Vesicovaginal Fistula and Ureteral Injury During Pelvic Surgery

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Introduction

Because of the proximity of the bladder and ureters to the uterus, iatrogenic injuries are a well-described complication of gynecologic surgery. If unrecognized, complications such as vesicovaginal fistula (VVF) and ureterovaginal fistula (UVF) may occur. VVF ranks as the second most common genitourinary tract injury, with the second highest cause of malpractice claims [1, 2]. Given the morbidity suffered by the patient and the medicolegal implications realized by the surgeon [3], the avoidance, recognition, and subsequent treatment of these complications are an important issue. This chapter focuses on iatrogenic causes of VVF and ureteral injuries, strategies to prevent and recognize them, and management of postoperative complications.

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Vesicovaginal Fistula

Definition and Etiology

A VVF is an anomalous communication between the bladder and the vagina. In developing countries, the most common cause is unrelieved obstructed labor [4–7]. In West Africa, prolonged labor results in VVF at a rate of 1–3 per 1,000 deliveries [4]. In more developed countries in which women have better access to more modern obstetric care, obstetric fistulas are much less common. In such areas, fistula formation most typically results from iatrogenic injury during pelvic surgery [8–11].

In fact, 90 % of VVFs in North America result from gynecologic surgery [12]. Abdominal and vaginal hysterectomies are the most common causative factors, accounting for 75 % of all VVFs [11, 13, 14]. The risk of fistula formation following hysterectomy is approximately 0.1 % [8–11]. Other iatrogenic causes include injury during laparoscopic pelvic surgery, antiincontinence procedures, gastrointestinal pelvic surgery, and pelvic radiation [15, 16]. Noniatrogenic fistulas may result from locally advanced pelvic malignancy [14, 17], foreign bodies [18–20] or in rare cases, infection due to tuberculosis [21], aspergillosis [22], or schistosomiasis [23].

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Pathogenesis

During obstructed labor, there is prolonged pressure exerted on tissues between the vaginal canal and the pubic bone by the infant's head lodged against the pubic bone for an extended period; ischemic injury to these tissues (i.e. bladder, urethra, and occasionally the rectum) results, causing significant tissue loss [24]. Risk factors for obstructed labor have been identified as women who are primiparous, younger age at conception, short in stature as compared to their peers and carrying a male fetus [25].

The foremost mechanisms of VVF formation following vaginal or abdominal hysterectomy are (1) unrecognized cystotomy or insufficiently repaired cystotomy, resulting in urinoma formation with subsequent fistulization to the vaginal cuff and (2) vaginal cuff sutures that inadvertently incorporate the posterior bladder, resulting in necrosis and fistula formation [26]. VVF formation after radiation results from progressive obliterative endarteritis, and may occur many years after treatment [24, 27].

Prevention

The prevention of the majority of obstetric fistula in the developing world is dependent on improvements in the healthcare infrastructure of those regions. To this end, care of the patient both during her pregnancy and during her delivery is necessary with the availability of prompt access to emergency obstetric services should labor become complicated. While improved obstetric care is recognized as an important step in lowering the rate of urogenital fistula in the developing world, this goal is far from being met at this time [28].

Prevention of urogenital fistula in the developing world also plays a large role in the overall wellbeing of the patient. Unfortunately, a large proportion of these patients end up ostracized from their communities, with up to 70 % facing divorce (which often leads to a life of poverty), and many are even banned from eating with their families [29, 30]. In several studies, rates of psychiatric disturbance in affected patients reach up to 97 %, with over half of these patients having suicidal thoughts [29, 31].

The most common factors that increase the risk of posthysterectomy VVF include previous pelvic radiation, prior uterine surgery, and a history of endometriosis. In addition, previous cervical conization [24], distorted anatomy secondary to fibroids or adnexal mass [32], and steroid use [33] have been affiliated with increased risk of VVF. Therefore, elective hysterectomy in a high-risk patient should be performed by an experienced surgeon with the availability of urological assistance if necessary [34].

The bladder's proximity to the cervix and anterior vaginal wall renders it susceptible to injury during hysterectomy. Prevention of inadvertent bladder injury is best accomplished by adherence to basic principles of surgery, namely, a thorough knowledge of surgical anatomy, as well as adequate surgical exposure and hemostasis. During hysterectomy, the bladder is most likely to be injured supratrigonally, at the level of the vaginal cuff. Sharp dissection, rather than the use of cautery or swabs, should be used to dissect the bladder off the uterus [11, 35]. Moreover, the bladder should be continuously decompressed during pelvic surgery with an indwelling catheter. If bleeding occurs, specific ligation of the bleeding site is preferred to excessive cautery. Prior to ligation of the uterosacral ligaments, adequate mobilization of the inferior and lateral aspects of the bladder is essential, and the ligaments should be taken close to the uterus to avoid injury to the bladder [36]. When extensive pelvic and perivesical fibrosis are encountered, *intentional* anterior cystotomy may be performed to prevent *accidental injury* to the bladder base [37]. Also, consideration of supracervical hysterectomy should be given when applicable as lower rates of urogenital fistula have been observed in those with subtotal hysterectomies as compared to total hysterectomy. The likely mechanism of such an effect is that bladder dissection off the cervix and upper vagina, where most injuries occur, is avoided [38].

Evidence suggests that cystoscopy at the end of hysterectomy cases is much more sensitive in identifying injuries to the bladder than strict

Table 20.1 Tissue interposition during vesicovaginal fistula repair

Abdominal approach
Greater omentum
Peritoneal reflection
Appendix epiploica of colon
Myofacial rectus flap
Posterior bladder wall advancement flap
Vaginal approach
Labial fat graft (Martius flap)
Peritoneum
Sartorius muscle
Gluteus muscle
Gracilis muscle

visual inspection (96 % vs. 38 %, respectively) [39]. If injury is suspected, the bladder should be filled with fluid to localize any site of leakage. Repair of the injury should not be attempted until tissues are adequately mobilized [40]. Urological consultation is recommended, and the cystotomy should be closed with self-absorbing suture (SAS) in multiple layers. If the closure is tenuous, interposition of adjacent well-vascularized tissue between the cystotomy repair and the vagina is recommended. The most commonly used interposition grafts are greater omentum, peritoneum, or labial fat grafts (Table 20.1). The development of a VVF after bladder injury repair has been identified to be much more likely in those injuries that extend into the trigone or bladder neck [41]. These injuries should also be considered for interposition grafts at the time of repair. The bladder should be drained via indwelling catheter for 2–3 week postoperatively, with catheter removal only after cystographic confirmation of complete healing. The majority of bladder injuries if managed appropriately in this setting will heal without formation of VVF (~97 %) [42].

Presentation

Bladder injuries not recognized during surgery may present immediately postoperatively or up to 3 week later. Radiation-induced fistulas may present up to 20 year after radiation [24, 43]. Patients typically present with continuous daytime and nighttime leakage per vagina [44]. Depending on the size of the fistula, varying amounts of urine may be voided vs. leaked per vagina. Patients may initially present with postoperative abdominal/pelvic pain and ileus secondary to urinoma formation [26] prior to frank fistulization of the urinoma to the vagina.

Diagnosis

The differential diagnosis of clear fluid per vagina includes urine, lymph, peritoneal fluid, fallopian tube exudates, and vaginal discharge [45]. A high fluid creatinine level confirms the diagnosis of urinary fistula. Identifying the origin of leakage—ureter, bladder, or proximal urethra—is the most important first step [12].

Vaginal examination with a speculum is mandatory for identifying the fistulous site, most commonly at the apex of the vaginal vault. With a large fistula, a bladder catheter may be visible or palpable per vagina. If the exam is unrevealing and suspicion remains high, methylene blue or indigo carmine can be instilled into the bladder via urethral catheter, and leakage may be observed per vagina.

Alternatively, the diagnosis may be confirmed by static cystography with lateral views (Fig. 20.1). Case reports using computed tomography to identify fistulas have also been reported but plain film remains the imaging standard. Cystoscopy is indicated to identify the relation of the fistulous opening to the ureteral orifices, to document free urinary outflow from each ureter, and to assess bladder capacity and rule out concomitant foreign body. With a patient who has a history of genitourinary carcinoma, biopsy is necessary to rule out recurrent malignancy [44].

Concomitant UVF must be excluded because the incidence of UVF exceeds 10 % in patients with a VVF [3, 13, 37]. Cystoscopy is usually performed as a primary examination with the presence of ureteral jets used to document patency. Intravenous urography, commonly performed with CT-IVP, and/or retrograde ureteropyelography are useful for identifying hydronephrosis,

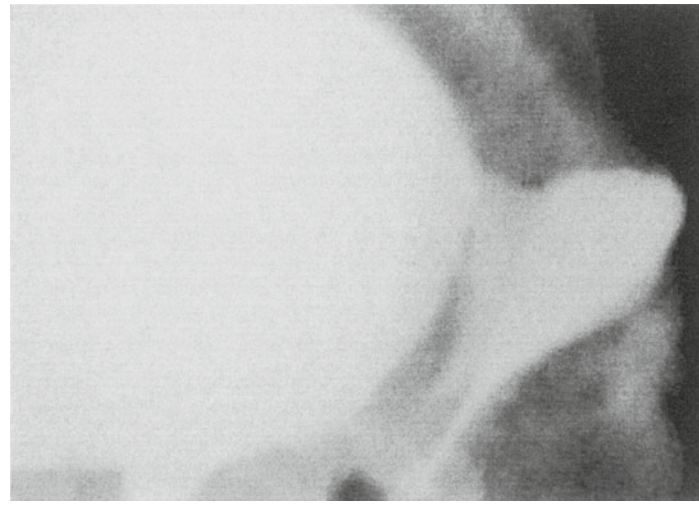

Fig. 20.1 Lateral cystogram demonstrating vesicovaginal fistula

ureteral obstruction, and fistula formation. If the diagnosis remains uncertain, the bladder may be catheterized and filled with blue dye while the patient is given oral pyridium. The vagina can be packed with gauze, and the patient asked to ambulate with a plugged urethral catheter. Blue staining confirms VVF; orange staining confirms UVF [46].

Concomitant Stress Incontinence

In addition to being a primary risk factor for VVF development, prior hysterectomy has also been identified as a risk factor for the development of stress urinary incontinence (SUI) [47]. Because of the continuous leakage per vagina however, the patient may not notice stress incontinence. In support of this, one investigation suggested that stress incontinence perceived as new onset following VVF repair may have been present before the repair was undertaken [48]. Any woman with a prior history of urinary incontinence must be adequately evaluated prior to fistula repair and warrants evaluation with multichannel videourodynamics if indicated. While a cough stress test after bladder filling may not be possible due to leakage out the fistulous tract at low bladder volumes, a positive "empty" cough stress test generally suggests a Valsalva leak point pressure less than 60 cm water [49]. Another finding suggestive of stress incontinence on videourodynamics is an open bladder neck during the filling phase, as this is typically not observed in continent patients [50]. Bladder neck funneling during provocative maneuvers is also more common in those with more severe SUI [51]. Lastly, maximal urethral closure pressure during urethral pressure profilometry is significantly less in women with SUI as compared to those without and can help to aid in diagnosis [52]. Repair of anatomic abnormalities contributing to stress incontinence may be performed concomitantly with fistula surgery (via abdominal or vaginal route) and may avoid the need for a further surgical procedure. Most important, incontinence surgery has not been demonstrated to increase fistula recurrence [43]. The use of synthetic sling material is not contraindicated unless the fistula repair involves the urethra.

In those patients with obstetric fistula, only one quarter is usually "dry" after successful closure of the VVF [53]. In a series of such patients complaining of incontinence who underwent subsequent urodynamic studies, over half were found to have SUI alone, with another third having mixed incontinence [54]. Risk factors for the development of incontinence in this population are injuries that include the urethra, are larger than 6 cm in size, and are associated with small bladder capacity (<50 cc) or in those needing more than one repair to close their VVF [55].

Management

Although most cases of VVF will ultimately require surgery for definitive cure, conservative management should be offered for small fistulas uncomplicated by ischemia, radiation, or malignancy. Continuous urethral catheter drainage plus oral antimuscarinics and antibiotics have been associated with a 2–10 % closure rate [3, 11, 33, 56, 57]. However, once the fistulous tract becomes epithelialized (usually 4–6 week), catheter drainage is unlikely to aid fistula closure [3]. A trial of deepithelialization has been advocated for mature small fistulas (1–3 mm) using silver nitrate, mechanical curettage [58], electrocautery [59], or laser therapy. Both Nd-YAG and holmium laser welding were successful for sealing small fistulas (up to 4 mm in size) in a recent series of 7 VVF patients with a 100 % success rate at a minimum 2-month follow-up [60]. Fibrin glue has also been described in the treatment of VVF, though to date no series with more than 1 case exist [61–65]. The use of a synthetic substance for fistula closure, cyanoacrylic glue, was recently reported on in 4 patients with VVF. In this series, 2 of 4 patients had cure at 5 months or more of follow-up. In both patients that failed, the fistula was greater than 1 cm in size, again suggesting that the use of these materials should be reserved for smaller fistulae [66].

For large VVFs and for the majority of smaller ones that fail conservative management, surgery is required for definitive repair. The routine use of preoperative urethral catheterization is controversial. Although bladder drainage may reduce skin excoriation and patient discomfort, catheterization exacerbates bladder sensitivity, intravesical inflammation, and the risk of urinary infection. It is generally recommended that any indwelling catheter be removed at least 1 week prior to surgery, and that the urine should be sterilized with broad-spectrum antibiotics at least 24 h prior to surgery. Preoperative estrogen replacement is recommended in postmenopausal women [67], and any vaginal yeast infection should be treated with an oral or vaginal antifungal agent.

Timing of Surgery

If a bladder injury or ureteral injury is recognized during pelvic surgery, urological consultation is recommended at this critical time, and immediate repair is warranted. The immediate repair of such bladder and ureteral injuries is covered in Chap. 21.

Although surgery had traditionally been deferred for 3–6 month following the injury to allow maximum resolution of the inflammation and edema, it is now commonplace to proceed to earlier and even immediate repair of iatrogenic VVF. A short waiting period is still recommended for a fistula related to obstetrical trauma to allow the ischemic tissue to declare itself fully. Similarly, with radiation-induced VVF, the surgeon should wait until the size of the fistula has stabilized, as verified by serial vaginal and cystoscopic examination. For radiation-induced fistulas associated with obliterative endarteritis, a waiting period of at least 12 months is recommended [24, 27].

Early surgical intervention for uncomplicated VVF caused by iatrogenic injury is now recommended because many series document excellent success rates with early fistula repair [8, 68–73]. One small series demonstrated excellent outcomes (92 % success) with surgical intervention as soon as 2–4 weeks after the initial injury presentation [74]. A larger series of 80 consecutive patients, comparing repair in patients with VVF at 3 months or earlier ($n=40$) as compared to those repaired at later than 3 months ($n=40$), showed no difference in outcomes (88 % success in each group) [75]. In addition, early repair avoids the discomfort associated with urinary leakage (odor, skin excoriation, urinary tract infection) as well as the adverse psychological and medicolegal impact of prolonged urinary leakage [32].

Surgical Technique

The principles of surgical repair are as follows: The fistula tract must be adequately exposed, and the fistula repair should be tension-free, watertight, multilayered with nonoverlapping suture lines, and should remain uninfected (Table 20.2). Whether the approach is vaginal, abdominal, or

Table 20.2 Principles of surgical repair for vesicovaginal fistula

Preoperative
Timing of repair
Vaginal vs. abdominal approach
Health of tissues
Estrogenization
Steroid use
Radiation
Planning of concomitant procedures
Stress incontinence surgery
Prolapse surgery
Augmentation cystoplasty
Ureteral surgery
Intraoperative
Good exposure of fistulous site
Wide mobilization of tissues
Tension-free approximation of tissue
Watertight closure
Multilayer repair with nonoverlapping suture lines
Interposition flaps
Postoperative
Avoidance of infection
Maximal and continuous bladder drainage
Adequate estrogenization
Prevention of bladder spasms

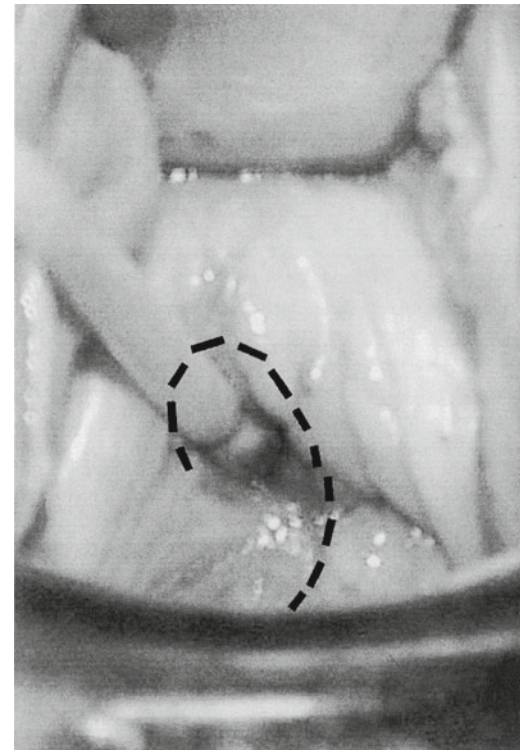

Fig. 20.2 Fistulous tract is dilated, and 8F Foley catheter is inserted. Inverted J incision aids with raising vaginal wall flaps anteriorly, posteriorly, and laterally

a combination of both routes, the initial attempt at repair has the highest success rate [4, 24]. The best approach should depend on the patient's anatomy, location of the fistula, and reconstructive considerations; these decisions must be individualized for each case. Compared to abdominal surgery, the transvaginal approach is associated with significantly decreased morbidity and length of hospitalization [76].

Vaginal Approach

Most VVFs are amenable to transvaginal repair. A vaginal operation is far less burdensome for patients than is an abdominal approach [14, 40, 77, 78]. Contraindications to the vaginal approach include severe vaginal stenosis and an inability to tolerate the dorsal lithotomy position (e.g., because of muscular contraction/spasticity). If the fistula encroaches on the ureteral orifices, transurethral placement of ureteral stents is indicated. Placement of both a urethral and suprapubic catheter can decrease the chance of postoperative catheter obstruction. Additionally, if the patient experiences bladder spasms refractory to antimuscarinics, the urethral Foley may be discontinued, thereby removing the catheter balloon from irritating the trigone, leaving the suprapubic tube for bladder drainage.

For access to the vagina, the patient is positioned in dorsal lithotomy. The fistulous tract should be dilated with lacrimal duct probes and pediatric urethral sounds until an 8F Foley catheter, which may be used for traction, can be inserted into the bladder. The vaginal wall surrounding the fistula is instilled with saline via a hypodermic needle to aid with subsequent dissection. The fistula is circumscribed sharply, and the incision is extended as an inverted J, with the long arm of the J ending at the vaginal apex (Fig. 20.2).

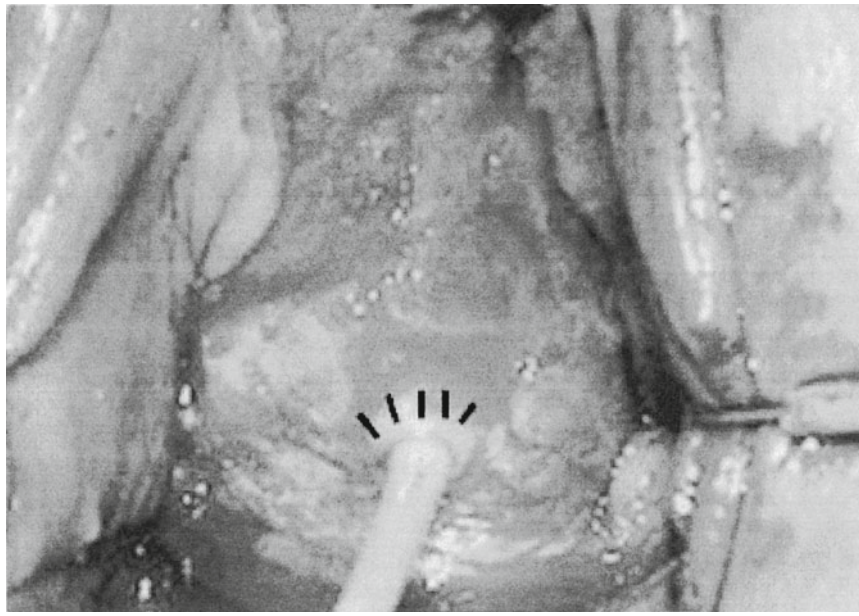

Fig. 20.3 Catheter is removed, and fistula is closed with 3-0 self-absorbing suture

Vaginal wall flaps (2–4 cm wide) are created anteriorly, posteriorly, and laterally. The perivesical fascia is exposed, and the circumscribed fistulous tract is left intact in contrast to general surgery principles in which it is entirely excised. Excision of the tract may unnecessarily enlarge the fistula and might increase the risk of bleeding. This approach is supported by a recent randomized trial showing no increase in successful closure rates whether or not the fistula edges were trimmed at the time of surgery. In fact, in those patients who failed, the resultant fistula was larger than the previous fistula in a majority of cases in which the fistula was trimmed as compared to the non-trimmed group [79]. Furthermore, the fibrous ring of the fistula can help improve the strength of the repair by providing a strong anchor for suture placement [44]. Prior to closure, the intrafistula catheter is removed, allowing for transverse closure of the tract with interrupted 2-0 SAS (Fig. 20.3).

A tension-free second closure layer is placed perpendicular to the first layer in an imbricating fashion, incorporating the perivesical fascia and detrusor muscle 5 mm from the previous closure. Should the surgeon be unable to close this layer tension-free despite adequate dissection, thought should be given to performing a one layer repair only. Alternatively an application of fibrin glue over the repair, which shows similar efficacy to local tissue flaps in a randomized trial of complicated VVF, can be performed [80]. Integrity of the closure is tested by filling the bladder via the urethral catheter. The distal vaginal flap is excised, and the proximal flap is advanced anteriorly at least 2–3 cm beyond the fistula repair. This third layer is closed with a running 2-0 SAS, covering the site of repair with healthy vaginal tissue, while avoiding overlapping suture lines (Fig. 20.4).

Abdominal Approach

All VVFs can be approached transabdominally. Abdominal repair is recommended, however, when the fistulous opening cannot be adequately exposed vaginally; simultaneous bladder augmentation is planned; or simultaneous ureteral surgery/ureteroneocystotomy is planned.

The patient is placed in the supine position with the legs slightly abducted to allow access to the vagina. Through a Pfannenstiel or lower abdominal midline incision, an intraperitoneal or

Fig. 20.4 Vaginal wall flap is advanced anteriorly 3 cm beyond the fistula repair

extraperitoneal approach to the bladder may be utilized. Packing the vagina is often helpful to temporarily seal the fistula so that the bladder can be filled through a urethral catheter.

Extraperitoneal Approach

The bladder dome is elevated, and dissection is carried posterior to the bladder and anterior to the vagina, down toward the fistulous tract. After the fistula is identified, a small opening is made sharply in the tract, and the bladder wall can be dissected off the tract. The vaginal opening and the bladder opening are each closed in two layers using 2-0 slowly absorbable suture (SAS) [40]. Perivesical or extraperitoneal fibrofatty tissue may be interposed between the two layers. Alternatively, a peritoneotomy may be used to harvest an omental flap, or the peritoneal reflection itself may be interposed between the bladder and vaginal closures. A transvesical extraperitoneal approach has also been described in which the fistulous tract is excised transvesically [81, 82].

Intraperitoneal Approach

The bladder is approached transperitoneally, and the bladder is bisected down to the fistula. The bladder and vagina are widely mobilized from each other, and the fistula is excised. The bladder and vagina are each closed in two layers using 2-0 SAS [83, 84]. When operating transperitoneally, harvesting an omental graft is more straightforward. If omentum does not easily reach the site of repair, a rotational flap based on the right gastroepiploic artery may be mobilized and secured between the bladder and vaginal closure with 3-0 SAS [85]. A suprapubic tube is placed in addition to the urethral catheter to allow maximal bladder drainage. A Penrose drain should be placed and brought out through a separate stab wound.

Laparoscopic Approach

A laparoscopic approach to VVF was first described by Nezhat et al. in 1994 [86]. Since that time, the use of robotic assistance to perform the case has also been described [87]. The repair of supratrigonal fistula is described in these reports and those that have followed. In brief, the patient is placed in the lithotomy position and ureteral catheters are placed bilaterally. A separate ureteral catheter is then placed through the fistula for identification purposes. A Foley catheter is introduced into the bladder and is placed on traction to prevent loss of pneumoperitoneum. The vaginal introitus is also occluded with Vaseline gauze for the same purpose. The patient is then placed in Trendelenburg to facilitate moving the bowel out of the pelvis and laparoscopic trocars are placed after pneumoperitoneum is established. The dissection and repair is then carried out in a similar fashion to the open abdominal approach. Advocates of the laparoscopic repair suggest that the pneumoperitoneum facilitates dissection of tissue planes, the magnification offered by the video camera can improve visualization of the tissue and that patient morbidity and hospital stay are decreased as compared to open surgery [86, 87].

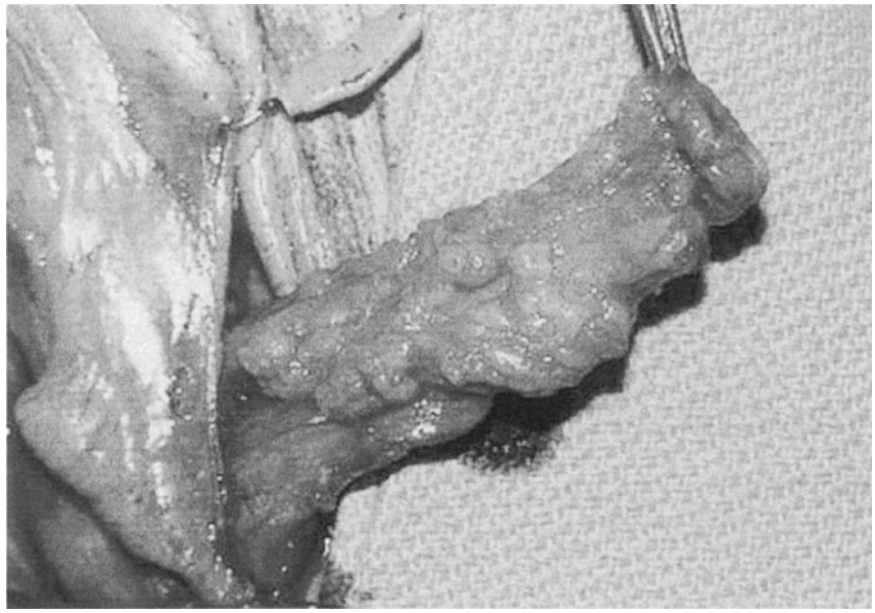

Fig. 20.5 Vascularized labial fat pad with blood supply based inferiorly on the inferior labial artery

Interposition Grafts

In cases of fistulas that are recurrent, radiation-induced, high in the vaginal vault or associated with poor tissue quality, the interposition of another source of healthy tissue is recommended (Table 20.2) [15]. In addition to the same basic principles of achieving a watertight, tension-free, uninfected repair, realizing a reliable closure often involves the need for interposing a well-vascularized tissue flap. When operating transabdominally, omental fat interposition is usually straightforward, and if increased mobility is necessary, the flap should be based on the right gastroepiploic artery [85, 88]. Alternatively, the peritoneal reflection of the cul-de-sac may be interposed between the bladder and vagina to help prevent refistulization [76]. Other choices of vascularized tissue include the appendix epiploica of the colon [33], a myofascial rectus flap [89], or an advancement flap derived from the posterosuperior bladder wall [90].

When approaching the recurrent fistula transvaginally, the most popular Martius flap derives from the labial fat pad, which can be tunneled under the labia minora to the site of repair (Fig. 20.5) [91, 92]. We prefer to use a peritoneal flap, which obviates the need for extravaginal harvesting. This technique was first described by Raz et al. [76] and involves dissecting the posterior vaginal wall flap posteriorly toward the cul-de-sac. The preperitoneal fat and peritoneum are sharply mobilized caudally. The peritoneal flap can then be advanced over the repair and secured with interrupted 3-0 SAS (Fig. 20.6).

Other reconstructive techniques have been described using sartorius, gluteus, rectus, and gracilis muscle [93–98]. These muscular and myocutaneous flaps are recommended for large radiation or ischemic fistulas [24, 93].

The use of a Martius flap interposition graft in a primary repair is not recommended based on a series of over 440 VVF repairs in which its use conferred no increase in the successful closure as compared to those repairs without a labial fat graft [99]. In contrast to this evidence suggesting no need for an interposition graft in primary fistula closures approached vaginally, evidence does support the advantage of an interposition graft when the VVF is approached abdominally. In two series where omental interposition was studied, the fistula cure rates were substantially

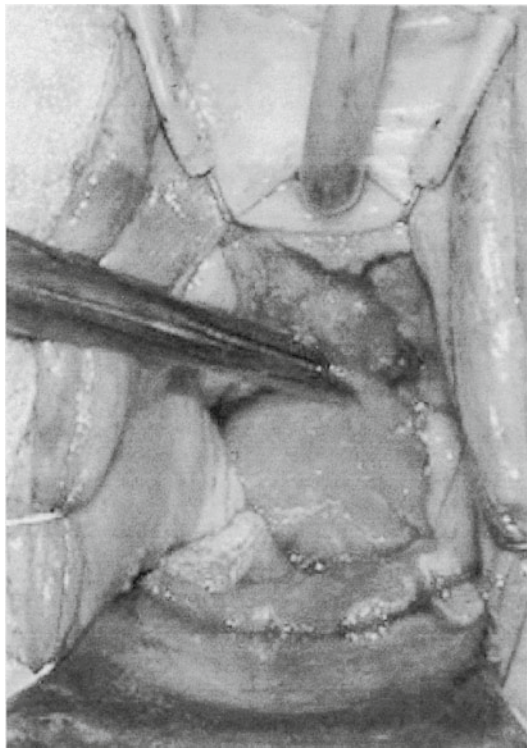

Fig. 20.6 Preperitoneal fat and peritoneum are mobilized in a caudal direction and sutured into position over the initial two-layer repair

higher in those that received an interposition graft (100 % and 93 %) as compared to those without (67 % and 35 %) [100, 101].

Postoperative Care

The vagina should be packed with an antibiotic-impregnated gauze for several hours to reduce the likelihood of vaginal wall hematoma formation. Maximal bladder drainage is recommended. In cases of simple fistula the use of a larger caliber urethral catheter alone can be undertaken or the surgeon can choose to place both a urethral and suprapubic tube. Urethral and suprapubic catheters should remain on gravity drainage until the urine is clear of any blood. The urethral catheter may be removed after the urine clears if it poses a threat of mucosal irritation at the site of repair (bladder neck or trigonal fistula) and a suprapubic catheter is in place. Extended antibiotic use after an initial 24 h of dosing in the immediate perioperative period is not necessary as evidenced by a recent large randomized control trial [102]. We do however recommend a single dose of antibiotic administration at the time of catheter removal in order to sterilize the urine after a period of colonization with the catheter in place. Bladder spasms should be treated with oral or rectal antimuscarinics because bladder overactivity has been postulated to compromise healing of the repair [103]. Oral or topical estrogen has been demonstrated to promote healing [93, 104]. To date, no study has been able to determine the exact time needed for bladder decompression with a catheter to promote optimal healing. One non-randomized study suggests no difference in recurrence rates between those catheterized for 10 days vs. 12 days vs. 14 days [105].

Cystography should be performed at 2–3 weeks postoperatively, prior to catheter removal, to document complete healing of the fistula, with discontinuation of antimuscarinics at least 24 h prior to voiding trial. If the fistula is healed and the patient voids to completion following the removal of the urethral catheter, the suprapubic tube, if in place, should be removed. If persistent fistula is noted during cystography, catheter drainage is recommended for an additional time period. Persistent leakage at 6 week requires repeat operative repair. Following successful repair, patients should avoid vaginal intercourse for 3 months.

Success Rates

Although success rates vary in the literature, approximately 85–90 % of VVFs caused by gynecologic iatrogenic surgical injury are repaired successfully at the first attempt [8, 10, 13, 69, 71, 80, 106–109]. At our institution, success rates in excess of 80 % have been achieved in repair of recurrent VVF. Other centers of excellence report similar results [40, 76]. Similar success rates are seen in patients with obstetrical fistula [99, 110]. Success rates for

radiation-induced fistulas are lower, ranging from 40 to 80 % [27, 72, 88, 93]. In the largest series on radiation induced VVF to date ($n = 216$), success rates of primary, secondary, and tertiary procedures were 48 %, 40 %, and 50 %, respectively [27]. While these success rates are lower, they do suggest that previous failure in a radiated field does not preclude further surgical treatment.

Complications

Early complications of VVF repair include vaginal bleeding, bladder spasms, and urinary or vaginal infection [44]. Intraoperative bleeding should be controlled with suture ligation, minimizing electrocautery. Postoperative bleeding is usually controlled by vaginal packing and bed rest. Bladder spasms can be treated with cholinolytics, and vaginal or urinary infections may be managed with appropriate oral antibiotics.

Late complications include unrecognized ureteral injury, vaginal stenosis, vaginal foreshortening, and fistula recurrence [44]. Vaginal shortening or stenosis usually results from excessive resection of vaginal tissue during posterior flap advancement and is more common in those with larger fistulae [4]. Delayed recognition of a ureteral injury is best managed initially by percutaneous nephrostomy, followed by definitive surgical repair after the inflammation has subsided. Cystoscopic approaches are contraindicated because distention of the bladder may lead to VVF recurrence. Recurrent fistula mandates reoperation, which is typically delayed for several months to allow the inflammation to subside. Interposition of vascularized tissue is always recommended for repair of recurrent VVF.

Complications after obstetric fistula repair are similar to those mentioned above. In addition, only 20 % of women are able to achieve pregnancy after repair of VVF, though this is likely a consequence of their previous pelvic trauma from obstructed labor rather than the repair itself. In those that are able to achieve a pregnancy following successful VVF repair, a cesarean section is preferred over vaginal delivery [111, 112].

Ureterovaginal Fistula

Definition and Etiology

A UVF may be defined as an abnormal communication involving the ureter and the vagina. This condition arises from an ectopic ureteral insertion into the vagina. It is rarely congenital, and more commonly is acquired, usually from a transmural injury to the ureter during pelvic surgery. An obstruction of the distal ureter leads to continued extravasation of urine and failure of the ureteral defect to heal. The most common cause of UVF is gynecologic surgery, most commonly after total abdominal hysterectomy for either benign or malignant disease [113]. Fistulas may also occur after prolonged or difficult delivery secondary to the pressure effect of the fetus on the distal ureter, resulting in necrosis [114].

The ureter is vulnerable during pelvic surgery because it lies close to the rectum and female reproductive organs within the pelvis. With laparoscopic pelvic surgery becoming more common, inadvertent electrocautery of the distal ureter, especially in laparoscopic hysterectomy, during ligation of the uterine artery is reported [115]. The ureter is also vulnerable to devascularization, as part of the distal blood supply originates from the uterine artery. Thus a ureter with insufficient collateral blood supply may be vulnerable to ischemic injury following routine uterine artery ligation during hysterectomy [116]. The ureteral blood supply may also be vulnerable during laparoscopic surgery, when the cardinal ligament is dissected and then divided below the uterine vessels [117]. Ureteral injury reportedly occurs in 0.5–1 % of all pelvic surgeries [118] and in 1.4–2 % of patients undergoing radical hysterectomy [119, 120]. In those in whom a concomitant VVF is present UVF exceeds 10 % [3, 13, 37].

UVFs occur when a ureteral leak persists, and the urine makes its way to the vaginal cuff. This adverse outcome of ureteral injury with its associated incontinence negatively affects the quality of life for the patient and causes anxiety on the part of the surgeon [121, 122]. Any unexplained

abdominal or flank pain or costovertebral angle tenderness, especially if fever is present, should alert the surgeon to the possibility of a ureteral injury. Often, there are no symptoms of ureteral injury or obstruction before urinary incontinence occurs. The usual UVF presentation is one of a sudden onset of urinary leakage from the vagina 1–4 week postoperatively [121, 122]. In addition to the constant incontinence, the patient voids normally because the contralateral ureter provides normal filling of the bladder.

Prevention

Prevention of unrecognized ureteral injuries is the first step in the management of this problem. A recent study suggests that relying on direct visual identification of a ureteral defect is insufficient at the time of surgery (7 % accuracy), while cystoscopic examination for ureteral efflux is vastly superior (100 % accurate) [39]. When using this technique, an intravenous injection of indigo carmine is given just prior to cystoscopy. Ureteral patency is then established cystoscopically via the visualization of contrast passing through the ureteral orfices bilaterally. Failure to achieve flow can be either due to prerenal causes (rectified by a bolus of intravenous fluid) or due to potential injury. Passage of a ureteral stent with concomitant retrograde pyelogram can serve for further diagnosis should poor or absent ureteral flow ensue and can prompt definitive repair if needed. Cystoscopic examination also has the added advantage of identifying an incidental cystotomy.

Assessment and Investigation

Several diagnostic studies have been utilized for the diagnosis of a ureteral injury in the postoperative period. Cystoscopy may reveal an absence of ureteral jets on one side and can additionally be used to screen for the presence of a bladder injury. In a female with vaginal leakage after pelvic surgery, a double dye test may differentiate between VVF and UVF [123]. To perform this test, the vagina is packed, and methylene blue is given intravenously; red carmine is instilled intravesically. The vaginal pack will stain red if a VVF is present and blue if a UVF is present. An intravenous urogram or CT-IVP will demonstrate varying degrees of hydronephrosis (Fig. 20.7) and may demonstrate an occasional silent kidney [124]. If imaging fails to reveal the fistula, a retrograde ureteropyelogram will usually demonstrate the location and magnitude of the fistula.

Fig. 20.7 An intravenous urogram will demonstrate varying degrees of hydronephrosis

Management

The objectives in management of a UVF are to preserve renal function, prevent or treat urinary sepsis, and cure the incontinence. Treatment options include observation, internal drainage via ureteral stent, external drainage via percutaneous nephrostomy, open surgical repair, and nephrectomy. However, controversy surrounds the role,

if any, of protective nephrostomy drainage and the timing of surgical intervention. Some surgeons advocate immediate surgical repair of the damaged ureter once the diagnosis is certain; although others advocate early drainage of the upper tract followed by delayed ureteral repair [13, 125–130]. There are reports of spontaneous healing of UVFs [13, 121, 131].

When the diagnosis of UVF is made, the surgeon must define the degree of ureteral obstruction distal to the fistula site. If distal ureteral obstruction remains, spontaneous healing of the fistula is extremely unlikely. The recommendation for both diagnostic and therapeutic reasons is to perform ureteral catheterization in addition to retrograde ureteropyelography. If a ureteral catheter is unable to be passed, the diagnosis of a distal obstruction is confirmed. If a stent can be placed to bypass the fistula, spontaneous healing is likely without further intervention [131–133]. The best-suited patients for nonsurgical management are those with unilateral ureteral injury, documented ureteral continuity, mild-to-moderate obstruction, and minimal extravasation. It is advantageous to attempt ureteral stenting to ensure decompression of the renal unit while simultaneously increasing the chance of healing. Conservative management has been successful when the above radiographic criteria were met, even when ureteral stenting failed [131]. In a patient who is nonoperatively managed, upper tract improvement and resolution of ureteral extravasation need to be documented on follow-up evaluation.

Endoscopic Techniques

Successful ureteral stenting may be achieved through several recently described endourological techniques. One option is the use of rigid ureteroscopy with low-flow irrigation to pass a 0.89-mm Glide wire retrograde across the ureteral injury [133, 134]. The advantage of ureteroscopy is direct visualization of the wire and improvement of the fulcrum at the level of the ureteral orifice, which increases the likelihood of achieving stenting.

If retrograde ureteral stenting is unsuccessful, antegrade percutaneous nephrostomy drainage may be attempted under local anesthesia. By placing the nephrostomy, the obstruction is relieved, and access for antegrade ureteral intubation is made available. Percutaneous nephrostomy is the first choice for a patient with infection or one who is too ill for general anesthesia or retrograde manipulation. A period of observation after percutaneous nephrostomy to allow for spontaneous healing of the damaged ureter is advocated by some [135, 136]. The spontaneous healing rate in highly selected individuals is reported as greater than 50 % following nephrostomy [135, 136].

In the majority of patients, a prolonged course of external drainage is less than desirable and antegrade stenting on an elective basis is recommended. In the event that antegrade stenting fails, a combination of antegrade-retrograde stenting technique may succeed. After passing one to two antegrade wires, cystoscopic removal of the bladder wire is performed. When tension is applied to both ends of the working wire, a retrograde ureteral stent is often able to pass across the fistula. Once a stent is placed, there is a 50–70 % chance that the UVF will heal without the need for open surgical intervention [133, 135–137]. In a study by Selzman et al. [137], eight women with UVFs underwent stent placement. All except one had the stent left in place for 4–8 week. All 7 patients had resolution of the fistula when the stent was left in for this amount of time and the ureter was given the chance to heal. The only complication was one stricture, which developed after stent removal and was repaired endoscopically. Because of the chance of ureteral stricturing, close follow-up is needed [131].

Surgical Repair

If neither antegrade nor retrograde ureteral access is achievable or even an option, open surgical repair is indicated. Controversy regarding the timing of the fistula repair is present because it is a reoperative procedure. Some surgeons recommend a “cooling down” period to allow the inflammation to resolve. In this instance, a percutaneous nephrostomy is performed to allow for drainage of infection and to protect the kidney [130, 138]. Some advocate nephrostomy only in the face of azotemia and urosepsis [121]. Drainage of the upper tract will not

necessarily solve the incontinence because some urine will proceed down the ureter and out the vagina through the fistula.

During a laparoscopic case, the chance of thermal injury to the ureter is a possibility, which may turn a less-invasive case into a debilitating one. In these circumstances, bipolar electrocautery is safer than unipolar because it reduces thermal spread [117]. To take this a step further, bipolar scissors are recommended over 5-mm forceps because it is thought they allow energy to be applied more accurately [115].

Should a thermal injury to the ureter occur and there is no urine extruding from one ureteral orifice on cystoscopy, a double-J stent should be placed for 6 week. This course of action is based on the belief that a burned ureter develops immediate mucosal edema that prevents urine passage. The double-J stent prevents fistula formation by diverting the urine while the ureter has a chance to heal. If cystoscopy reveals that a stent should be placed, even if the ureter is not really damaged, no harm is done. However, if a thermally injured ureter is not stented, a fistula with its related morbidity may form [117].

A movement toward early repair of the UVF is made because it involves a great deal of distress for the patient and anxiety for the surgeon. Early surgical repair may be undertaken if there is no significant urosepsis and renal function is relatively well preserved [123–125, 139]. Goodwin and Scardino were the first to demonstrate that early repair is achievable with excellent results [13].

Operative repair of the UVF is governed by several principles. Little attempt should be made to confine the surgery extraperitoneally, continuity between a normal ureter and bladder should be reestablished, and adequate drainage should be maintained [124]. Ureteroneocystostomy involves a bypass of the site of ureteral injury, eliminating the need for direct localization of the injured ureter by a difficult dissection [127]. It is the favored repair because most fistulas occur in the distal third of the ureter. On occasion, end-to-end ureteroureterostomy may be performed [121, 122, 126], but only in the case of limited inflammation and ureteral loss, so that as much of a tension-free anastomosis may be created as possible. However, ureteroureterostomy is generally not preferred in cases of distal ureteral injury due to concerns regarding insufficient vascular supply that could predispose to stricture.

Fig. 20.8 A psoas bladder hitch

The length of the ureteral segment needed to bypass, which depends on the location of the injury and obstruction, and the degree of ureteral and bladder mobility, will dictate the method of reimplantation. In the majority of cases, a direct ureteroneocystostomy can be performed, often aided by a psoas bladder hitch (Fig. 20.8) to relieve any tension of the anastomosis [119, 121, 128, 140]. The majority of reports revealed that, by using sound surgical principles, almost 100 % success can be achieved with ureteral reimplantation [119, 121, 125, 128, 137, 141]. Goodwin and Scardino [13] recommended using an antireflux submucosal tunnel in each patient; others did not feel this measure is necessary [113, 119]. Many believe that ureteroneocystostomy without the use of an antirefluxing anastomosis lowers the risk of postoperative ureteral obstruction.

If the injury to the ureter is distal, a vesicopsoas hitch is usually sufficient to render the anastomosis free of tension. A Boari flap replacement of the distal ureter may be employed when the obstructive segment lies proximally or when there are multiple sites of obstruction. A Boari flap is also used in the face of a pelvic abscess cavity, which allows the surgeon to perform the anastomosis of the ureter to the bladder away from any foci of infection [121]. A report by Falandry of 14 cases of UVF repair with a cuffed reimplantation with a tubular bladder plasty demonstrated no anastomotic stenosis or leak [141]. In the instance of high or long ureteral strictures, a more complex reconstruction such as transureteroureterostomy, renal decensus, renal autotransplantation, or ileouretero-cystoplasty may be necessary. The more specific details of these surgical procedures are covered in Chap. 4 ureteral trauma.

Conclusion

UVF is a rare complication of pelvic surgery, most often following total abdominal hysterectomy for benign disease and radical hysterectomy for malignancy. Some degree of distal obstruction with concomitant transmural injury results in constant urinary extravasation, with fistulization to the vaginal cuff. Urinary incontinence usually follows 1–4 week postoperatively without previous symptoms. Intravenous urogram or CT-IVP and ureteropyelography are adequate studies to demonstrate the location of the injury and the degree of distal obstruction and to provide information necessary to formulate an appropriate plan of treatment. The goals of treatment center on renal preservation, treatment of urosepsis, relief of any obstruction, and alleviation of incontinence.

Advances in endourological procedures have made retrograde or antegrade ureteral stenting prudent in patients with unilateral injury, only mild-to-moderate obstruction, minimal extravasation, and some demonstrable ureteral continuity. Percutaneous nephrostomy is indicated in patients with complete ureteral obstruction or obstruction with simultaneous infection. Patients who are not candidates for ureteral stenting and who fail conservative management need definitive surgical repair. The procedure of choice is reimplantation of the healthy ureter into a mobilized bladder. In the event of a proximal ureteral injury, a psoas hitch, Boari flap, or even transureteroureterostomy or ileal ureteral replacement may be required. Percutaneous ureteral occlusion or nephrectomy should only be used as a last resort.

Summary

Iatrogenic injuries are a well-described complication of gynecological surgery. The proximity of the ureters and the bladder to the cervix and anterior vaginal wall render them susceptible to injury during gynecological and pelvic operations. Iatrogenic injury, if unrecognized and untreated, can result in VVF or UVF—an anomalous communication between the bladder or ureter and the vagina. The avoidance, recognition, and subsequent treatment of these complications are important issues, given the morbidity suffered by the patient and the medicolegal implications realized by the surgeon.

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