Urinary Fistulas

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1. Introduction

A fistula is defined as an extra-anatomic communication between two or more epithelial or mesothelial-lined body cavities or the skin surface. The potential exists for fistula formation between any portion of the urinary tract (kidney, ureters, bladder, and urethra) and virtually any other body cavity including the reproductive organs, gastrointestinal tract, chest (pleural cavity), lymphatics, vascular system, genitalia, and skin. Fistulas are named based on the two organ systems which are communicating (**Table 1**).

Key words: fistula; urogenital fistula; vesicovaginal fistula; vaginal fistula; urinary fistula; urinary bladder fistula

Table 1. Urinary Tract Fistulas. Fistulas are named based on the two anatomic structures in communication.

Name	
Urogynecologic Fistulas	
Vesicovaginal Fistula	Bladder and Vagina
Ureterovaginal Fistula	Ureter and Vagina
Vesicouterine Fistula	Bladder and Uterus
Urethrovaginal Fistula	Urethra and Vagina
Uroenteric Fistulas	
Vesicoenteric Fistula	Bladder and Intestine
Colovesical Fistula	Bladder and Colon
Ureteroenteric Fistula	Ureter and Intestine
Pyeloenteric Fistula	Renal Pelvis and Intestine
Rectourethral Fistula	Urethra and Rectum
Urovascular Fistulas	
Renovascular Fistula	Kidney and Vasculature
Pyelovascular Fistula	Renal Pelvis and Vasculature
Ureterovascular Fistula	Ureter and Vasculature
Other Fistulas	
Nephropleural Fistula	Kidney and Lung Pleura

Nephrobronchial Fistula	Kidney and Bronchia
Vesicocutaneous Fistula	Bladder and Skin
Ureterocutaneous Fistula	Ureter and Skin
Urethrocutaneous Fistula	Urethra and Skin
Pyelocutaneous Fistula	Renal Pelvis and Skin
Nephrocutaneous Fistula	Kidney and Skin

2. Risk Factors and Pathophysiology

Table 2. Etiology of Urinary Tract Fistulas
Parturition, -Prolonged Obstructed Labor, Obstetric Trauma/Forceps Laceration, Uterine Rupture
Post-Operative/Iatrogenic -Gynecologic, Urologic, Pelvic Surgery, Use of Synthetic Mesh
Congenital Anomalies -Cloacal Variants
Malignant Disease -Cervical, Vaginal, Endometrial, Bladder, Colon Cancer
Inflammation -Endometriosis, PID, Urethral diverticulum
Infection -Perirectal Abscess, Diverticulitis
Ischemia
Radiation Therapy -External Beam, Brachytherapy
Foreign Body -Neglected Pessaries, IUD
Trauma -Sexual Violence, Penetrating Renal Trauma

Fistulas may occur as a result of: **(i) childbirth** (the most common etiology worldwide) **(ii) congenital anomalies (iii) malignancy (iv) inflammation and infection (v) radiation therapy (vi) surgical injury or (vii) external tissue trauma, (viii) foreign bodies (ix) ischemia**, and a variety of other processes (**Table 2**).[1,2,3] Most fistulas in the industrialized world are iatrogenic. **Vesicovaginal fistula (VVF)** is the most common acquired fistula of the urinary tract and as the name suggests is a communication between the bladder and vagina.

In the developing world where routine obstetrical care may be limited, VVFs most commonly occur from prolonged obstructed labor with resulting pressure necrosis and tissue ischemia to the pelvic floor (**Figure 1**).[4,5] The anterior vaginal wall, trigone and urethra generally experience the greatest direct pressure from the trapped fetus.[5] In some instances, VVF may result from the use of forceps or other instrumentation during operative delivery. Obstetric fistulas tend to be larger, located distally in the vagina, and may involve the proximal urethra. The constellation of problems resulting from obstructed labor is not limited to VVF and has been termed the **"obstructed labor injury complex"** and includes varying degrees of each of the following: **urethral loss, stress incontinence, hydroureteronephrosis, renal failure, rectovaginal fistula, rectal atresia, anal sphincter incompetence, cervical destruction, amenorrhea, pelvic inflammatory disease, secondary infertility, vaginal stenosis, osteitis pubis, and foot drop**.[6]

Post-hysterectomy VVFs are thought to result most commonly from an **unrecognized cystotomy** near the vaginal cuff (**Figure 2**). Other potential contributing causes include suture placement into the bladder leading to pressure necrosis and tissue loss, improper clamp placement or use of cautery, and infections of the vaginal or perivaginal tissues. The operative approach to hysterectomy is an important factor, as bladder injuries are at least two times more common during laparoscopic hysterectomy compared to total abdominal hysterectomy, and the rate of bladder injury may also be higher during robotic hysterectomy.[2,7] Subtotal abdominal hysterectomy and vaginal hysterectomy have lower risk of fistula.[8] **Risk factors for VVF after hysterectomy include: large cystotomy size, greater tobacco use, larger uterine size, longer surgery time, and more operative blood loss** .[9,10] Fistulas are more common in women who are over 50 years of age at the time of hysterectomy, presumably due to estrogen deficiency and resultant changes in vaginal tissue quality.[8]

Ureterovaginal fistulas form between the ureter and the vagina. Most ureterovaginal fistulas are secondary to **unrecognized distal ureteral injuries** sustained during gynecologic procedures including laparoscopic, abdominal or vaginal hysterectomy, caesarean section, prolapse surgery and **anti-incontinence surgery**.[11] The injured ureter spills urine into the peritoneal or extraperitoneal space which then leaks out of the vaginal cuff.[12] Occasionally, ureterovaginal fistulas may be secondary to endoscopic instrumentation, radiation therapy, pelvic malignancy, penetrating pelvic trauma, or other pelvic surgery (vascular, enteric, etc.). Risk factors for ureteral injuries include a prior history of pelvic surgery, endometriosis, radiation therapy, and pelvic inflammatory disease (PID); however, many ureteral injuries occur without an identifiable risk factor.[12,13] **Up to 12% of vesicovaginal fistulas may have an associated ureterovaginal fistula**.[14,15] Mixed reports exist on the preventative value of preoperative ureteral stenting; but, ureteral injury rates may lower with the

use of ureteral stenting in women undergoing major pelvic surgery.[16]

Urethrovaginal fistulas form between the urethra and vagina. Urethrovaginal fistulas are usually post-surgical in the industrialized world (urethral **diverticulectomy**, anti-incontinence surgery, anterior vaginal wall prolapse repair, etc.), although they may occur as a result of trauma, instrumentation (catheterization), radiation, pelvic fracture, vaginal neoplasm and childbirth (**Figure 3**).[17]

Enterovesical fistulas may form between any segment of bowel in the pelvis (colon, ileum, etc.) and the bladder. The most common cause of enterovesical fistula is diverticular disease of the colon.[18] Other common causes include neoplastic disease (colon cancer), inflammatory bowel disease (Crohn's disease), radiation therapy, and trauma.

Rectourethral fistulas (RUF) form between the rectum and the urethra.[19] RUF occur following prostatectomy for benign or malignant disease, anorectal surgery, external beam radiotherapy for pelvic malignancy, pelvic brachytherapy or cryotherapy, inflammatory diseases of the pelvis (e.g., prostatic abscess, Crohn's disease), or following penetrating pelvic trauma.[20] During radical prostatectomy, the anterior rectal wall may be injured during dissection of the apical portion of the prostate. A postoperative RUF may form from the reconstructed vesicourethral anastomosis to the injured portion of the rectum.[21] In the setting of radical prostatectomy, a prior history of pelvic radiation therapy may be associated with an increased risk of RUF.[21]

Urovascular fistulas form between the urinary tract and the vascular system and most commonly occur between the ureter and surrounding blood vessels such as the iliac artery. Risk factors include percutaneous procedures to the upper urinary tract, indwelling ureteral stents, vascular disease, prior pelvic surgery and radiation.[22]

Vesicouterine fistulas generally form between the bladder and the lower segment of the uterus; however they can also occur at the level of the cervical os. These are rare fistulas that most commonly occur following low-segment caesarean section.[23,24]

3. Epidemiology

The World Health Organization estimates that there are 100,000 new cases of urogenital fistula per year worldwide and that 2 million women with fistulae are untreated.[25] These numbers likely underestimate of the true incidence since many patients in developing countries lack access to care. The most common cause of VVF differs in various parts of the world.[5] **In the United States, the most common cause is injury to the bladder at the time of gynecologic surgery—usually hysterectomy for benign conditions (80%)**.[26] Obstetric events (10%), surgical intervention for gynecologic malignancy (5%), and pelvic radiotherapy (5%) are less common etiologies of VVF.[26]

In sub-Saharan Africa the incidence rate of obstetric VVF has been estimated at 10.3/100,000 deliveries.[27]

The incidence of iatrogenic **ureteral injury** during major gynecologic surgery is estimated at 0.03-1.5%.[7] In a large prospective contemporary study from Finland, the incidence of ureteral injury

associated with benign hysterectomy was 0.2% (10/5,279).[28]

The incidence of **urethrovaginal fistulas** is extremely low with the majority occurring due to obstructed labor in the developing world. In the industrialized world, the frequency appears to be increasing secondary to iatrogenic injury of the urethra at the time of sling surgery.[29,30]

The risk of **enterovesical fistula** formation in patients with diverticulitis is approximately 1-4%.[31] The vast majority of these fistulas are colovesical. The risk of fistula in patients with Crohn's disease is 2-5% with most of these fistulas being ileovesical. Approximately 0.5% of colon carcinomas lead to fistula formation.[31]

The risk of **rectourethral fistula after** radical prostatectomy is approximately 0.5%.[21] The risk of RUF after brachytherapy for prostate cancer is 0.2% but increases to 2.9% for combined treatment with external beam radiotherapy.[32] The risk associated with cryosurgical ablation of the prostate for localized disease is 0.5-2% while it's use for salvage therapy has a risk of 3.3%.[33,34,35] The risk of RUF after high-intensity focused ultrasound (HIFU) is approximately 2%.[3]

Urovascular fistulas are rare with the most reported type being ureteroiliac artery fistula.[36] Of the 37 patients summarized by Batter et al., 68% had prior pelvic surgery, 65% had ureteral stents, 46% had prior radiation therapy, 19% had prior vascular surgery and 19% had vascular pathology. All patients had at least one risk factor.

The incidence of **vesicouterine fistula** is extremely low with only 100 cases reported in the world literature between 1908-1986.[37] Vesicouterine fistulas represent approximately 1-4% of urogenital fistulas but their presence appears to be increasing with the more frequent use of cesarean section.[38] They most commonly occur after lower segment cesarean section (83%) but can also occur following long protracted labor, operative vaginal delivery, vaginal delivery after cesarean section, uterine rupture, intrauterine device, or tuberculosis of the genital tract.[23]

4. Diagnosis and Evaluation

The presenting signs and symptoms[39] of urinary tract fistulas are variable and depend to a large degree on the involved organs, the presence of underlying urinary obstruction or infection, the size of the fistula, and associated medical conditions such as malignancy. The most common complaint with VVF is constant urinary drainage per vagina, although small fistulas may present with intermittent wetness that is positional in nature and mistaken for stress incontinence. VVF must be distinguished from **urinary incontinence** due to other causes including stress (urethral) incontinence, urgency (bladder) incontinence, and overflow incontinence. Patients may also complain of recurrent cystitis, perineal skin irritation due to constant wetness, vaginal fungal infections, or rarely pelvic pain. When a large VVF is present, patients may not void at all and simply have continuous leakage of urine into the vagina. VVF following hysterectomy or other surgical procedures may present on removal of the urethral catheter or may present 1-3 weeks later with urinary drainage per vagina. VVF resulting from hysterectomy are usually located high in the vagina at or just anterior to the vaginal cuff. VVF resulting from radiation therapy may not present for months to years following completion of radiation.

These tend to represent some of the most challenging reconstructive cases in urology due to the size, complexity, and the associated voiding dysfunction due to the radiation effects on the bladder. The tissue ischemia that results from radiation therapy may involve the surrounding tissues, limiting reconstructive options.

A pelvic exam with a speculum should always be performed to locate the fistula and assess the size and number of fistulas present. Palpation to assess for masses or other pelvic pathology, which may need to be addressed at the time of fistula repair, should be performed. Additionally, an assessment of inflammation surrounding the fistula is necessary as it may affect timing of the repair. Instilling blue dye into the bladder and observing for discolored vaginal drainage can confirm the presence of a VVF. A double dye test may confirm the diagnosis of urinary fistula as well as suggest the possibility of an associated ureterovaginal or urethrovaginal fistula. To perform this test a tampon is placed in the vagina, oral phenazopyridine is administered, and blue dye is instilled into the bladder. If the tampon is discolored yellow-orange at the top, it is suggestive of a ureterovaginal fistula. Blue discoloration in the midportion of the tampon suggests VVF, whereas blue staining at the bottom suggests a urethrovaginal fistula. **Diagnosis and localization of urinary tract fistulae and evaluation of concomitant injury or pathology generally involves the use of voiding cystourethrography, urography (intravenous, CT or retrograde pyelography) or other cross-sectional imaging, with or without endoscopic evaluation**.

Voiding cystourethrography (VCUG) can be used to assess the size and location of a vesicovaginal or urethrovaginal fistula. Some small fistulas may not be seen radiographically unless the bladder is filled and a detrusor contraction is provoked. VCUG can also assess for vesicoureteral reflux. Intravenous urography, computed tomography urography (CTU) and/or retrograde pyeloureterography (RPG) can assess for concomitant ureteral injury, stricture, and/or ureterovaginal fistula, which has been reported to occur in up to 12% of patients with VVF. [14] Contrast material in the vagina, air in the bladder, and bladder wall thickening are signs suggestive of the presence of a fistula. Cross-sectional pelvic imaging (magnetic resonance imaging [MRI]/computed tomography [CT]) is recommended if malignancy is suspected. CT cystography can be useful when VCUG is nondiagnostic for reasons such as large body habitus or when the fistula tract is small.

Cystoscopy and possible biopsy of the fistula tract are performed if malignancy is suspected. Cystoscopy allows visualization of the location of fistula relative to ureters since repair of the fistula may require ureteral reimplantation if the fistula involves the ureteral orifice(s). In addition, cystoscopy provides an assessment of whether the fistula repair is feasible with a vaginal approach compared to an abdominal approach. The presence of foreign bodies including suture material, mesh and/or bladder calculi is also assessed (**Figure 4**).

Ureterovaginal fistulas may present with clear drainage per vagina or unilateral hydroureteronephrosis and flank pain secondary to partial ureteral obstruction. Flank pain, nausea, fever, and clear vaginal drainage following pelvic surgery are very suggestive of ureteral injury. Patients will have a normal voiding pattern if the contralateral kidney is unaffected. **Ureterovaginal fistula is generally evaluated with intravenous urography or CT urography**. A urogram may

demonstrate partial obstruction, hydroureteronephrosis, and drainage into the vagina. Cystoscopy and retrograde pyelography can be performed to evaluate for bladder injury and to visualize the distal ureteral segment if not well seen on the urogram. An attempt at retrograde stenting is reasonable if the pyeloureterogram demonstrates ureteral continuity. **Prolonged internal diversion (6-8 weeks) with ureteral stenting may result in resolution of the fistula. When possible, this is the first step in management according to the 2020 AUA Urotrauma Guideline**.[40] Cross-sectional imaging with CT or MRI may be useful to evaluate for pelvic malignancy when indicated or to evaluate for a urinoma in patients with persistent fevers. In cases in which a long segment of distal ureter is involved and a Boari flap is being considered for reconstruction, a cystogram or **cystometrogram** may be useful to evaluate the bladder capacity.

Percutaneous nephrostomy and antegrade nephrostogram can be helpful especially in situations where complete occlusion of the ureter exists. Percutaneous drainage of the involved kidney followed by antegrade instillation of contrast can provide decompression of a partially obstructed kidney as well as anatomic localization and demonstration of the fistula. As well, according to the 2020 AUA Urotrauma Guideline, when a fistula involving the kidney exists after renal trauma, urinary drainage is indicated. [40]

Urethrovaginal fistulas are often asymptomatic if located in the distal third of the urethra (beyond the continence mechanism); otherwise, the presentation is similar to VVF. Occasionally, these patients may present with symptoms suggestive of stress or urgency incontinence and cystourethrography along with a detailed pelvic exam is necessary to make the diagnosis. Dyspareunia or recurrent urinary tract infections (UTIs) are sometimes seen. Urethrovaginal fistulas are generally evaluated with voiding cystourethrogram (VCUG). Voiding images must be obtained in patients with a competent bladder neck and proximal sphincteric mechanism or the fistula will not be demonstrated. Cystoscopy is useful to evaluate for concurrent abnormalities of the bladder and urethra and to specifically assess for the presence of any mesh material from prior sling and/or residual urethral diverticulum.

Enterovesical fistula may present with recurrent UTIs, fecaluria, pneumaturia, and hematuria. Presentation with sepsis or GI symptoms is rare. Gouverneur's syndrome (suprapubic pain, urinary frequency, dysuria, and tenesmus) is the hallmark of enterovesical fistula.[41] Evaluation may include a charcoal test, which includes the oral administration of activated charcoal. Several hours after ingestion, flecks of charcoal may be noted in the urine. Cystoscopic visualization has a very high yield for the identification of enterovesical fistula with 80 to 100% of cases demonstrating bullous edema, erythema, or exudation of feculent material from the fistula site. Generally, colonic fistulas occur on the left side and dome of the bladder, whereas small bowel fistulas occur on the dome and right side of the bladder. Biopsy of the fistula is indicated in cases in which malignancy is suspected. Colonoscopy and/or barium enema are useful to evaluate the intestinal lining. Although less common than diverticular disease, it is important to exclude primary intestinal malignancy as the cause for the fistula. CT or MRI with oral, rectal, or intravesical contrast is generally considered to have the best diagnostic yield. Air in the bladder in the absence of prior lower urinary instrumentation (cystoscopy,

catheterization, etc.) is highly suggestive of an enterovesical fistula. The triad of **findings on CT that are suspicious for colovesical fistula consist of (i) bladder wall thickening adjacent to a loop of thickened colon, (ii) air in the bladder, and (iii) the presence of colonic diverticula**. VCUG may demonstrate the fistulous connection in some cases.

Rectourethral fistula may present with recurrent UTI, fecaluria, pneumaturia, or urine per rectum.[42] In RUF forming after prostatectomy, a defect may be palpable at the level of the vesicourethral anastomosis. If a Foley catheter is indwelling, it may be palpable on rectal exam. VCUG will often demonstrate a fistula between the rectum and urethra. Intravenous or CT urography may be utilized if there is concern for ureteral injury and barium enema may be helpful to rule out concurrent colonic malignancy. Cystoscopy and/or colonoscopy will help visualize size, location, and extent of tissue involvement. CT or MRI may be utilized to evaluate for inflammatory collections or other pelvic masses (e.g., malignancy).

Urovascular fistulas may present with vigorous hematuria in the setting of a chronic indwelling stent in a previously irradiated patient or a patient with a history of vascular surgery. If the patient is stable, imaging studies including CT, MRI, or angiography may be indicated to identify the location of the fistula.

Vesicouterine fistulas may present with **Youssef's syndrome**: menouria, apparent amenorrhea, patent cervix, and urinary continence. VCUG or CT cystography generally demonstrate the fistula. When the fistula occurs below the level of the internal os, total urinary leakage per vagina is typical.

5. Treatment

Treatment of urinary fistulae depends on several factors including its **location, size, etiology (malignant or benign), and surrounding tissue quality**. The importance of timely and successful repair cannot be overstated. This condition has a profound impact on patient wellbeing with nearly approximately 50% of individuals experiencing anxiety and depression. Successful repair can markedly improve mental health.[43]

5.1 Non-surgical management VVF

Effective conservative management of urinary tract fistulae with maximal drainage and diversion of urine (and stool, when involved) may obviate the need for surgical intervention. Foley catheter drainage is the initial treatment in most cases when the VVF is recognized early in the clinical course and an epithelialized tract has not yet had an opportunity to form. Antibiotics, anticholinergics, and topical estrogen creams are adjuvant measures to prevent infection, promote bladder relaxation and facilitate healing. Fulguration of the fistula tract with electrocautery followed by catheter drainage has been shown to have some efficacy in very small (< 5 mm), uncomplicated fistulas. Adjuvant measures such as fibrin glue have been reported in small series in conjunction with fulguration and catheter drainage as a “plug” in the fistula as well as “scaffolding” to allow the ingrowth of healthy tissue. Platelet-rich plasma, a novel therapeutic with tissue regenerative and repairing capacity, has been proposed as a neoadjuvant treatment prior to surgery for recurrent VVF.[44,45]

5.2 Surgical management VVF

Table 3. Surgical principles of urinary tract fistula repair.
Adequate exposure of the fistula tract with debridement of devitalized and ischemic tissue
Removal of involved foreign bodies or synthetic materials from region of fistula, if applicable
Careful dissection and/or anatomic separation of the involved organ cavities
Watertight closure
Use of well-vascularized, healthy tissue flaps for repair (atraumatic handling of tissue)
Multiple layer closure
Tension-free, nonoverlapping suture lines
Adequate urinary tract drainage and/or stenting after repair
Treatment and prevention of infection (appropriate use of antimicrobials)
Maintenance of hemostasis

Surgical intervention for urinary tract fistulae involves **multi-layer**, **tension free**, **closure with interposition of well-vascularized tissue**. Adherence to basic surgical principles is essential to achieve successful repair of all urinary fistulas (**Table 3**). The timing of the repair should take into consideration the degree of inflammation present, presence of infection, general health and nutritional status of the patient, as well as patient comfort.[46] Early intervention is advocated for the vast majority of situations in the developed world. In the setting of significant inflammation, infection or radiation damage, a 3-6 month waiting period is advised. Success rates approach 90–98% regardless of surgical approach.

Choice of the optimal surgical approach to VVF (transabdominal, transvaginal, or intravesical) is controversial and generally depends on the characteristics of the fistula as well as the skill set of the surgeon. [47,48]

No single approach is applicable to all VVFs. The transabdominal approach is ideally suited for fistulas located near a ureteral orifice when ureteral reimplantation may be necessary and/or fistulas located high on the posterior wall in an area difficult to reach through the vagina. The transvaginal approach may be ideally suited when the etiologic surgery was performed abdominally (as there may be adhesions).

5.2.1 Transabdominal Approach

Through a **midline infraumbilical incision, a Pfannenstiel incision**, or via a **laparoscopic or a robotic technique** the bladder is exposed and either a transvesical or extravesical approach to the fistula tract is used. In a transvesical approach, the bladder is opened in the sagittal plane down to the level of the fistula. The extravesical approach has been proposed as less traumatic since the bladder is not fully opened to expose the fistula tract; however, depending on the location of the VVF and patient anatomy, visualization of the fistula tract may be limited with this approach.[49] Regardless of approach, the bladder is dissected and separated off the vagina beyond the level of the fistula. The fistulous tract is biopsied if there is any concern for malignancy and debrided back to healthy tissue if necrotic. The bladder and vagina are closed separately, in multiple layers, with incorporation of the fistula tract in most situations. Often, well-vascularized tissue such as omentum is interposed between the vagina and bladder as an additional layer to promote healing and prevent recurrence. When omentum cannot be mobilized, peritoneum is used as an interposition layer. (see **Robot-assisted repair of recurrent vesicovaginal fistula**)

5.2.2 Transvaginal Approach

Many vaginal approaches have been described including those by Sims, Latzko, and Raz.[12,50,51,52,53,54] Generally, an inverted U incision on the anterior vaginal wall is created and mobilized circumferentially around the fistula tract. Either the fistula tract is excised with edges of the debrided tract forming the first layer of closure, or the tract is left in situ with fistula edges rolled over forming the primary layer of closure. The perivesical fascia on either side of the first layer of closure is then imbricated over the primary suture line forming the second layer. A labial fat pad (Martius flap),

peritoneal flap, or gracilis muscle flap may be placed over the suture lines as a well-vascularized flap similar to the omental flap in the transabdominal approach.[55] Finally, a flap of vaginal wall is advanced over the repair forming the final layer of closure. The Latzko technique involves denuding the vaginal epithelium around the fistula tract and performing a partial colpocleisis. While this technique can shorten the vagina and may not be desirable in sexually active women, it can concomitantly treat pelvic organ prolapse in non-sexually active women opting for minimally invasive surgery. (see **Modified Latzko Procedure (Partial Colpocleisis) for VVF: Technique and Outcomes**)

Regardless of approach, maximal urinary drainage (with urethral and/or suprapubic catheter) is maintained postoperatively. A cystogram is usually obtained 2-3 weeks following repair to confirm successful closure. Antimuscarinic or beta-3 agonist medications may be prescribed to help promote bladder relaxation and assist the patient in tolerating the catheter(s).

5.2.3 Intravesical Approach

There is much less literature to support the intravesical approach which utilizes laparoscopic trocars placed directly into the bladder and instruments guided by cystoscopy.[56,57] Given the recent interest in single port surgery and the evolution of laparoscopic instruments to support this technique ergonomically, greater interest may be found in coming years.

5.3 Ureterovaginal Fistula

Ureterovaginal fistula can be treated with ureteral stenting as noted above. If high-grade partial obstruction exists in the setting of sepsis, percutaneous drainage and a course of antibiotic therapy are indicated prior to definitive repair. If retrograde stenting is unsuccessful but the pyeloureterogram shows continuity of the ureteral lumen, then an attempt at antegrade stenting may be undertaken. When stenting is unsuccessful and the fistula is located distally, ureteroneocystostomy (ureteral reimplantation, with or without psoas hitch and Boari flap) is performed transabdominally, laparoscopically or robotically. The psoas hitch maintains the anatomic position of the bladder. It is not necessary to excise the distal ureteral segment or even close the fistula unless vesicoureteral reflux is present. Fistulas located in the middle third of the ureter may be amenable to ureteroneocystostomy in conjunction with a Boari flap advancement from the bladder. A proximal fistula requires resection of the involved portion of the ureter, proximal and distal mobilization and primary ureteroureterostomy over a stent.

5.4 Urethrovaginal Fistula

Catheter drainage may be useful in a limited number of cases if the fistula is noted promptly following the causative event. Transvaginal surgical excision of any foreign body material with concomitant urethral reconstruction, multiple layer closure using periurethral fascia, a labial fat pad (Martius flap), and vaginal wall flaps is usually highly successful. (see **Urethrovaginal fistula repair with martius flap**). It should be noted that concomitant stress urinary incontinence treatment with synthetic mesh midurethral sling placement at the time of urethrovaginal fistula repair is not advised according to the

stress urinary incontinence guideline by the AUA/SUFU.[58] Delayed placement of a mesh sling after the fistula has healed or concomitant use of an autologous pubovaginal sling can be considered.

5.5 Enterovesical Fistula

Treatment may include bowel rest and hyperalimentation (total parental nutrition - TPN), to promote spontaneous closure in some cases. Medical therapy is most applicable in enterovesical fistula secondary to Crohn's disease. Appropriate use of TPN, corticosteroids, sulfasalazine, and antibiotics may promote spontaneous resolution. The application of surgery most commonly involves a one-stage approach;[59] however, a two-stage approach may be needed depending on the presence of inflammation, malignancy, and adjacent organ involvement. In cases managed in two stages, temporary fecal diversion is performed at the time of fistula repair. Patients with an inflammatory cause of the fistula, but without gross contamination, can be treated with a one-stage procedure, whereas those with unprepared bowel, gross contamination, or abscess may require a two-stage procedure. The surgery involves an abdominal approach (laparoscopically, robotically or in an open fashion). During the surgery, the bladder is separated from the bowel and the bowel is either resected and anastomosed or a temporary ostomy is created. The need for primary closure[60] of the urinary tract is debated in the setting of benign fistulas where no significant bladder leakage is noted. In some cases, however, partial cystectomy may be necessary. Interposition of well-vascularized tissue such as omentum between the bowel and bladder may promote healing and prevent recurrence. The second stage of surgery (if needed) involves reconstitution of bowel continuity once the fistula has healed.

5.6 Rectourethral Fistula

Many approaches have been advocated for repair of this complex problem.[42] Often, however, despite successful repair of the fistula and reconstitution of the GI and genitourinary tracts, the patient may have severe problems with urinary and fecal incontinence postoperatively and should be counseled regarding this possibility prior to attempted repair. Both two-stage and one-stage repairs have been advocated, although most authors would agree that fecal diversion should be performed as an initial measure. In two stage repairs, the GI tract is reconstituted only after the fistula has been repaired. Colostomy and urethral catheter drainage are generally instituted at initial presentation or diagnosis of the problem. An attempt at fecal diversion with colostomy and urethral drainage is a reasonable option in most patients especially if recognized early. With prolonged fecal diversion, the fistula may close over the urethral catheter.

Colostomy followed by a combined abdominal, perineal, and/or transrectal surgery is often the next step if conservative treatment measures fail. The rectum is separated off the urethra and both are closed primarily. Well-vascularized tissue such as omentum, gracilis or a dartos flap is interposed between the layers. Buccal grafts can be used for larger defects on the urethra. With the transrectal approach (York-Mason or trans-sphincteric approach), the fistula is exposed using either anal dilation and a speculum or transection of the anal sphincters. The fistula is then repaired in multiple layers by

advancement and rotation of rectal wall flaps. [61]

5.7 Urovascular Fistula

If the patient is in extremis (exsanguinating), immediate surgical intervention is indicated. In some cases, surgery may be avoided with the use of interventional radiologic techniques such as endovascular stenting.[62]

5.8 Vesicouterine Fistula

Occasionally, successful spontaneous closure has been seen with prolonged catheter drainage for 4-6 weeks when implemented in the early postpartum period. Hormonal induction[63] of amenorrhea can allow involution and closure of the fistula tract. These fistulas are most commonly surgically treated. This involves either hysterectomy and closure of the bladder (if the patient has completed childbearing) or excision of the fistula tract and separate closure of the bladder and uterus with interposition of omentum.

5.9 Post-Operative Pathway

There are no post-operative pathways that can universally be followed for patients with fistula given their variable characteristics as well as the differences in surgical approaches. However, there are some general principles that are commonly followed postoperatively. A bladder catheter and/or ureteral stent is usually used for several days to weeks after surgical repair to aid in tissue healing. The optimal duration of catheterization is not currently clear, but studies have investigated if shorter catheterization times are sufficient. [64,65] Prior to catheter and/or stent removal, many surgeons will re-evaluate the fistula using either imaging (e.g. fluoroscopy) and/or physical exam with the help of dyes (e.g. methylene blue); currently, there is no universally accepted method for evaluating fistula resolution. In terms of pharmacotherapy, several drugs can be used in the postoperative period in addition to pain medications (see drug **Table 4** below). Anticholinergic and/or beta-3 agonist medications may help prevent bladder spasms. Vaginal estrogen may help improve and maintain vaginal tissue quality. An antibiotic or urinary antiseptic (e.g. methenamine) can be used to help prevent bacteriuria while drains are in place, though the need for suppressive therapy during the post-operative period is debatable. **Postoperative pain**, including the use of opioids should be managed with guidance from the 2021 AUA White Paper on reducing postoperative opioid prescribing.[66]

Table 4. Medication Treatment Table

Class	Examples	Mechanism of Action	Some Adverse Effects*
Anticholinergics	Oxybutynin, Tolterodine, Darifenacin, Solifenacin, Trospium, Fesoterodine	Blocks action of acetylcholine to decrease bladder contractility	constipation, dry mouth, urinary retention, blurred vision
Beta-3 agonist	Mirabegron, Vibegron	Activates the beta-3 receptor to relax detrusor	elevated blood pressure, dry mouth, nasopharyngitis
Estrogen	Estradiol vaginal cream, Conjugated estrogens vaginal cream	Binds to estrogen receptor to improve and/or maintain vaginal tissue quality	increase risk of gynecologic and breast malignancy, thromboembolism, stroke, myocardial infarction
Urinary antiseptics	Methenamine	Concentrates in urine as formaldehyde to kill bacteria	nausea, stomach upset, allergic reaction

*complete list of side effects available in package inserts

5.10 Surgical Complications

There are a number of possible complications associated with operative repair of fistula. These include: bleeding, **infection**, failure, recurrence, pain, de novo urinary incontinence, de novo urinary urgency and/or voiding dysfunction, damage to surrounding structures, dyspareunia, and cardiopulmonary risks of surgery. Complication rates of operative fistula repair are difficult to compare given the wide variation in surgical techniques, differences in terminology, and inconsistency in the reporting of complications in the literature.[67]

6. Costs

Limited data is available on the economic burden or cost effectiveness of treating urologic fistulas in the developing world, and the cost of care in developing countries in no way equates to the cost of care in the United States. The cost of fistula repair depends upon the complexity of the fistula and a variety of factors,[68] but costs of operative repair in the developing world have been estimated as approximately $100-$400 per basic fistula.[69] Although data on the topic is limited, research has suggested that the transvaginal approach to VVF repair may potentially be more cost effective compared to the abdominal approach.[70]

7. Clinical Care Pathways

Patients should first be evaluated with a thorough history and complete physical exam. Diagnostic radiologic studies and evaluative procedures such as cystoscopy are important for assessment of fistula size, location, and local tissue integrity. Management strategies are based on individual patient factors as well as objective fistula characteristics.

8. Abbreviations

- VVF: Vesicovaginal fistula
- PID: Pelvic inflammatory disease
- RUF: Rectourethral fistula
- VCUG: Voiding cystourethrogram
- CTU: Computed tomography urography
- MRI: Magnetic resonance imaging
- CT: Computed tomography
- RPG: Retrograde pyeloureterography
- UTI: Urinary tract infection
- TURP: Transurethral resection of the prostate
- TPN: Total parenteral nutrition
- GI: Gastrointestinal
- ICD: International Classification of Diseases
- HIFU: High intensity frequency ultrasound

9. Figures

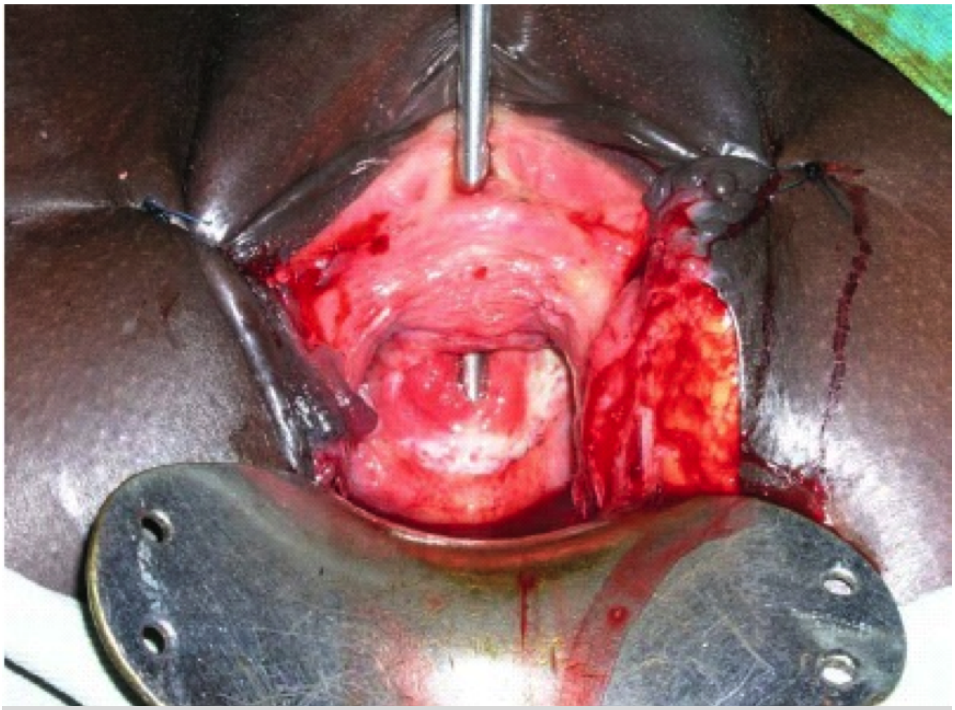

Figure 1: Photograph of an obstetric fistula demonstrating a large vesicovaginal fistula at the level of the trigone/bladder neck following prolonged obstructed labor.

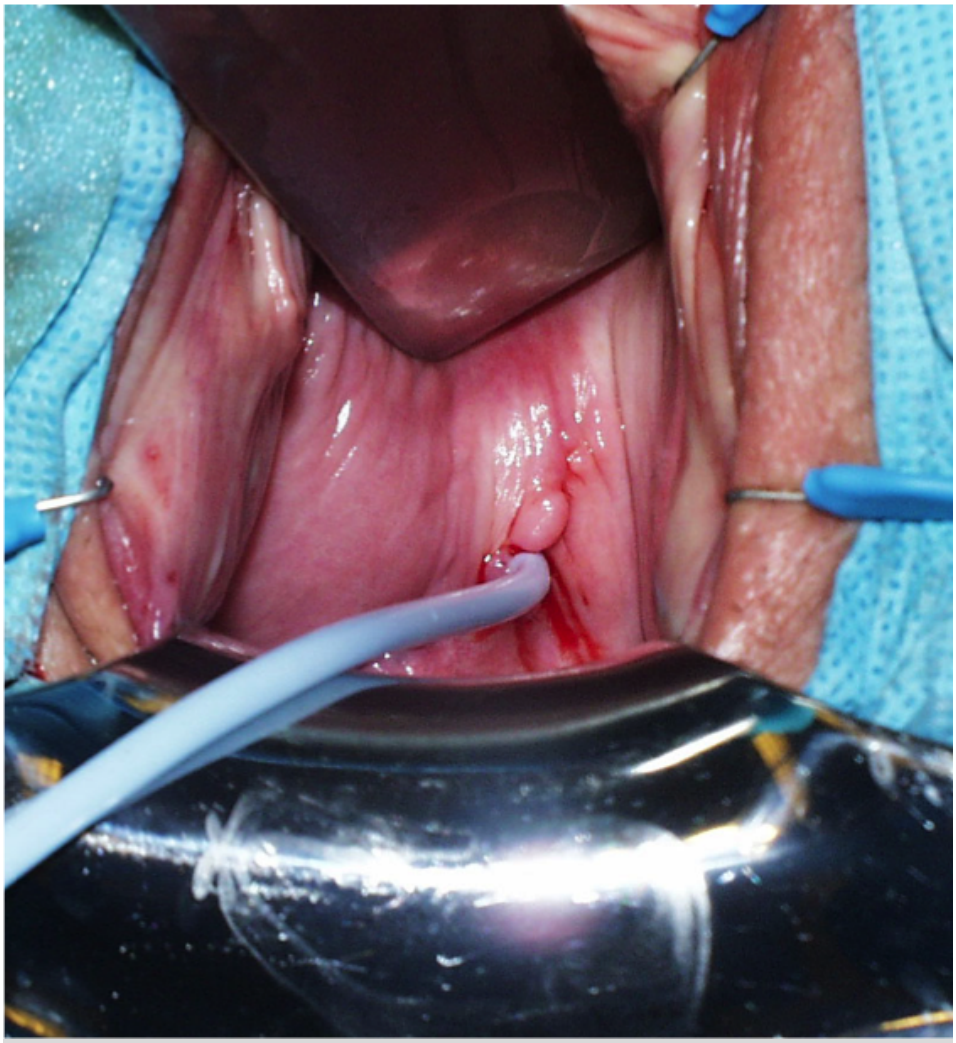

Figure 2: Photograph of a post hysterectomy fistula demonstrating a small vesicovaginal fistula at the level of the posterior bladder wall near the apex of vagina.

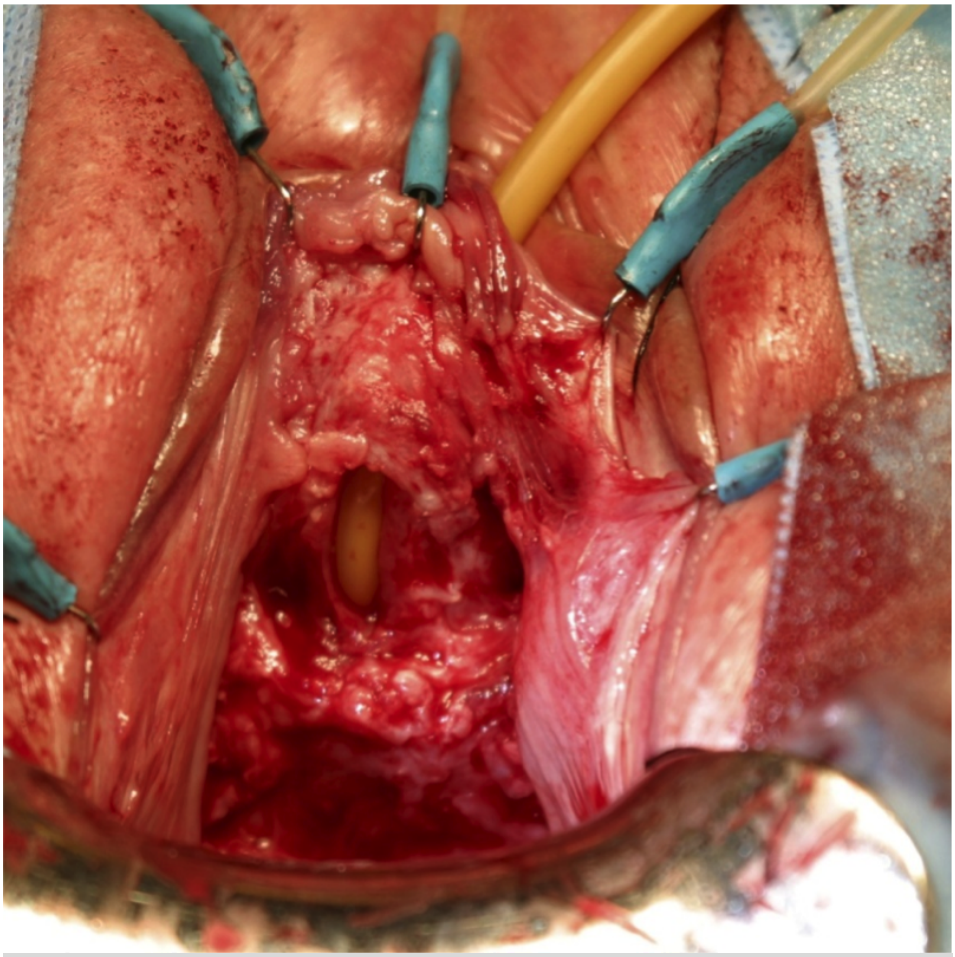

Figure 3: Photograph of a urethrovaginal fistula following removal of an eroded mesh sling

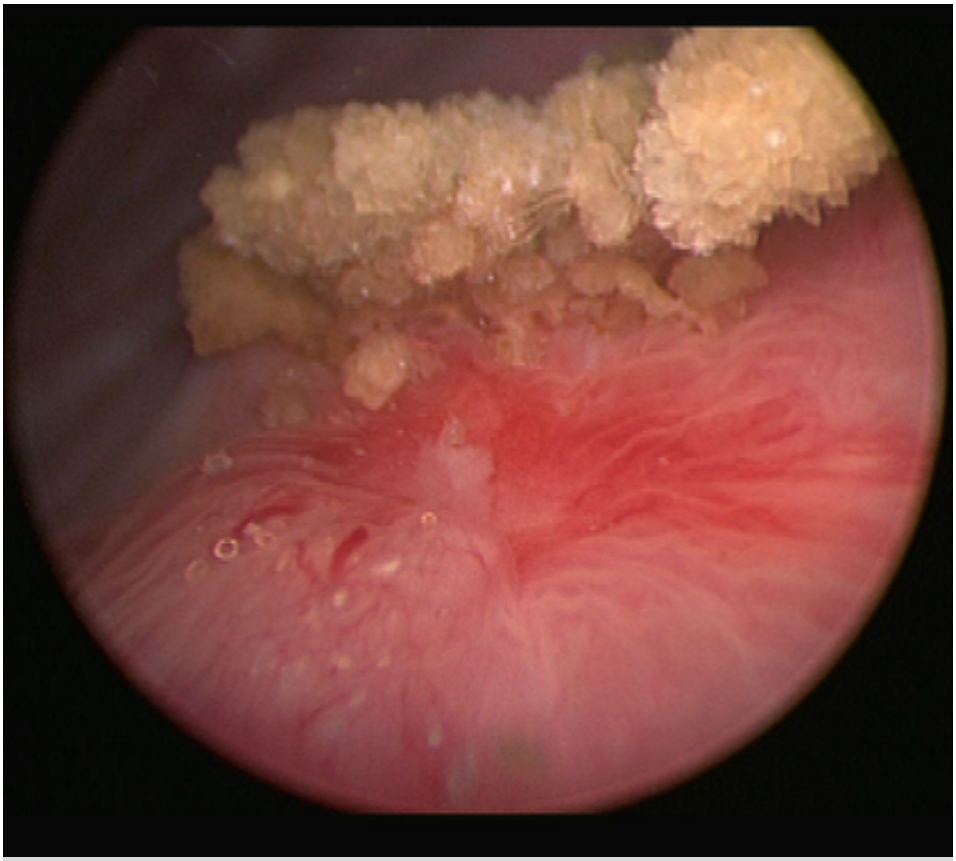

Figure 4: Cystoscopy demonstrating a bladder calculus that is adherent to intravesical mesh. The patient was referred for evaluation of new lower urinary tract symptoms and incontinence that occurred after pelvic organ prolapse repair with mesh.

Videos

Robot-assisted repair of recurrent vesicovaginal fistula

Modified Latzko Procedure (Partial Colpocleisis) for VVF: Technique and Outcomes

Urethrovaginal fistula repair with martius flap

Presentations

URINARY FISTULAS Presentation 1

References

1 De Ridder D, Abrams P, De Vries C, Elneil S, Emasu A, Esegbono G, Gueye S, Mohammad R, Muleta M, Hilton P, Mourad S, Pickard R, Stanford E, Rovner E. . Fistula. In: Abrams P, Cardozo L, Khoury S, Wein AJ, ed. Incontinence. 5th ed. Paris: ICUD-EUA; 2013:1527-1580.

2 Aarts J, Nieboer TE, Johnson N, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2015;8.

3 ☆ Netsch C, Bach T, Gross E, Gross AJ. Rectourethral fistula after high-intensity focused ultrasound therapy for prostate cancer and its surgical management. Urology. 2011;77(4):999-1004.

4 Wall LL KJ, Kirschner C, Arrowsmith SD. The obstetric vesicovaginal fistula: characteristics of 899 patients from Jos, Nigeria. Am J Obstet Gynecol. 2004;190(4):1011-1019.

5 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. European urology. 2016.

6 Arrowsmith S, Hamlin EC, Wall LL. Obstructed labor injury complex: obstetric fistula formation and the multifaceted morbidity of maternal birth trauma in the developing world. Obstet Gynecol Surv 1996;51:568-574.

7 Teeluckdharry B, Gilmour D, Flowerdew G. Urinary tract injury at benign gynecologic surgery and the role of cystoscopy: a systematic review and meta-analysis. Obstetrics & Gynecology. 2015;126(6):1161-1169.

8 Forsgren C, Lundholm C, Johansson AL, Cnattingius S, Altman D. Hysterectomy for benign indications and risk of pelvic organ fistula disease. Obstet Gynecol 2009;114(3):594-599.

9 Duong TH, Gellasch TL, Adam RA. Risk factors for the development of vesicovaginal fistula after incidental cystotomy at the time of benign hysterectomy. Am J Obstet Gynecol. 2009;201:512 e511-e514.

10 Duong TH, Taylor DP, Meeks GR. A multicenter study of vesicovaginal fistula following incidental cystotomy during benign hysterectomies. Int Urogynecol J. 2011;22(8):975-979.

11 Shaw J, Tunitsky-Bitton E, Barber M, Jelovsek J. Ureterovaginal fistula: a case series. International urogynecology journal. 2014;25(5):615-621.

12 Bai SW, Huh EH, Park JH, Rha KH, Kim SK, Park KH. Urinary tract injuries during pelvic surgery: incidence rates and predisposing factors. International Urogynecology Journal. 2006;17(4):360-364.

13 Vakili B, Chesson RR, Kyle BL, et al. The incidence of urinary tract injury during hysterectomy: a prospective analysis based on universal cystoscopy. American journal of obstetrics and gynecology. 2005;192(5):1599-1604.

14 Goodwin WE, Scardino PT. Vesicovaginal and ureterovaginal fistulas: a summary of 25 years of experience. J Urol. 1980;123(3):370-374.

15 Seth, Jai, et al. "Incidence, type and management of ureteric injury associated with vesicovaginal fistulas: Report of a series from a specialized center." International Journal of Urology(2019).

16 Merritt, A. J., Crosbie, E. J., Charova, J., Achiampong, J., Zommere, I., Winter-Roach, B., & Slade, R. J. (2013). Prophylactic pre-operative bilateral ureteric catheters for major gynaecological surgery. Archives of gynecology and obstetrics, 288(5), 1061-1066.

17 Badlani GH, De Ridder DJMK, Mettu JR, Rovner ES. Urinary Tract Fistulae. In: Wein AJ, Kavoussi LR, Partin AW, Peters CA, ed. Campbell-Walsh Urology. Vol 3. 11th ed. Philadelphia: Elsevier Saunders; 2016:2103-2139.

18 Moss RL, Ryan JA. Management of enterovesical fistulas. The American Journal of Surgery. 1990;159(5):514-517.

19 Thompson IM, Marx AC. Conservative therapy of rectourethral fistula: a five-year follow up. Urology. 1990;35(6):533-536.

20 Bukowski TP, Chakrabarty A, Powell IJ, Frontera R, Perlmutter AD, Montie JE. Acquired rectourethral fistula: methods of repair. J Urol. 1995;153(3 Pt 1):730-733.

21 ☆ Thomas C, Jones J, Jäger W, Hampel C, Thüroff JW, Gillitzer R. Incidence, clinical symptoms and management of rectourethral fistulas after radical prostatectomy. The Journal of urology. 2010;183(2):608-612.

22 Nelson HN, Fried FA. Iliac artery-ureteral fistula associated with Gibbons' catheter: a case report and review of the literature. J Urol. 1981;125(6):878-880.

23 Porcaro AB, Zicari M, Zecchini Antoniolli S, Pianon R, Monaco C, Migliorini F, Longo M, Comunale L. Vesicouterine fistulas following cesarean section: report on a case, review and update of the literature. Int Urol Nephrol. 2002;34(3):335-344.

24 Rajamaheswari N, Chhikara AB. Vesicouterine fistulae: our experience of 17 cases and literature review. International urogynecology journal. 2013;24(2):275-279.

25 Lewis G, De Bernis L. Obstetric fistula: guiding principles for clinical management and programme development. World Health Organization; 2006.

26 Chen CCG, Karram MM. Lower urinary tract fistulas. Urogynecology and reconstructive pelvic surgery. 4 ed: Elsevier Health Sciences; 2015:602-621.

27 Vangeenderhuysen C, Prual A, Ould el JD. Obstetric fistulae:incidence estimates for sub-Saharan Africa. Int J Gynaecol Obstet. 2001;73:65-66.

28 Brummer TH JJ, Fraser J, Heikkinen AM, Kauko M, Mäkinen J, Seppälä T, Sjöberg J, Tomás E, Härkki P. FINHYST, a prospective study of 5279 hysterectomies: complications and their risk factors. Hum Reprod. 2011;26(7):1741-1751.

29 Reisenauer C, Wallwiener D, Stenzl A, Solomayer FE, Sievert KD. Urethrovaginal fistula- a rare complication after the placement of a suburethral sling (IVS). Int Urogynecol J Pelvic Floor Dysfunct. 2007;18(3):343-346.

30 ☆ Blaivas JG, Mekel G. Management of urinary fistulas due to midurethral sling surgery. The Journal of urology. 2014;192(4):1137-1142.

31 Scozzari G, Arezzo A, Morino M. Enterovescial fistulas: diagnosis and management. Tech Coloproctol. 2010;14(4):293-300.

32 ☆ Marguet C, Raj GV, Brashears JH, et al. Rectourethral fistula after combination radiotherapy for prostate cancer. Urology. 2007;69(5):898-901.

33 Chin JL, Pautler SE, Mouraview V, Touma N, Moore K, Downey DB. Results of salvage cryoablation of the prostate after radiation: identifying predictors of treatment failure and complications. J Urol. 2001;165(6 Pt 1):1937-1941.

34 Zippe CD. Cryosurgery of the prostate: techniques and pitfalls. Urologic Clinics of North America. 1996;23(1):147-163.

35 ☆ Long JP, Bahn D, Lee F, Shinohara K, Chinn DO, Macaluso JN. Five-year retrospective, multi-institutional pooled analysis of cancer-related outcomes after cryosurgical ablation of the prostate. Urology. 2001;57(3):518-523.

36 Batter, S. J., McGovern, F. J., & Cambria, R. P. (1996). Ureteroarterial fistula: case report and review of the literature. Urology, 48(3), 481-489.

37 Tancer ML. Vesicouterine fistula: a review. Obstet Gynecol. 1986;41:743-753.

38 Yip S-K, Leung T-Y. Vesicouterine fistula: an updated review. International Urogynecology Journal. 1998;9(5):252-256.

39 ☆ Update Series: Contemporary Evaluation and Management of Vesicovaginal Fistula. Ehlert M, Haraway AM and Atiemo HO, Vol. 32, Lesson 7, 2013 https://auau.auanet.org/content/update-series-volume-32-2013

40 ☆ Morey, A. F., Broghammer, J. A., Hollowell, C. M., McKibben, M. J., & Souter, L. (2021). Urotrauma guideline 2020: AUA guideline. The Journal of urology, 205(1), 30-35.

41 Sans, J. V., Teigell, J. P., Redorta, J. P., Serrano, M. V., & Gassol, J. B. (1986). Review of 31 vesicointestinal fistulas: diagnosis and management. European urology, 12, 21-27.

42 ☆ Holden, Marc M. et al. Etiology, Diagnosis and Clinical Management of Rectourethral Fistulas. AUA Update Series. 36 Lesson 1. (2017)

43 Fujisaki, A., Kinjo, M., Shimoinaba, M., Honda, S., & Yoshimura, Y. (2020). An evaluation of the impact of post-hysterectomy vesicovaginal fistula repair on the mental health of patients in a developed country. International urogynecology journal, 31(7), 1371-1375.

44 Streit-Cieckiewicz D, Futyma K, Miotla P, Grzybowska ME, Rechberger T. Platelet-Rich Plasma as Adjuvant Therapy for Recurrent Vesicovaginal Fistula: A Prospective Case Series. J Clin Med. 2019 Dec 2;8(12):2122. doi: 10.3390/jcm8122122. PMID: 31810344; PMCID: PMC6947156.

45 Prodromidou, A., Zacharakis, D., Athanasiou, S., Protopapas, A., Michala, L., Kathopoulis, N., & Grigoriadis, T. (2021). The Emerging Role on the Use of Platelet-Rich Plasma Products in the Management of Urogynaecological Disorders. Surgical Innovation, 15533506211014848.

46 ☆ Ehlert M, Haraway AM, Atiemo HO. Lesson 7: Contemporary Evaluation and Management of Vesicovaginal Fistula. AUA Update Series. 2013;32:66-75.

47 Lee, Dominic, and Philippe Zimmern. "Vaginal Approach to Vesicovaginal Fistula." Urologic Clinics 46.1 (2019): 123-133.

48 McKay, Elishia, Kara Watts, and Nitya Abraham. "Abdominal Approach to Vesicovaginal Fístula." Urologic Clinics 46.1 (2019): 135-146.

49 Zhou, P., Deng, W., Li, J., Pan, H., Wang, Y., Song, C., ... & Fu, B. (2021). Transvesical versus extravesical approach to laparoscopic posthysterectomy vesicovaginal fistula repair: A retrospective study from two medical centers. Neurourology and Urodynamics 40(6),1593-1599.

50 Sims JM. On the treatment of vesico-vaginal fistula. The American Journal of the Medical Sciences. 1852;45:59-82.

51 ☆ Eilber KS, Kavaler E, Rodriguez LV, et al. Ten-year experience with transvaginal vesicovaginal fistula repair using tissue interposition. J Urol. 2003;169:1033-1036.

52 Latzko W. Postoperative vesicovaginal fistulas: genesis and therapy. The American Journal of Surgery. 1942;58(2):211-228.

53 ☆ Raz S, Bregg K, Nitti V, Sussman E. Transvaginal repair of vesicovaginal fistula using a peritoneal flap. The Journal of urology. 1993;150(1):56-59.

54 Luo, De-Yi, and Hong Shen. "Transvaginal Repair of Apical Vesicovaginal Fistula: A Modified Latzko Technique—Outcomes at a High-volume Referral Center." European urology (2019).

55 Margules, Andrew C., and Eric S. Rovner. "The Use of Tissue Flaps in the Management of Urinary Tract Fistulas." Current urology reports 20.6 (2019): 32.

56 Liu, S. J., Ye, H. Y., Li, Q., Xu, K. X., Zhang, X. P., Yu, L. P., & Wang, X. F. (2010). Intravesical laparoscopic repair of vesicovaginal fistula. Beijing da xue xue bao. Yi xue ban= Journal of Peking University. Health sciences, 42(4), 458-460.

57 Tavares, M. A., Lpiseau, S. C., Canis, M., & Botchorishvili, R. (2021). Intravesical repair of vesicovaginal fistula guided by cystoscopy. Facts, Views & Vision in ObGyn, 13(2), 175.

58 ☆ Kobashi, Kathleen C., et al. Surgical Treatment of Female Stress Urinary Incontinence (SUI): AUA/SUFU Guideline 2017. http://www.auanet.org/guidelines/stress-urinary-incontinence-(sui)-new-(aua/sufu-guideline-2017). Accessed 6/5/2017.

59 Granieri, S., Sessa, F., Bonomi, A., Paleino, S., Bruno, F., Chierici, A., & Cotsoglou, C. (2021). Indications and outcomes of enterovesical and colovesical fistulas: systematic review of the literature and meta-analysis of prevalence. BMC surgery, 21(1), 1-13.

60 Dziki, L., Wlodarczyk, M., Sobolewska-Wlodarczyk, A., Mik, M., Trzcinski, R., Hill, A. G., & Dziki, A. (2019). Is suturing of the bladder defect in benign Enterovesical fistula necessary?. BMC surgery, 19(1), 85. https://doi.org/10.1186/s12893-019-0542-4

61 van der Doelen, Maarten J., et al. "Results of the York Mason Procedure with and without Concomitant Graciloplasty to Treat Iatrogenic Rectourethral Fistulas." European urology focus(2019).

62 Ghouti, C., Leon, G., Seddik, S., Said, K. A., Vaudreuil, L., & Tillou, X. (2021). Uretero-arterial fistula: Six new cases and systematic review of the literature. Progrès en Urologie.

63 DiMarco, C. S., DiMarco, D. S., Klingele, C. J., & Gebhart, J. B. (2006). Vesicouterine fistula: a review of eight cases. International Urogynecology Journal, 17(4), 395-399.

64 Barone, Mark A., et al. Breakdown of simple female genital fistula repair after 7 day versus 14 day postoperative bladder catheterisation: a randomised, controlled, open-label, non-inferiority trial. The Lancet 386.9988 (2015): 56-62.

65 Nardos, Rahel, Birhanu Menber, and Andrew Browning. Outcome of obstetric fistula repair after 10?day versus 14?day Foley catheterization. International Journal of Gynecology & Obstetrics 118.1 (2012): 21-23.

66 ☆ Robles J, Abraham NE, Brummet C, et al: Rationale and Strategies for Reducing Urologic Post-Operative Opioid Prescribing (2021). American Urological Association.

67 Bodner-Adler, Barbara, et al. Management of vesicovaginal fistulas (VVFs) in women following benign gynaecologic surgery: A systematic review and meta-analysis. PloS one 12.2 (2017): e0171554.)

68 Fistula Care. Estimating Costs to Provide Fistula Services in Nigeria and Ethiopia: Key Findings. fistula 2012; https://fistulacare.org/pages/da/files/1/1.1/Estimating_Costs_Fistula_Services.pdf. Accessed 3/24/2016.

69 Nathan LM, Rochat CH, Grigorescu B, Banks E. Obstetric fistulae in West Africa: patient perspectives. American Journal of Obstetrics and Gynecology. 2009;200(5):e40-e42.

70 Warner, Ross, et al. "The cost effectiveness of vaginal versus abdominal repair of vesicovaginal fistulae." International urogynecology journal (2019): 1-7.