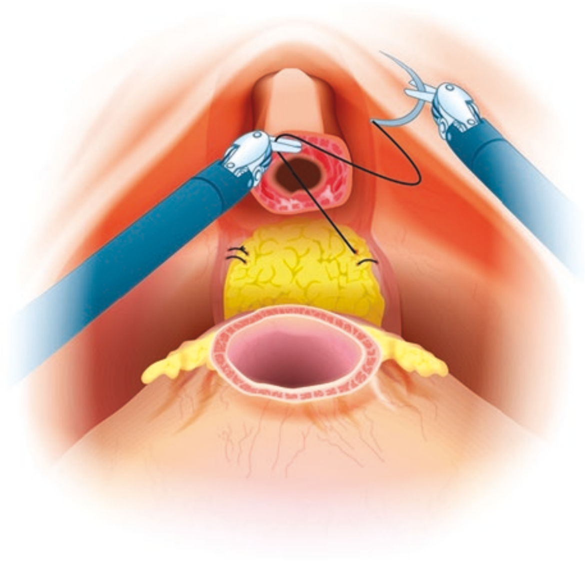

Fig. 20.4 Omental anchoring

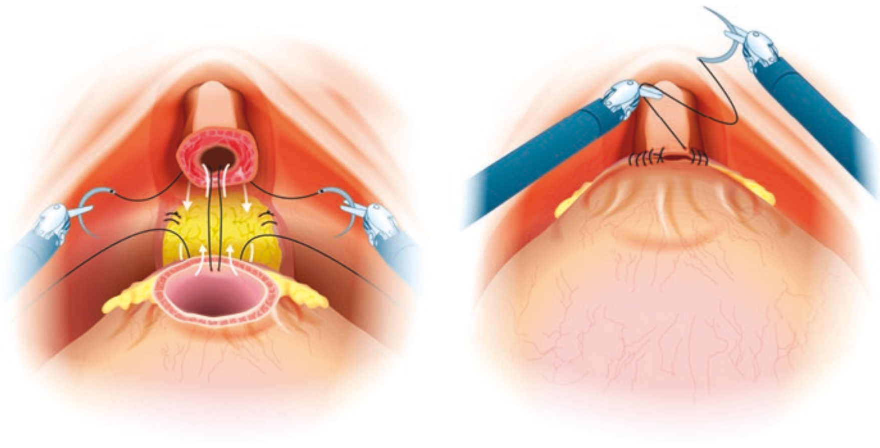

Fig. 20.5 Single knot running van Velthoven VUA

1. Bladder neck lateral release, this would allow for distal mobilization of the bladder neck.
2. Posterior bladder neck reconstruction to decrease the distance between the bladder neck and the urethra.
3. Primary bladder ladder neck closure + neocystotomy: the cystotomy is done at a more favorable location to perform a tension-free VUA
4. Transperineal urethral mobilization for proximal mobilization of the urethra.
5. Bladder neck closure + suprapubic tube placement
6. Appendicoumbilicostomy (Mitrofanoff technique) or a transverse ileal tube (Yang-Monti procedure)
7. Cystoprostatectomy + ileal conduit

A Jackson-Pratt drain is positioned at the cul-de-sac before closure of the abdominal wall.

Postoperatively

Patients require close monitoring of the Foley catheter as acute urinary retention due to a clot blocking urine output can occur. The surgical drain is typically removed on postoperative day 3 after measuring fluid creatinine, and the urethral catheter or suprapubic tube is removed three weeks post-surgery with prior confirmation of no urinary leakage via normal cystogram. In cases of fecal diversion, laparoscopic Hartmann procedure reversal is performed around four months after confirmed successful repair [2].

Follow-up visit should be performed at one, three, and six months postoperatively. A detailed patient interview looking for RUF recurrence symptoms and

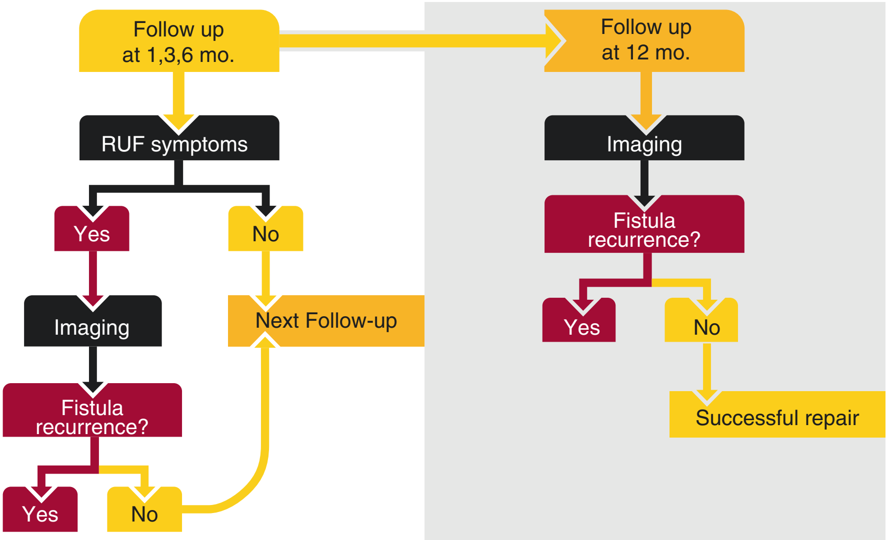

Fig. 20.6 RUF follow-up algorithm

physical examination should be performed. Then, at twelve months an imaging study such as a cystoscopy and/or CT urogram will help to confirm the successful repair (Fig. 20.6).

Conclusions and Recommendations

The robotic approach for rectourethral fistula management represents a feasible and successful option for patients with clear indications of surgery that are candidates for a transabdominal approach. It allows for excellent visualization and range of motion and provides the ability to perform fecal diversion simultaneously, if necessary. More extensive comparative studies are required to establish the future role of robotics in the repair of rectourethral fistula.

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Chapter 21
Urethropubic, Urethrocutaneous and Urethroperineal Fistulas

Leo R. Doumanian

Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
CAUF	Congenital anterior urethrocutaneous fistula
CIC	Clean Intermittent Catheterization
CPUF	Congenital posterior urethroperineal fistula
CT	Computed tomography
DF	Dartos Fascia
FB	Foreign bodies
HIV	Human Inmunodeficiency Virus
MRI	Magnetic Resonance Imaging
NGB	Neurogenic Bladder
OIF	Onlay Island Flap
PCa	Prostate Cancer
RT	Radiotherapy
SCC	Squamous Cell Carcinoma
SCI	Spinal Cord Injury
TB	Primary Tuberculosis
TIP	Tubularized Incised Plate
TVF	Tunica Vaginalis Flaps
UCF	Urethrocutaneous Fistula
UPF	Urinary-Pubic symphysis Fistula
VCUG	Voiding cystourethrogram VCUG
VMMC	Voluntary medical male circumcision

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Introduction

Urinary tract fistulas represent a complex group of pathologies with significant management challenges. Defined as an abnormal extra-anatomic communication between two epithelial surfaces, there are many different types of urinary fistulae, as demonstrated throughout this book. In general, fistulae can be congenital or acquired in nature. Regardless of etiology, urinary fistula formation is influenced by many factors. Depending on the type of lesion and severity, the medical impact can range from minimal to life-threatening infections. In cases where urinary or fecal continence is compromised, the psychological impact and effects on quality of life can be debilitating [1].

Our understanding of congenital fistulas is limited. Two specific entities, Congenital Anterior Urethrocutaneous Fistula (CAUF) and Congenital Posterior Urethroperineal Fistula (CPUF) are quite rare. In fact, there are less than 100 combined patients identified these two conditions in the published literature as case reports. The debate continues regarding the proposed embryological theories behind CAUF and CPUF formation.

Alternatively, the numerous origins of acquired fistulas are well described [2–5]. Neoplasms causing necrosis can erode into the urinary stream. Blunt traumatic forces from straddle injury or penile fracture compromise urinary tract integrity [6]. Infections, urethral calculi, and foreign bodies can fistulize over time. Hypospadias repair, circumcisions and priapism have their inherent surgical complications.

Urinary tract fistulas are nearly always unexpected occurrences that can have a significant medical, functional, and psychological impact on patients [1]. Large or small, urinary tract fistulas represent a complex group of pathologies. Ultimately, most fistulas require definitive surgical intervention involving primary repair or permanent urinary diversion. Recurrence rates can be high; therefore, technical success presents significant challenges for the reconstructive surgeon.

The urinary cutaneous focus of this text will emphasize urethropubic, urethroperineal and urethrocutaneous fistulae. Unfortunately, iatrogenic mishaps can predominate the etiology of most acquired fistulae in this chapter.

Diagnosis and Evaluation

The presenting signs and symptoms of urinary fistulas are varied depending on the size, location, and specific circumstance of the lesion. Leakage may range from imperceptible to functionally debilitating. Fistulas distal to the continence mechanism often present with intermittent urinary seepage, a weak stream or spotting. Iatrogenic post-surgical complications are more obvious. New onset patient complaints include a split and secondary urinary stream or moisture in the undergarments.

Diagnosis and evaluation include a multimodal approach with imaging, endoscopy, and physical examination. The goal is to identify the size and location of the lesion, its anatomic relationships to other structures, and the availability and viability of surrounding tissues. Recognition of relevant comorbid conditions, such as additional fistulas or concomitant urethral strictures can influence further testing. A thorough physical exam is mandatory and may uncover relevant tissue concerns and penile anatomy.

Direct endoscopic visualization to assess location, complexity, and tissue quality guides treatment approach. Fistula identification can be a challenge. Simultaneous urethroscopy with wire or probe placement into the fistula can help locate the origin. Should clinical suspicion arise for malignancy, biopsy is indicated. Adjunctive CT imaging and T2-weighted MRI has been further applied to the work-up algorithm. Finally, various forms of fluoroscopy typically used include voiding cystourethrogram, retrograde urethrogram, or fistulogram.

Surgical Tenants

Spontaneous resolution of small fistulae with catheter diversion has been reported. Endoscopic interventions including tract cauterization or injection with biomolecules are limited with variable success rates based on limited data. Ultimately, less invasive treatments fail resulting in the need for surgical correction.

Many contributing factors influence both surgical plan and procedure. Expert opinions vary on the ideal timing for fistula repair. Although concerning for patient and family, urgent intervention is rarely indicated. The timing of surgical correction should optimize the chance for success.

Multiple operative repairs are described in the literature. Surgeon preference and experience usually dictates the timing, approach and technical nuances involved in reconstruction. Regardless, a series of well-established fundamentals guide fistula repair as summarized by Margules and Rovner (Table 21.1). Basic principles include (1) adequate exposure, (2) mobilization of well-vascularized tissue flaps, (3) carful dissection, and (4) separate, water-tight, tension free anastomoses with non-overlapping suture lines.

Fistula tract excision with primary closure is feasible when mobility, health and vascularity of surrounding tissues are robust. In this setting, success rates can be high. However, more complex fistulas are destined to fail without interposing tissue flaps. This is commonly seen with radiation, tissue ischemia, poor nutrition, inflammation/infection, and recurrent fistulas. The principal benefit of interposition includes separation of potentially overlapping suture lines and filling the intervening space with healthy well-vascularized tissue support. This maneuver can improve success even in the most hostile of fistula environments.

Table 21.1 Principles of urinary fistula repair

1. Adequate exposure of the fistula tract
2. Watertight closure of each layer
3. Well-vascularized, healthy tissue for repair
4. Good hemostasis and minimal use of electrocautery
5. Multiple layer closure
6. Tension-free, non-overlapping suture lines
7. Adequate urinary drainage after repair
8. Prevention of infection (use of pre-, post-, and intraoperative antibiotics)
9. Beware of malignant etiology of fistula (biopsy fistula tract if known history of malignancy)
10. Nutritional optimization

Congenital Fistula

Congenital Anterior Urethrocutaneous Fistula (CAUF)

Congenital anterior urethrocutaneous fistula (CAUF) is a rare anomaly defined as a localized defect in the penile urethra of congenital origin. Often seen as an isolated deformity that may accompany genitourinary or other malformations, limited information exists about this topic with clinical characteristics that are not properly defined [7–9]. Most information gathered about this condition comes from case reports or original articles with very limited patient populations [10].

The multifocal etiology of CAUF remains unclear with several pathogenetic theories to explain its causes [11–13]. Two such hypotheses are often cited. Olbourne theorized that fistulae located in the penile shaft likely reflects a focal or temporary defect in urethral plate function resulting in a complete or partial deficiency in urethral fistula with chordee [13]. Goldstein believed a transient deficiency in testicular evocator substance produces congenital urethral fistula with chordee [12]. Research continues to further define the prenatal factors preventing urethral fold fusion resulting in a focal urethral plate defect [11, 12].

In the largest series published by Caldamone et al., isolated CAUF's were divided into two types based on the presence of normal prepuce or absence of chordee: ruptured urethral diverticulum and variant of hypospadias. The former type may be caused by a blowout phenomenon of a urethral diverticulum [14]. This provides rationale for Matsumoto's description of a CAUF opening to the perineum in his case report [14].

To date, 65 cases of CAUF has been reported in the literature, demonstrating the rarity of this condition [10, 15]. In a systemic review by Lin et al. [10], subcoronal fistula was detected in 29 of 63 patients with CAUF, mid-penile shaft in 24, proximal penile to subcoronal in 4 and penoscrotal in 1. Subcoronal and midpenile locations are most typical for CAUF. With CAUF, associated penile and urethral anomalies encountered includes chordee, undescended testes, inguinal hernia, penoscrotal transposition, bifid scrotum, duplicated urethra, megalourethra, anorectal malformations and congenital heart disease. A thorough physical exam is required because associated findings may necessitate an alternative surgical approach to fistula repair [8].

Congenital Posterior Urethroperineal Fistula (CPUF)

Congenital posterior urethroperineal fistula (CPUF) is a urothelium-lined tract between the posterior urethra and perineum. This rare condition has been proposed to be a urethral duplication variant with 30 cases reported in the English literature [16]. Patients typically present without a history of anorectal malformations, perineal trauma, or pelvic surgery [17–19]. The penile exam is normal with complaints of perineal dribbling when voiding; however, patients are otherwise continent [20–22]. Other symptoms include perineal swelling and pain, perianal lesion and recurrent UTI's [17, 18, 20]. There may be a small dimple in the perineum with variable proximity to the anal verge [17, 18, 20]. Suprapubic compression can cause drops of urine to appear in the perineum [23].

The embryology of CPUF remains unclear. An abnormal midline fusion of the lateral ridges of the urorectal folds giving rise to an accessory urogenital sinus, which induces the development of a completely duplicated urethra of CPUF has been proposed [17]. CPUF may also result from a persistence of the mesonephric duct coupled with anomalous development of the urorectal septum [17].

Diagnosis can be challenging and may involve multiple studies. Voiding cystourethrogram (VCUG) or fistulogram through the perineal orifice may demonstrate a thin channel from the posterior urethra towards the perineum [17, 18, 20, 21]. Retrograde urethrogram may visualize the fistula with the potential for false negative [21]. Increased voiding pressures with Crede maneuver may help opacify the defect. A fluid-filled fistula arising from the posterior urethra exiting towards the perineum without rectal involvement can be seen with MRI [18, 19]. Cystourethrography can help identify the fistula opening in the posterior urethra while confirming dorsal urethral patency to the bladder [19]. Instilling methylene blue via the perineal opening of the fistula tract at the time of direct visualization with observation of flow into the prostatic urethra can aid diagnosis [24]. The internal opening is often found just proximal to the verumontanum on either side [24].

This rare entity mimics type II A2, Y-duplication described by Effmann et al. [24]. Y-duplication, a variant of hypospadiac urethral duplication, demonstrate a functional ventral urethra and a hypoplastic stenotic dorsal urethra. This is in contradistinction to CPUF with a hypoplastic ventral urethra and functional dorsal urethra [21]. Surgical correction is vastly different between the two entities. All treatments described for CPUF involve preservation of the dorsal urethra and excision of fulguration of the hypoplastic accessory ventral urethra [21].

Acquired Fistula

Post-circumcision Urethrocutaneous Fistula

Circumcision is one of the most common and oldest operations performed in the world. An estimated one in three men are circumcised globally [25, 26]. Worldwide public attention continues to drive voluntary medical male circumcision (VMMC). A 60% decrease of male HIV heterosexual transmission has been demonstrated with VMMC [25, 27, 28]. Although generally believed to be a minor procedure, complications continue with inexperienced personnel.

In the context of male circumcision, a urethrocutaneous fistula (UCF) is an acquired iatrogenic condition resulting from the procedure. Fistulas typically occur from damage to the urethral wall by cutting, crushing, or suturing near the frenulum, where the urethra is closest to the skin [25, 29, 30]. Injury risk is particularly greatest when attempting to achieve hemostasis at this location. During a 4-year campaign in Africa from 2015–2019 referred to as the President's Emergency Plan for AIDS Relief (PEPFAR), there were 41 UCF complications from 14.9 million male circumcisions [31]. With an estimated rate of 0.28 fistulas per 100,000 procedures, the median interval from circumcision to UCF appearance was 14–27 days [31].

Although highly concerning for patient and family, post-circumcision fistulas do not require urgent intervention. Important components of UCF care require a period of 3–6 months for fistula stabilization and conservative management that may include antibiotics, catheterization, and local wound care. There is potential for fistula closure with urinary diversion. For surgical correction, the critical components for repair technique must include gentle tissue handling, the use of fine sutures, a subepithelial urethral closure and the interposition of tissue to avoid direct contact of suture lines [32].

Spinal Cord Injury (SCI), Neurogenic Bladder and Urethrocutaneous Fistula

Neurologic insults secondary to trauma, neurological disease or congenital anomalies result in dysfunctional urine storage and voiding for the neurogenic bladder (NGB) [33]. Upper tract preservation combined with urinary control and improved quality of life are the primary goals in NGB management. Reliable urinary bladder drainage through various methods includes clean intermittent catheterization (CIC), indwelling catheters, suprapubic catheters, and condom sheath catheters.

Unfortunately, over time, these alternative drainage techniques can result in urethral erosion, urethral strictures and urethrocutaneous fistulae (UCF) [34]. Such factors contributing to UCF formation in the neurogenic population include infection or erosion of decubitus ulcers, wound infection or abscess formation, condom catheter complications, traumatic CIC, and pelvic trauma [35, 36]. Preventive measures emphasize proper catheter management to avoid sepsis, osteomyelitis and death because UCF's carry such a poor prognosis in this population [37, 38].

The most frequent cause of UCF is iatrogenic catheter related trauma. Lack of mobility and need for reliable bladder drainage often necessitates chronic indwelling urethral foley catheterization for many with NGB. Despite the many known risk factors associated with chronic catheters for this vulnerable population, a large multi-center French cohort revealed that one fourth of SCI patients had indwelling catheters for a median of 9 years [39].

The position of the male bulbous urethra is directly under the urogenital diaphragm and close to the perineal skin. Naturally, this anatomical location is subject to downward pressure. The urethra in this area is covered by the corpus spongiosum and enveloped by a thin membrane (tunica albuginea) that is easily injured. Therefore, the curve of the bulbous region is especially at increased injury risk when a urinary catheter is inserted, and an external force is exerted from the skin side.

Clean intermittent catheterization, the preferred method for bladder drainage when feasible, can decrease, but not eliminate the risk [40, 41]. However, the absence of penile sensation can also make repeated trauma more likely during CIC, increasing the possibility for penile fistula formation [40]. Surgical treatment of catheter-related defects requires fistula repair by excision and urethroplasty, either primarily or with grafting. Tissue interposition, if possible, is always recommended. Even with successful fistula repair, strictures are a common complication of urethral reconstruction which can make future catheterization impossible [41].

Specific to SCI patients, a pressure ulcer is the most common complication and cause for rehospitalization [42]. Approximately 30% are in the sacrum and perineum. Risk factors for pressure ulcers include ethnicity, completeness and level of lesion, low functional independence, previous pressure ulcer surgery, ischial lesion, pulmonary disease, hypoalbuminemia, anemia, and uncontrolled diabetes [43]. Despite preventive measures, decubitus ulcers complicated by UCF's present a real therapeutic challenge.

Case reports detailing perineal or sacral decubitus ulcers causing UCF exists in the literature, as extensive ulcers can erode into the membranous and/or distal penile segments of the urethra [44, 45]. Additionally, existing osteomyelitis or abscess formation can cause fistulization to the urinary tract [38, 46]. In these patients, spontaneous fistula resolution may be possible with diligent wound care, intravenous antibiotics, and frequent Foley catheter changes [44].

For chronic non-healing fistulae with decubitus ulcers, surgical intervention involving fistula resection with primary repair and urethroplasty may be successful [46, 47]. Complex cases require skin grafting, buccal grafts, tissue interposition or muscle flaps to facilitate closure of the defect [45, 48]. Unfortunately, surgical repair alone may be insufficient to lead to successful closure without permanent urinary diversion to allow for healing. Many in the reconstructive community strongly advise permanent urinary diversion as primary therapy for fistulae closure in this population [39]. Indeed, suprapubic tubes can prove to be the best long-term option for urinary control. If all else fails, urinary diversion with a conduit may be the last resort and hope for success.

Urethrocutaneous Fistula Following Hypospadias Repair

Hypospadias is the most common congenital anomaly in males and its true incidence appears to be increasing [49]. In boys with hypospadias, the urethra forms abnormally during weeks 8–14 of pregnancy. The abnormal opening can form anywhere from just below the end of the penis to the perineum. In its most simplistic form, hypospadias is classified into three different types: glanular (first degree), penile (second degree) and penoscrotal (third degree) [50, 51].

The goals of hypospadias repair include normal urinary and sexual function with acceptable cosmesis. Over 300 methods of surgical correction have been described with no one procedure accepted as the gold standard for each degree of hypospadias [52]. Despite advancements in the field, urethrocutaneous fistula (UCF) rates range from 4% to 28% [53]. Considered an acute post-operative complication related to surgical technique, 73–90% of UCF's present within the first year [54, 55].

Historically, post-surgical UCF rates indicate success of repair [56]. Even at high volume centers of excellence, baseline UCF complications are expected after correction. In fact, smaller fistulae less than 4 mm in diameter have a known recurrence rate of 2.5% demonstrating complexity of hypospadias repair [57]. Contributing factors associated with post-surgical UCF formation includes severity of hypospadias, patient age at the time of surgery, operative technique, surgeon experience, number of prior operations and post-operative distal urethral obstruction [58, 59].

The most frequently performed technique for single-stage primary hypospadias repair is the tubularized incised plate (TIP) urethroplasty [60]. This technique was first described by Snodgrass for correction of distal hypospadias, and its indication was then extended for mid-shaft and proximal penile hypospadias with no or mild curvature [61, 62]. During TIP repair, a U-shaped skin incision is made along the edges of the urethral plate and the penis is degloved. A midline incision is made to widen the urethral plate along its length, which is tubularized over a stent [61, 62]. Additional repair methods include onlay island flap (OIF) urethroplasty, such as the Mathieu procedure [61]. This approach utilizes a meatal-based skin flap that is turned 180 degrees and sutured into the incision on both sides of the glanular groove and along the tip. The skin on the penile shaft is mobilized and closed over the "flap gap" to complete tubular reconstruction [62]. Surgical correction for more proximal hypospadias with chordee, such as the Byars technique, is a 2-stage process that begins with a straightening procedure [63]. The more proximal the repair, the higher the likelihood of fistula formation, with scrotal and perineal areas presenting unique challenges and reoperation rates over 10% [52].

Much has been written about minimizing the risks of UCF after hypospadias repair. The major advancement in the twentieth century was the development of tissue barrier techniques to help prevent the development of fistulae [64, 65]. Both dartos fascia (DF) and tunica vaginalis flaps (TVF) have been utilized as suture line coverage during hypospadias correction, even well before Snodgrass popularized the TIP urethroplasty [65, 66]. Overall fistula rates have decreased for all repairs using single or double-layer DF or TVF coverage. UCF incidence for distal hypospadias was only 5.1% for single-layer and 0.6% for double-layer coverage [67]. For proximal hypospadias, the incidence was higher at 8.8% [67]. Urethral covering is now routinely performed by most surgeons to minimize fistula formation risk [62].

Urinary-Pubic Symphysis (Urosymphyseal) Fistula Following Radiotherapy

Urinary-pubic symphysis fistula (UPF) is an uncommon but severely debilitating complication following radiotherapy (RT) or energy ablation for prostate cancer (PCa) [68]. Radiation induced damage to cells and surrounding tissues develop fibrosis, reduced vascularity, and poor healing response. Chronic pelvic pain after surgery or radiotherapy for PCa is often diagnosed as osteitis pubis, osteonecrosis, or osteomyelitis [69–72]. If treatment refractory osteomyelitis progresses to incapacitating pain, urinary obstruction and urosepsis, clinical suspicion should arise for UPF [68, 73].

The direct fistulization from the urinary tract to the pubic bone or symphysis pubis is difficult to identify on conventional imaging. There is a paucity of literature regarding UPF, consisting mainly of case series for this under-recognized diagnosis. UPF can arise as the primary result of RT or because of repetitive endoscopic manipulation of treatment-refractory RT induced posterior urethral stenosis (PUS) [69–72]. Urinary extravasation into the retropubic space causes an uncontrolled urinary fistula and chronic infection within an irradiated field. Temporizing conservative management often fails and requires extensive surgical debridement and intervention [71, 74, 75].

Findings suggestive for UPF on preoperative urethroscopy include bladder neck sloughing, necrosis, dystrophic calcification, and cavitation [76]. The imaging gold standard T2-weighted MRI of the pelvis confirms the diagnosis of a UPF [76–78]. Combined MRI and cystoscopy enable the precise characterization of the fistula defect relative to the urinary sphincter complex and rectum, both of which are critical to operative planning [68]. Additional investigatory tools include retrograde urethrography for fistula visualization and CT-guided bone biopsy to help direct antibiotic management.

Definitive surgical management involves fistula decompression with debridement and excision of grossly infected bone combined with urinary tract reconstruction. For smaller fistulae, primary repair includes removal of the tract with urethral anastomosis. Interposition of omentum or local tissue advancement is prudent. Larger fistulae require utilization of muscle flaps with the potential involvement of plastic surgery. Failure of primary repair will oftentimes lead to permanent urinary diversion to achieve adequate urinary management.

Urethrocutaneous Fistula Associated with Urethral Calculi

Urinary urethral calculi are uncommon and account for 1–2% of all stones in the genitourinary tract [79]. Primary calculi formed de novo in the anterior urethra are small and come in multiples composed of magnesium ammonium phosphate (struvite) [80]. Upper tract stones with secondary downward decent are larger, located in the posterior and vesico-prostatic urethra and are predominantly composed of calcium oxalate or citrate [80, 81].

Predisposing factors for urethral stone formation include urinary stagnation, infection, and inflammation. Urethral stones are often associated with stricture disease or other forms of urethral obstruction [82]. The presenting symptoms often includes acute urinary retention, frequency, burning sensation in the urethra during voiding, perineal or rectal discomfort or a stinging in the anus. Other less common symptoms include hematuria, dribbling or incontinence, interruption of urinary stream and a history of stone passage [83]. Some patients can also be asymptomatic.

However rare, UCF secondary to urethral calculi result in serious discomfort for the patient. An important cause of UCF formation due to urinary calculi may be related to a delay in recognition, diagnosis, and treatment [83]. For example, a peculiar case report in the literature describes a large urethral calculus discovered in a urethral diverticulum causing a urethroperineal fistula [84]. Fistula excision and repair after removal of the offending stone applies to surgical corrective action in these patients.

Urethrocutaneous Fistula Secondary To Foreign Body

Retained foreign bodies (FB) in the urinary tract will fistulize over time. Whether intentionally placed or inadvertently left behind, the wide variety of objects and their unimaginable character makes the diagnosis and treatment a challenge [85]. Initial steps of fistula correction involve FB removal. Two examples will be given below.

Hong et al. describe an elderly gentleman suffering from intermittent gross painful hematuria, partial urinary retention, and dysuria [85]. Urethrography depicted a urethrocutaneous fistula to the low scrotum. Urethroscopy revealed a forgotten and amputated urethral catheter segment piercing through the bulbomembranous urethra to the scrotal skin. Careful endoscopic removal of the retained FB with several weeks of foley decompression resulted in spontaneous fistula closure.

In the early 2000’s, an off-label use of the bulking agent Tegress (C.R. Bard, Inc., Murray Hill, NJ) included the periurethral implant for post-prostatectomy incontinence [86]. Despite successful clinical trials, the ethylene vinyl alcohol co-polymer was reported in post-market studies to have a significant risk of urethral erosions [86]. A retrospective review of 17 men by Hurtado and colleagues reported 41% of men with subsequent UCF [87]. The manufacturer voluntarily withdrew the bulking agent form the market in December 2007.

Urethrocutaneous Fistula Following Penile Fracture

Penile fractures resulting in urethral injury can range from 1–38% of patients [88, 89]. Associated clinical findings include meatal blood, hematuria, or difficulty voiding. Diagnostic uncertainty and retrograde urethrography can produce a 28.5% false negative rate [89, 90]. Subsequent UCF formation from missed urethral injuries during penile fracture is well described in the literature [91].

Urethrocutaneous Fistula and Tuberculosis

Primary tuberculosis (TB) may manifest in the penis and urethra [92]. If left untreated, TB can extend into the urethra and corpus cavernosum resulting in cavernositis and a UCF [93, 94].

Urethrocutaneous Fistula and Squamous Cell Carcinoma

Non-healing penile, scrotal, and perineal wounds with passage of urine have been described in the literature as a rare presentation of squamous cell carcinoma (SCC) secondary to primary urethral carcinoma in men [95].

Urethrocutaneous Fistula and the Hair-Thread Tourniquet Syndrome

This pediatric emergency is characterized by progressive strangulation of an appendage by hair or thread. Up to 25% of cases involve the external genitalia [96]. Predisposing factors that favor this syndrome include a moist environment with nocturnal enuresis, lack of cleanliness, lower socioeconomic status and the presence of pubic hair that extends beyond the coronal sulcus in circumcised boys [97]. As a result of penile strangulation, obstructed venous drainage causes edema and tissue necrosis with eventual erosion into the urethra resulting in a UCF.

Conclusion

Urinary tract fistulas represent a complex group of pathologies with significant management difficulties. Regardless of etiology, urinary fistula formation is caused by many factors. There are many different types of urinary fistulae as demonstrated throughout this book. Depending on the type of lesion and severity, the medical impact can range from minimal to life-threatening infections. In cases where urinary or fecal continence is compromised, the psychological impact and effects on quality of life can be debilitating [1]. Ultimately, most fistulas require definitive surgical intervention with primary repair or permanent urinary diversion. Recurrence rates can be high; therefore, technical success presents significant challenges for the reconstructive surgeon.

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Part V
Fistulas After Gender Reassignment Surgery (GRS)

Chapter 22
Neovagina Fistulas

Min Suk Jun, Nkiruka Odeluga, and Richard A. Santucci

Introduction

Feminizing genitoplasty, commonly referred to as vaginoplasty, refers to the creation of two distinct feminine organs, the vulva and vagina. The vagina, which more specifically refers to the vaginal canal, exists to serve the dual function of relieving gender dysphoria and allowing for receptive vaginal penetration. Creating a vaginal cavity during feminizing vaginoplasty requires dissection deep into the perineum in a plane between the rectum posteriorly, and the urethra, prostate, and bladder anteriorly. This dissection is generally the most difficult portion of the procedure as the close apposition of these organs places them all at risk for injury. Inadvertent damage to the urethra, bladder, and rectum is the most serious complication and can develop into urethroneovaginal, vesiconeovaginal or rectoneovaginal fistula, respectively (Fig. 22.1). This chapter will focus on the prevention, diagnosis, and treatment of these entities.

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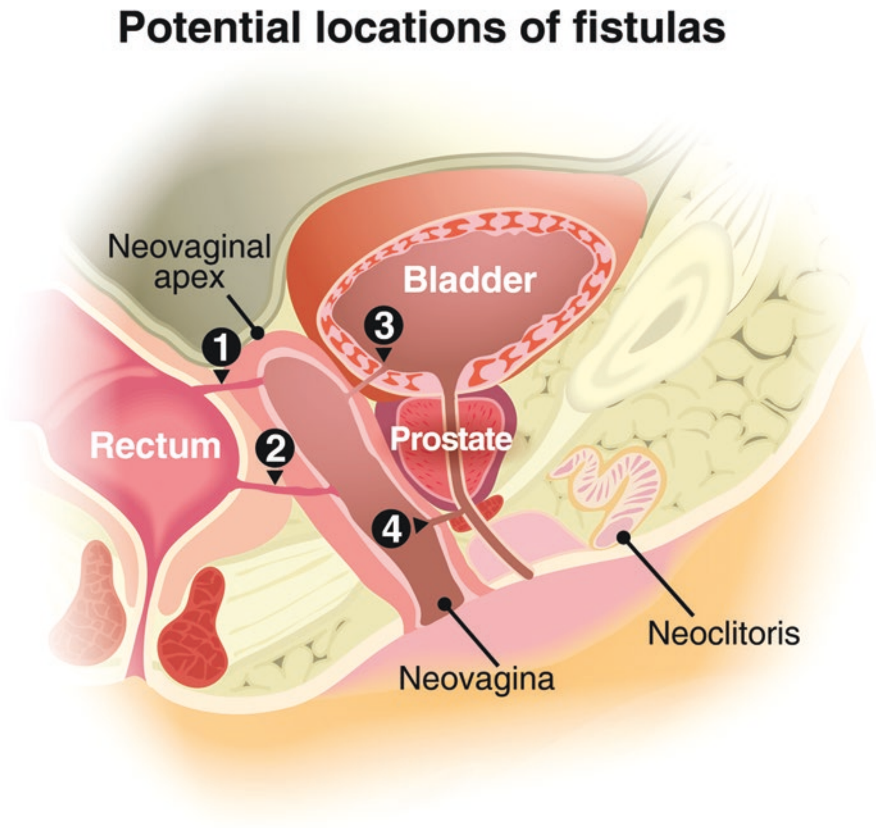

Fig. 22.1 Potential Fistula Locations. A sagittal vertical view of the location of the neovagina and potential locations of fistulas. Rectoneovaginal fistulas at the (1) apex of the vagina and (2) Level of the apex of prostate. (3) Vesiconeovaginal fistula. (4) Urethrovaginal at the level of the membranous urethra

Definition, Specific Considerations, Classification

To understand how injuries occur, one must understand the perineal anatomy germane to the creation of the vaginal canal. After harvesting the scrotal and perineal skin as a skin graft to line the vaginal canal, we dissect through Colle's fascia to the corpus spongiosum and the bulbospongiosus muscle overlying the bulbar urethra. This muscle is dissected free from its anterior and lateral attachments and is reflected posteriorly. This muscle remains attached posteriorly as it may serve as a useful well-vascularized interposition flap should a urethral or rectal injury occur in the following steps. A urethral catheter should be placed at this time if not already in place. Palpation of the catheter can aid in avoiding urethral injury. Dissection is carried along the posterior edge of the bulbar urethra as it curves superiorly toward the prostate and bladder. The perineal body can be palpated as this dissection progresses proximally, exposing the rectourethralis muscle beneath. Some surgeons advocate for the use of the Lowsley prostatic retractor for this portion of the dissection. The Lowsley retractor is an intraurethral device with arms that deploy in the bladder that allows for traction to be applied to the prostate. By using the pubic bone as a fulcrum, one can rotate the prostate into view. It has also been suggested that this maneuver will block the venous outflow of the urethra, making more apparent the boundaries of the bulbar urethra [1]. The dissection of this area, which includes the perineal body, rectourethralis muscle and prostatic apex is a critical one, as the rectum can be densely adherent. As such, while the rotation of the prostate with the Lowsley retractor can expose the prostate, it can also pull the adherent rectum into the surgical field, making this region one prone to rectal injury (Fig. 22.2). Hydrodissection with diluted epinephrine may also be useful in creating more space between these structures while also decreasing the risk of thermal injury by reducing the need for hemostasis with electrocautery. Digital rectal palpation may be useful during this critical portion of the dissection to more clearly delineate the rectal wall. While placing a rectal dilator may be useful for palpating the rectum, it can efface the rectal wall, potentially resulting in excessive rectal wall thinning and is avoided for this reason by some surgerons. In addition to the rectum, the membranous urethra is also located nearby and prone to injury. While the bulbar and prostatic urethra are relatively thick walled, the membranous urethral is very thin. As such, there is little margin of error if the dissection plane deviates anteriorly toward the urethra.

Once the rectourethralis muscle has been divided, the canal is widened by dividing the levator ani muscles laterally. Denonvillier's fascia will come into view and the potential space between its anterior and posterior layers are entered. This

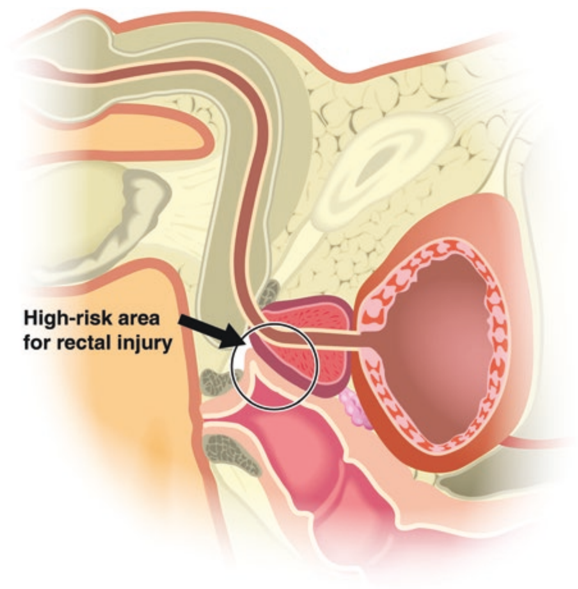

Fig. 22.2 High Risk Areas. The rectum can be tented up and closely attached to the apex of the prostate by the rectourethralis muscle, making it a high-risk area for rectal injury during vaginal canal dissection

potential space is developed with blunt dissection aided by the use of a lighted retractor, providing anterior retraction of the prostate and bladder. Despite the use of a lighted retractor, exposure can remain limited, and much of the blunt dissection within Denonvillier's fascia can be semi-blind. Though this avascular plane usually separates easily, one must remain vigilant during this dissection, as the prostate, bladder and rectum remain at risk for injury. The dissection is stopped once the target vaginal depth or the peritoneal reflection has been reached. If the peritoneum is perforated, it must be closed. This can be a difficult repair due to lack of exposure and the risk of bowel injury. It should be performed by placing the patient in Trendelenburg position to allow the bowel to fall superiorly. If bowel can be seen herniating through the perforation, negative abdominal pressure through forced expiration performed by the anesthesiologist may help.

Recently, robotically-assisted laparoscopic peritoneal flap vaginoplasty has emerged as a viable method for not only lining the superior vaginal canal with peritoneum, but also performing the vaginal canal dissection with robotic assistance [2–4]. In this technique, the peritoneum overlying the vas deferens as they converge medially is incised, similar to the posterior approach during a robotically-assisted laparoscopic radical prostatectomy. Dissection is advanced underneath the vas deferens and the space within Denonvillier's fascia is entered. The canal is widened and advanced with the benefit of laparoscopic vision until the pelvic floor is reached. A perineal dissection is performed as previously described up to the level of the prostatic apex. A thin layer of tissue remains between the dissection planes, which the perineal surgeon connects with the benefit of laparoscopic vision from within the pelvis to ensure dissection advances on the correct plane (Fig. 22.3). In their most recent update, the NYU group has reported 145 robotically assisted laparoscopic peritoneal flap vaginoplasty with one rectovaginal fistula that developed 2 weeks post operatively. No rectal injury was identified at the time of surgery [3].

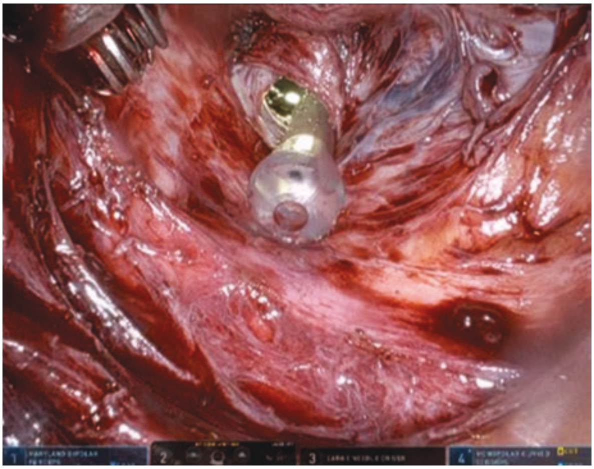

Fig. 22.3 Vaginal Canal Dissection. Dissection has been carried distially within Denonvillier's fascia with robotic assistance. This dissection plane is connected with the external dissection plane. A Yankauer suction tip can be seen placed through this connection. The rectum is below and the lower urinary tract is above

Classification, Clinical Features, Diagnosis

Urethroneovaginal fistulas can be distinguished based on their anatomic location. (i.e. bulbar, membranous, and prostatic urethroneovaginal fistulas). History and physical are usually sufficient to make the diagnosis, but additional studies, such as cystourethroscopy, retrograde urethrogram, or voiding cystourethrogram, may be required to make or further refine the diagnosis. Patients typically present at a median time to diagnosis of 5.3 months with symptoms such as urinary discharge thorough the neovagina while voiding, a splayed urinary stream, recurrent urinary tract infections, and position-dependent urinary discharge through the neovagina [4]. Bulbar urethroneovaginal fistulas are less consequential than membranous or prostatic fistulas since both continence mechanisms (rhabdosphincter and bladder neck) are proximal to the lesions. If the bulbar urethroneovaginal fistula is proximal enough so that the posteriorly deflected urinary stream fills the vagina with urine, post void dribbling or pseudo-incontinence may occur. Some patients may even present with a chief complaint of vaginal discharge. Some patients have no complaints at all, and the bulbar fistula is only incidentally found on physical exam. If the urethroneovaginal fistula is located at the membranous or prostatic urethra, then the patient may or may not experience incontinence. If the internal urinary sphincter (a.k.a. bladder neck) is competent, the patient may be continent. The symptoms, in this case, will mirror that of the proximal bulbar fistula, but with a higher chance of vaginal voiding since the fistula is more proximal. In a systematic review, Dunfort et al. reported urethroneovaginal fistula rates based on vaginoplasty technique, with incidences of 2.5% (21/853), 0.48% (3/626), and 0% (0/42) for penile inversion, penoscrotal, and intestinal vaginoplasty, respectively [5]. In the single largest series to date of 1082 patients, Van der Sluis et al. reported 11 urethroneovaginal fistulas (1%). In 6 patients (55%), the urethroneovaginal fistula occurred after a surgical complication such as meatal stenosis, partial or complete necrosis of the inverted penile skin flap, or partial or complete vaginal prolapse [6]. These factors, including distal urinary obstruction, should be seen as significant risk factors associated with the formation of urethroneovaginal fistula formation. It may be reasonable to consider treating meatal stenosis, even when asymptomatic, to prevent urethroneovaginal fistulas.

Vesiconeovaginal fistula is by nature a proximal entity and rarely occurs as the surgeon is dissecting the vaginal canal bluntly within Denonvillier's fascia at the level of the bladder. The largest incidence of vesiconeovaginal fistula was reported by Gaither et al. with 3 of the 330 (0.9%) primary vaginoplasties by an experienced surgeon [7]. While blunt dissection is generally considered safe, this does highlight the fact that even in experienced hands the dissection plane can deviate. If a bladder injury is identified at the time of vaginoplasty, every attempt should be made at repairing the bladder primarily followed by bladder drainage. The duration of bladder drainage will depend on the complexity of the injury and repair. With simple repairs, we remove the catheter after a week of drainage if a cystogram confirms that the bladder is completely healed. Removing the catheter after 14 days without a cystogram is also reasonable with simple injuries. For complex injuries, we prefer to keep the catheter in place for 14 days and will only remove it after a negative cystogram.

Rectoneovaginal fistula is perhaps the most dreaded complication of vaginoplasty, usually arising from a known or possibly undetected rectal injury during canal dissection. Intraoperatively recognized rectal injuries range from 0.4% to 4.2% while rectoneovaginal fistula formation rates range from 0.6 to 4.2% [1, 6–17]. The largest series of complications of vaginoplasty reported 23 (2.1%) intraoperative rectal injuries during 1082 total vaginoplasties. All were oversewn immediately followed by five days of a low-residue diet. These measures were sufficient to prevent the formation of rectoneovaginal fistula in 83% of these 23 patients. Despite these measures, 17% (4 of 23) went on to develop a rectoneovaginal fistula. Of the 13 total rectoneovaginal fistulas, 5 (38%) are presumed to be related to unrecognized intraoperative rectal injury. Notably, 5 rectoneovaginal fistulas resulted from 80 (6.3%) revision vaginoplasties, highlighting the increased difficulty in dissecting in a reoperative field. The authors note that 4 patients with rectoneovaginal fistulas were initially treated with a low residue diet, which succeeded in fistula resolution in 1 (25%) [6].

As one might glean from the van der Sluis experience, every effort should be made to repair intraoperatively identified rectal injuries in multiple layers. This will prevent most from developing into rectoneovaginal fistulas. However, one must recognize that a significant portion of rectoneovaginal fistulas result from unidentified iatrogenic injury during vaginoplasty, such as thermal injury. As such, thermal energy should be limited during the vaginal canal dissection. A digital rectal examination performed at the time of vaginoplasty might detect some unseen injury and areas of excessive rectal wall thinning. Mann et al. have adopted rectal examination with methylene blue dyed lubrication to enhance rectal injury detection [18]. Another option to confirm a possible rectal injury is to fill the vaginal cavity with irrigation and instill air per rectum. Rectal injuries will manifest as air bubbles per vaginal canal. If a rectal injury is particularly large, severe, or difficult to repair in multiple layers, one might consider immediate fecal diversion, but this may be extreme considering only 17% will proceed to form a fistula.

Rectoneovaginal fistula is typically an early complication, with the median time of diagnosis of 0.4 months [6]. Upon vaginal packing removal, patients will report symptoms of malodourous feculent discharge and flatus through the vagina. History and physical are usually sufficient to make the diagnosis, however in some cases further investigation with vaginoscopy, rectoscopy, fistulography, magnetic resonance imaging or computed tomography may be needed to diagnose or more precisely locate and characterize the fistula [19].

Treatment Approaches

Urethroneovaginal Fistula

Urethroneovaginal fistula repairs start with exam under anesthesia and cystoscopy to definitively identify the location of the fistula. A guidewire will be inserted into the fistula and delivered through the vagina. This can be repeated if more than one fistula is identified. Vaginoscopy may be additionally useful in identifying the precise location of the fistula.

Bulbar Urethroneovaginal Fistulas

Because an infrasphincteric urethroneovaginal fistula is distal to the external urethral sphincter, patients will not complain of continuous urinary leakage. Rather, the symptoms will consist mainly of splaying of the urinary stream and vaginal voiding. The degree of bother of these symptoms will vary. As such, the threshold for treatment should be congruent with the degree of bother to the patient. If splaying of the urine is present, it is likely due to what amounts to a tissue bridge distal to the fistula. Treatment will consist of lysing this tissue bridge. If a meatal stricture is also present, the urethra should be incised ventrally until normal caliber urethra is encountered. The urethra can then be matured in standard fashion.

When vaginal voiding is present and bothersome, fistula repair is indicated. If the fistula is very small (<5 Fr), it may be reasonable to divert the urine via a suprapubic catheter to allow for spontaneous closure, though evidence to support this practice after vaginoplasty is lacking. Since the fistula is distal to the urinary sphincters, there is no need for a drainage bag, and the patient can be given the option of clamping the suprapubic tube and emptying intermittently. If this fails, formal fistula repair should be performed. If the fistula is amenable to a primary repair that will not narrow the urethral lumen to less than 18 French, then the fistula can be approached transvaginally and ventrally. A fistulectomy is performed and the urethral muscosa is closed primarily with local advancement flaps in multiple layers and running fashion with absorbable suture. This was sufficient in the Van der Sluis et al. experience for most of their 11 urethroneovaginal fistula repairs. Two of these patients required additional suprapubic urinary catheterization for full resolution [6]. Alternatively, the fistula may be closed transversely in a Heineke-Mikulicz fashion to avoid narrowing the urethral caliber. If a primary fistula repair will significantly narrow the urethra or if there is a concomitant urethral stricture, a buccal graft urethroplasty is indicated. Of note, the buccal graft cannot be placed ventrally since there is a dearth of vascularized tissue to support the graft. Therefore, the buccal graft will need to be placed dorsally. This can be accomplished by using a dorsal inlay technique [20] in the style of Asopa [21].

Membranous Urethroneovaginal Fistula

To our knowledge, membranous urethroneovaginal fistulas have not been reported in the literature. That said, it would represent a considerable challenge. If the patient is continent, this would suggest that the bladder neck is competent in its role as a continence mechanism. As such, any of the previously mentioned techniques may be employed in the repair of this fistula. Importantly, a membranous urethroneovaginal fistula should be approached perineally to avoid iatrogenic damage to the bladder neck, which could lead to urinary incontinence. If the patient has a membranous urethroneovaginal fistula and is incontinent, this suggests that the bladder neck is not fully functional as a continence mechanism. The fistula should be repaired as described previously, but with an emphasis on minimizing dissection to conserve any remaining function of the rhabdosphincter. If the patient shows signs of stress urinary incontinence despite successful fistula closure, pelvic floor strengthening exercises should be encouraged.

Prostatic Urethroneovaginal Fistula

The prostate is highly vascular and easily palpable during vaginoplasty. As such, injury to the prostatic urethra with resulting prostatic urethroneovaginal fistula is uncommon unless there is a predisposing factor, such as previous transurethral resection of the prostate or other ablative treatments for enlarged prostates. Due to the ablation of the bladder neck commonly seen with these procedures, one can expect patients with prostatic urethroneovaginal fistulas to be incontinent. Traditional techniques such as gracilis flap interposition would narrow the neovagina due to the flap's significant bulk. To circumvent this, Sager et al. have described their technique for this type of fistula via a lateral approach to avoid the neovagina, incising the urethra dorsally. A buccal mucosa graft was then inlaid in the style of Asopa. The urethra was then rotated anteriorly to close the fistula in multiple layers. Of note, the patient in this case report regained continence after this procedure [20].

One can also approach a prostatic urethroneovaginal fistula abdominally, especially if the injury is especially proximal or also involves the bladder. A robotically assisted laparoscopic approach might be useful, due to difficulty with visualization with a traditional open approach. Furthermore, a perineal approach would risk damage to the rhabdosphincter since one would need to dissect through or very near this structure in order to expose the fistula. An abdominal approach would minimize risk to the rhabdosphincter as one can avoid it all together. Once the fistulectomy is completed, the urethra can be closed primarily or with a buccal mucosal graft as a dorsal inlay. Omentum can then be interposed between urethra and neovagina if there is insufficient local tissue to close in multiple layers. Alternatively, peritoneal flap vaginoplasty may be performed, which will double as a well-vascularized interposition and vaginal deepening procedure [4].

Vesiconeovaginal Fistula

Exam under anesthesia, cystoscopy, and vaginoscopy should be used at the beginning of the repair to identify the fistula, and to place a guidewire through it. If the fistula is near the ureters, one might consider placing a ureteral catheter to aid in identifying the ureters intraoperatively. Due to their proximal nature, vesiconeovaginal fistulas should be approached abdominally. We prefer a robotically assisted laparoscopic approach due to its excellent reach and visualization. The fistula can be approached directly by separating the bladder and neovagina. As one approaches the fistula, a vaginal dilator should be placed to assess the vaginal caliber. We prefer to leave more tissue on the neovagina to avoid neovaginal stenosis upon closure of the neovaginal defect. The bladder defect should be closed in standard 2-layer fashion with running, absorbable suture. The bladder is usually robust and heals well as these patients tend to be young and healthy, but if there is any concern that the fistula may reform, a well-vascularized interposition should be performed with omentum or peritoneum. If the patient requires vaginal canal revision, a peritoneal flap or colon vaginoplasty may be used as it will double as a well-vascularized interposition layer. Alternatively, the fistula can be approached transvesically and closed in similar fashion, though one cannot place an interposing layer with this technique. A vaginal pack should be placed for 1–7 days postoperatively, and urinary catheter should be left in place for 7 to 10 days. The patient should resume vaginal dilation with a vaginal dilator one size smaller than what the vagina was calibrated to during the repair.

Rectoneovaginal Fistula

If a rectoneovaginal fistula is identified at the time of vaginal pack removal, one must decide whether or not to initiate vaginal dilation. While continued dilation may preserve the vaginal canal, it would at the least impede spontaneous fistula closure while at worst enlarge it, increasing the need for a fecal diversion. Thus, it is our practice to tend towards having our patients refrain from dilating. This conservative approach, combined with a low residue diet, can lead to spontaneous closure of the rectoneovaginal fistula, especially if it is small. It will likely lead to the need for revision vaginoplasty as the vagina will stenose, but this is preferred over a fistula repair with the possible need for a fecal diversion. Alternatively, if the vagina is dilated despite the presence of a rectoneovaginal fistula, the fistula is unlikely to spontaneously close. This does give the patient a chance at maintaining vaginal depth and caliber, though the vagina is still at peril since a fistula repair must be performed at a later time. Additionally, it is difficult to recommend dilation as Dy et al. have recently demonstrated a safe and reliable means of deepening a vaginal canal after vaginal stenosis through robotic peritoneal flap vaginoplasty [4]. Ultimately the path chosen by the patient and surgeon depends on the capabilities of the center. For example, if robotics is not available as a means of revision vaginoplasty, it may be best to preserve vaginal caliber and depth because a rectoneovaginal fistula repair is more realistic than a revision vaginoplasty. In that scenario, a reasonable compromise might be to resume dilation after refraining for 2 weeks.

Perhaps the most difficult decision is that regarding fecal diversion. While a low residue diet and abstinence from vaginal dilation can lead to spontaneous fistula shrinkage or closure, fecal diversion, usually through loop ileostomy, would likely enhance this effect. Evidence is insufficient, however, to quantify just how much fecal diversion would increase the likelihood of fistula shrinkage or closure. Regardless of fecal diversion status, fistula repair should not be pursued for at least six months to allow for residual inflammation to abate. One should investigate the fistula at the end of this “cool down” period. While we prefer MRI with rectal/ contrast, other investigational modalities include but are not limited to barium enema CT, exam under anesthesia, colonoscopy, and vaginoscopy. These studies are especially important if the patient was diverted and flatus and feces per vagina has ceased. One must be certain that the fistula has closed before reversing the fecal diversion.

If the rectoneovaginal fistula persists, strong consideration should be given to fecal diversion if repair is planned. If a previous thorough repair ultimately fails, we consider this an absolute indication for fecal diversion. If the rectal injury was identified during the index vaginoplasty and closed primarily, one should consider one of the following alternative or adjunctive technique since primary closure previously failed. In our practice, the approach we take is dependent on the fistula location. If the rectoneovaginal fistula is distal to the pelvic floor muscles, a perineal approach is preferred. Once the fistulectomy is complete, a primary repair can be performed with interposition of a well-vascularized flap in the form of a gracilis flap. While this is an excellent technique for fistula closure, the bulk of the gracilis muscle may compromise the vaginal lumen, sometimes severely enough that it impedes receptive vaginal intercourse. An alternative technique is a pedicled pudendal thigh flap as an island flap (Singapore flap). This has be used as a sensate and reliable flap for vaginal reconstruction [6, 22] and has also been successfully used in the repair of rectovaginal fistulas [23]. Of note, this technique can be particularly useful if there is concurrent introital stenosis.

For fistulas at or proximal to the pelvic floor muscles, we prefer a laparoscopic approach with robotic assistance. A horizontal peritoneal incision is made at the level of the seminal vesicles and dissection is carried in the plane between the prostate and rectum and advanced distally towards the vaginal apex. A vaginal dilator is placed in the vaginal canal to aid in vaginal identification. Dissection is directed towards the fistula. By nature, the rectum is in close proximity to this dissection; therefore, concurrent transrectal ultrasound can be helpful to gauge rectal proximity to avoid additional injury to the rectum. Once the fistulectomy is complete, the rectum is primarily closed. Peritoneal flaps will then be dissected, and the posterior

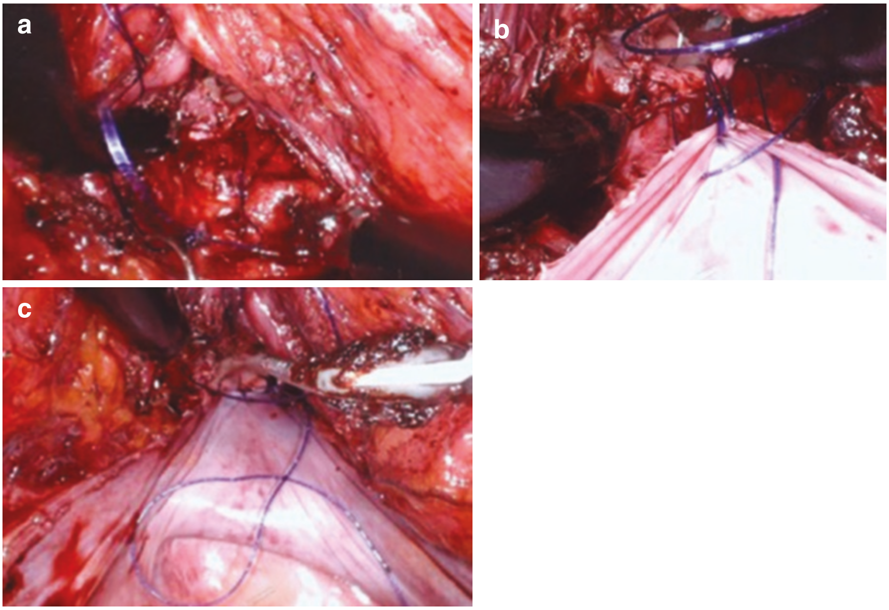

Fig. 22.4 Robotic Rectoneovaginal Fistula Closure and Peritoneal Flap Interposition. (**a**) The rectoneovaginal fistula is dissected free and closed primarily. (**b**) The edge of the vaginal canal is anastomosed to the peritoneal flap, which will serve as a well-vascularized interposition layer. (**c**) Completed posterior peritoneal flap closure. (With permission from Lee Zhao and NYU Urology)

peritoneal flap will be anastomosed to the edge of the vaginotomy. This serves as a well-vascularized interposition without overlapping suture lines while simultaneously augmenting the vaginal canal as described by Dy et al. [4] (Fig. 22.4). Alternatively, the vaginal canal is adequate, the vaginotomy may be closed primarily with an intervening layer of omentum between the rectal and vaginal closures. Yet another option is to augment the canal with bowel, which like peritoneum, will also serve as a well vascularized interposition.

Conclusions and Recommendations

The current state of feminizing vaginoplasty reflects a very individualized practice pattern with little high-quality data to guide the surgeon through the treatment of complex problems, such as the neovaginal fistula. We remain hopeful that this field will accelerate greatly in the near term as greater acceptance for transgender health results in more experience and higher quality research. This chapter and the following recommendations represent what is known about the treatment of the neovaginal fistula and our anecdotal experience in how to approach specific issues.

- Urethroneovaginal fistulas are divided anatomically.
  - Bulbar fistulas are treated expectantly. Tissue bridges are lysed to treat spraying. Formal fistula repair is performed if bothersome vaginal voiding or recurrent urinary tract infections are present.
  - Membranous fistulas are generally approached perineally with careful dissection to minimize damage to the rhabdosphincter. Fistulas are repaired primarily. A buccal mucosa graft can be used if the urethral lumen is compromised.
  - Prostatic fistulas can be approached perineally if the bladder neck is intact. Otherwise, an abdominal approach is preferred to avoid damage to the rhabdosphincter. Fistulas are repaired primarily. A buccal mucosa graft can be used if the urethral lumen is compromised.
- Vesiconeovaginal fistulas are generally approached abdominally. A primary repair is usually sufficient as the bladder wall is typically highly vascularized.
- Rectoneovaginal fistulas result from rectal injury. Every effort to detect and repair rectal injuries at the time of index vaginoplasty should be performed.
  - We suggest not dilating once the fistula is detected with a low-residue diet to encourage spontaneous closure. Repair should not be attempted for at least six months.
  - Fistulas resulting from unrecognized rectal injury can be initially approached with a primary repair.
  - Fecal diversion is helpful but is ultimately it is up to the individual surgeon to decide when to perform this. All patients who fail an initial repair should be diverted.
  - Fistulas distal to the pelvic floor can be approached perineally and closed primarily with an interposing Singapore or gracilis flap.
  - Fistulas proximal to the pelvic floor can be approached abdominally. After primary repair, an interposition layer should be placed with omentum, peritoneum, or rectus flap.
  - If vaginal canal deepening is required, robotic peritoneal flap vaginoplasty has emerged as an excellent means to do so. Other techniques includes intestinal vaginoplasty.

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Chapter 23
Neopenis Fistulas

Brenna Briles and Richard A. Santucci

Abbreviations

ALT	Anterolateral thigh
GAS	Gender affirmation surgery
RFFF	Free radial forearm flap

Introduction

Genital gender affirmation surgeries (GAS) are sometimes used as a component of surgical transition for transgender individuals experiencing gender dysphoria. These include feminizing (vaginoplasty) and masculinizing (phalloplasty, metoidioplasty, penile/testicular implants) procedures that are customized to the individual needs of the patient. Such gender affirming surgeries have been associated with increased gender congruence [1] (agreement between gender identity and body characteristics) and decreased need for psychological treatment of gender dysphoria [2].

Due to the amount of reconstruction involved, complication rates of masculinizing genital surgery remain of concern, particularly of transmasculine patients compared to cismale patients. An aggregate study of 1216 patient, 856 of whom were transmale and 360 cismale, found urethral complication rates after phalloplasty of

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39.4% and 24.8%, respectively [3]. Urethral fistula rates may be as high as around 50% after phalloplasty and 25% for after metoidioplasty, [4] although our high-volume group has achieved much lower fistula rates: 22% for ALT phalloplasty and 10% for RFF phalloplasty [5]. Metoidioplasty is usually associated with lower rates of urethral fistulae due to the less extensive urethral lengthening and reconstruction that is required. Free radial forearm flap (RFFF) phalloplasty, the most common type of phalloplasty, has been associated with urethral fistula rates between 10%–68% [6]. In the specific case where RFFF is performed after previous metoidioplasty, the fistula rate was 30%, although rates have declined significantly with the development of new urethroplasty techniques [5]. Common sites for urethral fistulae include the ventral shaft of the phallus and at the perineum-scrotal junction. For phalloplasty specifically, the pars fixa/pars pedulans junction [4] is the most common site of fistulae formation.

Definition, Specific Considerations, Classification

Phalloplasty

Phalloplasty involves complete phallic reconstruction from a donor site, usually from the forearm or thigh, although less commonly the latissimus dorsi (MLD) can be used. The RFFF is the most commonly selected method today, likely owing to its many advantages over the ALT: higher density of neuronal and vascular networks (to maintain cutaneous sensation and prevent flap loss), pliability of the skin (to construct the pars pedulans and penile neourethras simultaneously), and thin graft size in patients with large body habitus [7]. Disadvantages include limitations on phallic length depending on the length of the arm and presence of scarring in a relatively more visible area. The ALT phalloplasty affords advantages such as the potential for longer phallic length and girth, a donor scar site that is more easily hidden, and avoiding microvascular connection as the ALT flap is transferred on its pedicle. However, it is also associated with significant complications such as unnaturally widened girth due to presence of more subcutaneous fat in the thigh necessitating phallic liposuction or plication, lower nerve density which may or may not result in clinically meaningful decreases in sensation, and the tendency towards a higher degree of partial flap loss due to lower vascular density [7].

Commonly, phalloplasty is accompanied by vaginectomy, urethroplasty, and scrotoplasty if desired. Owing to the short length of the natal female urethra, significant urethral lengthening and reconstruction must be performed in order to achieve standing micturition. The pars fixa (perineal) urethra is created from bilateral mucosal flaps from the tissue underneath the clitoris and on either side of the vagina. It bridges the space between the native urethral orifice and the pars pedulans (penile) urethra at the base of the phallus. Construction of the penile urethra is generally a "tube within a tube" design. The penile flap is rolled such that one 4.5 cm edge creates the urethra, and the rest of flap is rolled to create the phallus around the urethra. A small 1 cm portion of the graft is de-epithelialized to allow for tensionless closure of the neourethra, while its inner surface remains cutaneous. Other techniques for urethral reconstruction have been used: in ALT or MLD phalloplasty the urethra may be constructed with a separate RFFF urethral free flap, or urethral construction may be staged by construction of the phallus followed by insertion of a urethral graft later on [7], although the staged or multiple-flap procedures are not generally performed at our center. The anastomosis between the pars fixa and pars pedulans urethras is the most common site of urethral fistula formation after phalloplasty. This is likely due to the relatively poor areas of perfusion at the edges of either flap meeting at the anastomosis [8].

Metoidioplasty

Metoidioplasty involves phallic reconstruction using native genital tissues, namely the native clitoris that is enlarged with hormone therapy. Patients may choose this type of masculinizing genital surgery due to concerns about donor site morbidity and neophallus complications like urethral fistulae, urethral strictures, and flap loss. Simple metoidioplasty consists of primarily clitoral lengthening alone, while any combination of scrotoplasty, vaginectomy or urethral lengthening may be chosen in a “full metoidioplasty” procedure [9]. Simple metoidioplasty is associated with the lowest complication rates of phallic reconstruction, considering that urethral lengthening, scrotal construction, or vaginectomy are generally not also performed [10].

Metoidioplasty with urethral reconstruction is generally performed in an identical fashion as for phalloplasty. The ventral chordee is relieved by a Heinicke-Mikulicz-type transverse urethral plate incision which is closed vertically. Rates of urethral fistula formation in patients with this technique have been reported between 10% and 26% [9]. Other techniques, such as augmenting the dorsal urethral plate with buccal grafts have been described [11].

Clinical Features and Diagnosis

Preoperative imaging studies are not strictly required, as the clinical diagnosis of fistula is usually obvious. Cystoscopy at the start of the repair surgery is always performed, and fistula anatomy confirmed, although preoperative cystoscopy or urethrography may be performed if desired.

Phalloplasty & Metoidioplasty: Small Fistulae

Small fistulae are those <5 mm that typically occur from the fusing of the ventral urethral suture line to the penile skin suture line (Fig. 23.1), creating an epithelialized fistula. Patients with these fistulae typically present as one would expect, with an errant urine stream coming out of the fistula hole.

Phalloplasty: Large Fistulae

Large fistulae after phalloplasty are those >5 mm that usually occur from dehiscence of the penile urethra (Fig. 23.2). These fistulae are larger and often have an intact, dehisced, urethral plate which is clinically obvious. These are typically identified by patient complaint and by physical exam alone.

Fig. 23.1 Repair of small ventral neophallus urethrocutaneous fistula using standard multilayer closure

Fig. 23.2 Repair of large ventral neophallus base urethrocutaneous fistula, caused by actual dehiscence of the urethral tube. Technique is identical to the closure of a second stage Johansen urethroplasty defect

Metoidioplasty: Large Fistulae

Large fistulae usually occur in metoidioplasty patients who haven't had vaginectomy, and are found at the native urethra/pars fixa junction (Fig. 23.3). They are similar to large phalloplasty fistulae in that the urethral plate is often preserved, but is ventrally dehisced and wide open. These fistulae are very common in those who do not elect simultaneous vaginectomy, as a second layer flap of bulbospongiosus muscle is not available to augment the first layer of mucosal flap urethral construction, resulting in much higher urethral failure rates [12].

Treatment Approaches

Several techniques have been employed to accompany phalloplasty to decrease the likelihood of fistula formation. For phalloplasties with simultaneous vaginectomy, components of the endogenous genital tissues are used to reinforce the integrity of the neourethra: the bulbospongiosus muscle is wrapped around the proximal pars fixa as a second layer suture line and the distal pars fixa is wrapped in labia minora tissue,

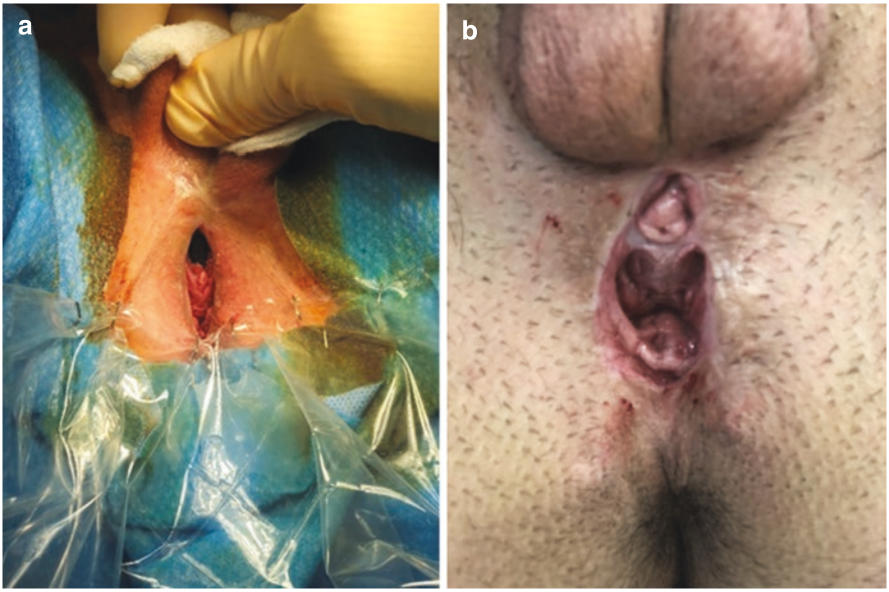

Fig. 23.3 (**a**) Urethrocutaneous fistula occurring at the proximal aspect of the pars fixa and native urethra junction in a patient with vaginal sparing metoidioplasty. This complication is very common when perivaginal tissues are not available to provide second layer closure of the pars fixa urethra. (**b**) Second exemplar of urethrocutaneous fistula after metoidioplasty with urethral lengthening, occurring as it often does, at the anastomosis to the native urethra

once the full length of the bulbospongiosus is used. Patients undergoing simultaneous vaginectomy using these techniques have been associated with significantly lower rates of urethral complications than those with vaginal preservation [12]. Some techniques (other than thorough second layer closure with bulbospongiosus tissue proximally, and periurethral tissue distally) have been described to decrease urethral fistula rates, but none have been proven sufficiently enough to be used widely, such as gracilis muscle flaps augmentation of the ventral urethral suture line. Experimentally, human chorion/amnion membrane (Amniofix; MiMedx; Marietta, Georgia, USA) as a second layer appears promising, but no clinical data supporting its use yet exists [8].

The principles of successful fistula closure are classically described: watertight, multilayer, tensionless closure using well-vascularized tissue. Repair should not be performed until all inflammation has cleared and induration has returned to baseline. In some cases, the surgical bed is not ideal and must be improved through surgical effort (such as adding graft to enlarge an open urethral plate before closure).

Urethral fistulae may occur as a symptom of a more distal urethral stricture, and this entity should be ruled out and/or surgically addressed at the time of fistula repair. After urethral fistula repair, urinary diversion using a suprapubic or urinary catheter is mandatory for a period after surgery, usually 21 days in our hands. Successful repair can be documented with urethrography before catheter removal, if desired [10].

After identification by cystoscopy, small fistulae are excised and healthy surrounding tissues are brought together in multi-layer closure (urethra, surrounding tissues, and outer skin), as shown in Fig. 23.1. The closure site can be supported by using a variety of grafts, such as the gracilis, fasciocutaneous groin, and labial fat pad, although not generally done at our center except for the most recalcitrant fistulae. Buccal mucosa may be used due to its histologic similarity to urethral epithelium, low donor site morbidity, and low rates of complications, but any suitable graft may be used to enlarge the urethral plate if need be. The gracilis muscle graft is bulky and is only used as a last option at our center.

Large fistulae are repaired in a similar method as a second-stage Johansen urethroplasty. Three options are presented for the repair of these large fistulae, depending on the state of the surgical bed and size of the urethral plate. First, repair may proceed as a second stage Johansen urethroplasty. Second, if the urethral plate is not large enough to achieve tensionless closure, fistula repair may be staged with the placement of a cutaneous graft followed by a waiting period of 6 months then closure of the urethral plate. At our center, cutaneous grafts are harvested as full thickness skin grafts and subsequently thinned to partial thickness. Lastly, a graft may be placed to widen the urethral plate and immediately closed in a single stage. This option is typically avoided, as it is difficult to monitor the state of the graft after closure.

Conclusions

Urethral fistula rates following masculinizing GAS have decreased over time from rates as high as 70% in 1987 to as low as 10% in more recent reports [13]. Improvements in surgical technique have contributed to the decline. The extensive nature of urethral reconstruction involved in masculinizing genital GAS should prompt diligence in fistula prevention. Repair of fistulae follows established principles: tensionless, watertight, multilayer, well-vascularized repair.

Recommendations

1. Vaginectomy accompanying phalloplasty or metoidioplasty allows the use of local genital tissues (bulbospongiosus muscle) as a well vascularized second urethral support layer and is associated with significantly lower rates of urethral fistulae.
2. Staging has not been shown to significantly decrease the rates of urethral complication [7, 8].
3. Prevention of fistula formation is aided by meticulous technique, in-depth anatomical knowledge, and surgical experience by a dedicated transgender surgery team.
4. Adherence to classical principles such as using tensionless closure technique, healthy vascularized tissues (grafts and surgical bed), and non-overlapping suture lines should be followed as closely as possible to maximize the chance of repair success.

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Part VI
Complications After Fistula Repair

Chapter 24
Complications of Vaginal Fistula Repair

M. Sherif Mourad and Ahmed Maher Gamil Ahmed Higazy

Abbreviations

BNO	Bladder neck obstruction
DO	Detrusor overactivity
ICS	International Continence Society
OBS	Overactive bladder syndrome
SUI	Stress urinary incontinence
UTI	Urinary tract infections
VVF	Vesicovaginal fistula

Introduction

Surgical repair of vaginal fistulas can reach a success rate of up to 90% for uncomplicated cases. Two weeks or more are needed to ensure a successful outcome. Counseling and support are also valuable to address the emotional damage and facilitate social reintegration.

The complications related to the obstetric fistula or the surgical intervention to repair are many and these include:

- Infections: wound, urinary tract infections (UTI), pyelonephritis, and/or urosepsis.
- Recurrent Fistula:

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  - The success rate of uncomplicated vesicovaginal fistula (VVF) is 70–80%.
  - The success rate of complicated VVF is 50–60%.

- Voiding Dysfunction.
- Ureteric obstruction (ligation – fibrosis – injury).
- Outlet obstruction (meatal stenosis, urethral stricture, bladder neck obstruction [BNO]).
- Bladder contracture.
- Vaginal stenosis (overcorrection—fibrosis).
- Sexual dysfunction (vaginismus—dyspareunia).
- Rare complications (granulomas—diverticulum formation).
- Neurological complications (foot drop—neurogenic bladder).
- Complex neuropathic bladder dysfunction and urethral sphincter incompetency often result, even if the fistula can be repaired successfully.
- Psychological trauma (social isolation—divorce).

Assessment of Fistula

Fistula size, site, number, and location are crucial for a successful repair that would render the patient fully dry following a successful surgery. Clinically, it will be important to assess the number of fistulae, surrounding fibrosis present, and if there is the involvement of the ureters and or the urethra.

A complaint of refractory leakage needs to be evaluated properly. First, to assure fistula closure. This simply can be done by placing a balloon catheter into the bladder, occluding the bladder neck, and filling the bladder with a solution of water colored with indigo carmine or methylene blue. If the fistula has not been closed successfully, the leakage should be readily apparent.

To differentiate transurethral incontinence from a urethrovaginal fistula, it could be done simply by occluding the urethral meatus and asking the patient to strain and examine for leakage.

Limited data from urodynamic studies by Carey and Goh *et al.* suggest that detrusor overactivity and changes in bladder compliance are frequent causes of urinary incontinence in fistula patients with post-repair incontinence. This is in addition to the leakage resulting from successful closure but persistent intrinsic sphincter deficiency [1, 2].

Overactive Bladder After Vaginal Fistula Repair

Despite successful anatomical repair of VVF, the patient may still complaint of urine leak. Failure to store urine is another problem that may occur after vaginal fistula repair. This is caused by what is called the "Overactive Bladder Syndrome" (OAB).

According to the ICS definition of 2002, OAB is urgency, with or without urgency incontinence, usually with frequency and nocturia, if there is no proven infection or other obvious pathology [3].

Although urine incontinence following fistula repair tends to be linked to urethral dysfunction, a few urodynamic studies suggested that bladder dysfunction may play a role [2, 4].

It is often assumed that OAB (a symptomatic diagnosis) is caused by detrusor overactivity (DO; urodynamic diagnosis), even if this does not always seem to be the case [5, 6].

A small study of 22 women who underwent urodynamic studies to evaluate post-surgical repair urine incontinence revealed that a total of 41% suffered from urodynamic stress incontinence, while 41% had a combined urodynamic stress incontinence and detrusor overactivity, 14% had a small non-compliant bladder, and 4% of the patients had a voiding disorder and overflow incontinence. The results are different from the leakage that occurred through the original fistula [2].

Because of these concerns regarding the incidence of both sphincter involvement or functional abnormalities of the lower urinary tract with VVF, it is important to counsel patients regarding the postoperative outcome.

In the Addis Ababa Fistula Hospital, they recorded the incidence of abnormal lower urinary tract function in VVF patients. Out of the 38 patients, 47% developed stress incontinence, 40% showed detrusor instability, and 17% presented with impaired bladder compliance while fifteen patients had more than one abnormality. It was noted that functional abnormality was higher in those patients with urethral or bladder neck fistulae. Eventually they concluded that many of these abnormalities appear to resolve after an early successful surgical repair of the fistula, although detrusor instability may persist for a longer time and require further treatment in some women [7].

Urge-related voiding dysfunction can be managed with antimuscarinic drugs. In cases where there has been extensive tissue loss of the bladder or in case of poor bladder compliance due to fibrosis, augmentation cystoplasty can be performed, using a segment of the bowel. In some cases, urinary diversion may be indicated, but only after careful discussion of the issues involved with the patient [8].

Contracted Bladder as a Complication of VVF Repair

The contracted urinary bladder is a recognized complication of VVF, however, there is limited data available in the literature. Nardos and colleagues mentioned that among 1045 women who underwent a repair of obstetric VVF, 17% suffered from small bladder capacity postoperatively. They also reported that small bladder capacity is considered a major risk factor for failure of VVF repair [9].

contracted bladder probably resulted from a substantial loss of bladder tissue during the pathogenesis of obstetric VVF or repeated repair and tissue scarring. It is very difficult to diagnose this problem pre-operatively except in very obvious cases. It is crucial during the surgical repair of the VVF to spare much bladder tissue as possible. Contracted bladder can be one of the causes of persistent incontinence after successful repair of VVF with a poor outcome. At that time, the diagnosis should rely on filling cystometrogram, which typically shows a small cystometric capacity [10–12].

The only treatment option available for a contracted bladder is an augmentation cystoplasty since pharmacological manipulation, detrusor botulinum toxin injection, and neuromodulation is unlikely to work because the problem is primarily myogenic [12].

It is wiser to postpone treatment of contracted bladder with a VVF until the successful repair of the fistula is achieved. Nevertheless, a group in India attempted to repair complex VVF and augment the bladder with the ileum during the same procedure. Their repairs were successful in all the four cases they treated, in three of these cases, the fistula was obstetric in origin, and one was secondary to genital tuberculosis [13]. Eilber and colleagues suggested that an abdominal approach to repair the fistula could be utilized if bladder augmentation is planned simultaneously [14].

Urinary Tract Infection

On rare occasions, a urogenital fistula may be causally related to infective pathologies (like schistosomiasis, tuberculosis, or actinomycosis) representing (0.3%) of the reported cases in the literature as an infective etiology for VVF [15–17].

Urinary tract infection (UTI) is relatively uncommon in women with fistula, given the free drainage of urine from the bladder, and few of such patients may suffer voiding dysfunctions. A UTI may however be seen as a complication of surgical repair of the fistula or of the prolonged catheter drainage that usually follows such procedures.

Ayed et al., based on a multivariate analysis of a retrospective cohort, reported that UTI before the repair was an adverse prognostic factor for successful surgery ($p = 0.03$); the OR however was not significant (OR 2.72; 95%CI 0.69, 12.1) making the conclusions of the study of limited significance (69). In a small series of post-hysterectomy fistulas; managed by laparoscopic, open abdominal, or vaginal repair; Ou et al. reported only a single episode of UTI following a vaginal procedure (1 out of 6 cases), and none following the alternative approaches [18].

Chigbu et al. reported no difference in the rate of successful fistula closure or postoperative UTI between abdominal and vaginal repair procedures in women with juxta cervical fistulas. The numbers of patients included, and the methodology used in these reports makes conclusions on the relative rate of UTIs following different repair procedures inappropriate [19].

Contracted Vagina, Dyspareunia, and Sexual Dysfunction

The problem of cicatrization in association with vesicovaginal and urethrovaginal fistulas is well recognized and known to be more associated with obstetric fistulas related to obstructed labor, or post-radiation fistulas than with other etiologies. In the first case, acute ischemia occurs as a result of prolonged unrelieved pressure on the bladder base and urethra by the fetal presenting part. In the second case, progressive devascularization occurs as a result of chronic endarteritis, which may be progressive over several decades [10, 12].

The extent of the scar has been considered an important predictor of the surgical success of VVF fistula repair and has been incorporated into fistula classification systems. Muleta and colleagues reported severe vaginal scarring or obliteration in 14.9% of 14,373 women undergoing obstetric fistula repair in Ethiopia. The impact that this scarring may have on subsequent sexual function has been little investigated [7, 20–23].

Sexual symptoms following pelvic surgeries especially vaginal surgeries are well recognized and has been reported before in many reports, especially in the context of urinary incontinence procedure and pelvic organ prolapse surgeries.

In a study of quality of life four years after VVF anatomically successful repair, both urinary and sexual symptoms were found to be common and were reported with approximately twice the prevalence of the local population of comparable age. Whilst the residual urinary symptoms had little impact on the quality of life for the majority of women, the persistent sexual symptoms were reported as "quite a problem" or "a serious problem" by 27%. No comparable prevalence data for sexual dysfunction in obstetric fistula patients have been identified from the literature [24, 25].

Urethral Complications of Vaginal Fistula Repair

Urethral complications of obstetric genitourinary fistula can occur as a complication of genitourinary fistula repair or can be associated with it. These complications include urethrovaginal fistula, urinary incontinence, obstruction secondary to stricture, and extensive fibrosis.

Urethrovaginal fistula is a distinct type of fistula that has to be differentiated from VVF. It can occur as a standalone fistula or can accompany a VVF. Furthermore, it can extend to involve the bladder neck, and the trigone. Incontinence and obstruction are other consequences that can occur after the repair of genitourinary fistulas [26, 27].

Obstructed labor is the main cause of obstetric urethrovaginal fistula from extensive fibrosis and ischemic necrosis. A urethrovaginal fistula may occur alone or associated with VVF and in some rare cases as a complication of surgical repair of VVF [27–29].

Stress urinary incontinence (SUI) can result after treating urethrovaginal patients. It is not clear from the literature whether SUI that occurs after the repair of the urethrovaginal fistula in over half of the patients is secondary to the repair of the fistula or was a sequel of the original pathology. During the repair of such pathology, intrinsic sphincteric deficiency may occur resulting in stress incontinence. In contrast, urethral stenosis and obstructive symptoms may also complicate such a repair [30].

In a study by Hilton et al., including a review of 25 years of surgical experience in VVF fistula repair in Nigeria, urethrovaginal fistula compromised 2.8% of 2484 patients presented with urogenital fistula, most of them are of obstetric etiology (92.2%) [26]. Similarly, Raassen et al., found that urethral involvement occurred in 5% of patients with obstetric urogenital fistulas [30].

When patients were categorized according to urethral status by Lewis et al., the success rate was 84%, 51%, and 71% for patients with intact, partially damaged, and complete destruction of the urethra, respectively [29]. In contrast, another study by Raassan Et al, couldn't find this influence of urethral involvement on the repair results. In that study, the patients were categorized according to the Waaldijk classification. Involvement of the urethra didn't influence the results of the repair in a multivariate analysis [30].

Pushkar and colleagues suggested repairing the urethrovaginal fistula by circumferential incision involving the fistula. The urethra is then mobilized and closed transversely to avoid constriction of the urethra. They advised against extensive trimming of the fistula edges since there are usually minimal tissues left for repair. They tested the urethra for any residual opening using a metallic sound inserted in the urethra. A second layer from the periurethral tissues was placed before closing the vagina. A urethral catheter is placed for 6–9 days. Using this technique obtained a success rate of 90.14%. Recurrent fistulas were re-repaired and were successful in all but one patient [27].

The use of an intervening layer is always advisable. Martius labial fat pad flaps are the most easily accessible and the most used flaps [10, 27, 31].Others have described the use of peritoneal flaps with similar success to that of the Martius flap although most of the fistulas in that report were non-obstetric. They have shown as well that the use of full-thickness labial flaps is feasible [32].

Bruce and colleagues have described the use of the rectus abdominis muscle flap as an intervening layer between the urethral and the vaginal layers [33]. The use of autologous fibrin glue has been shown to function equally to the use of Martius graft in the complex genitourinary fistula. The clear advantage of this was shown in the form of decreasing the complexity of an already complex procedure and decreasing operative time. Additionally, it doesn't preclude the use of Martius graft simultaneously [34].

Stress Urinary Incontinence Post-Vaginal Fistula Repair

Stress urinary incontinence is the most prevalent complication of the repair of genitourinary fistula in one of the studies. It was reported in a study by Lewis et al., over 505 patients. The incidence rate was about 10% of the patients. Unfortunately, it was not further analyzed as regards the etiology of this incontinence [29].

In another study by Murray et al., 55% of 58 patients complained of persistent incontinence after successful closure of the genitourinary fistula. Urodynamics showed that 31% had stress incontinence, 4% due to detrusor overactivity and 20% had mixed incontinence [35].

The original site of the fistula and whether it involves the urethral closure mechanism has a direct relation to the post-repair occurrence of stress urinary incontinence. Raassen et al., demonstrated that if the original site of the urogenital fistula is more than 5 cm from the external urethral meatus (Type I of Waaldijk classification), the incidence of postoperative stress urinary incontinence is significantly lower than if the fistula is less than 5 cm from the external meatus (Type II). Involvement of the urethral closing mechanism and circumferential fistula (with destruction of the bladder neck) leads to a significantly higher incidence of postoperative stress urinary incontinence as compared to those cases without involvement of the urethral closure mechanism and those without circumferential fistula [30].

Stress urinary incontinence that develops after urethrovaginal fistula repair can be treated with a suburethral sling, whether autologous or synthetic. Most of the patients in one study by Pushkar et al., (59.46%) were objectively cured, while 32.43% expressed they were satisfied, and 8.11% of the patients remained incontinent [27].

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