Rectourethral Fistula

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Abbreviations

RUF	Rectourethral fistula
RP	Radical prostatectomy
EBRT	External beam radiation therapy
XRT	Radiation therapy
TURP	Transurethral resection of the prostate
HIFU	High-intensity focused ultrasound
CT	Computed tomography
MRI	Magnetic resonance imaging
RUG	Retrograde urethrogram
VCUG	Voiding cystourethrogram
BMG	Buccal mucosa graft
SPT	Suprapubic tube

Introduction

Rectourethral fistula (RUF) is a congenital or acquired abnormal communication between rectal and urethral epithelium. Congenital fistulas include those that occur in conjunction with anorectal malformations and are usually corrected at the time of pediatric anoplasty. Acquired fistulas may develop secondary to iatrogenic surgical injury, trauma, infection/inflammation, malignancy, or tissue ablation [1]. Today, although rare, acquired fistulas most often result from complications of prostate cancer treatment. PSA testing has led to an increase in prostate cancer diagnosis and treatment over the last several decades. Multimodality therapy and tissue ablative techniques are also being performed with increasing frequency, leading to higher rates of RUF. While surgical fistulas are often small and uncomplicated, fistulas associated with radiation and/or tissue ablation are frequently larger with poorly vascularized tissues leading to more difficult repairs with poorer outcomes.

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Etiology and Pathophysiology

The risk for rectal injury during radical prostatectomy (RP) is small and only a subset of these injuries will develop into an iatrogenic RUF. Thomas and colleagues published that the incidence RUF formation is 0.53 % (12/2447) following open radical prostatectomy [2]. The risk for fistula formation was higher in perineal (1.04 %) versus retropubic prostatectomy (0.34 %). Of these men, only 54 % of them were known to have an incidental rectal injury during prostatectomy, which was repaired at the time in two layers. Sixty-two percent of the men had extracapsular disease, suggesting either adherence to the rectal mucosa or surgeon attempts at wide local excision contributed to fistula formation. Robotic-assisted laparoscopic techniques

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appear to have even lower rates of rectal injury and fistula formation, though no direct comparisons can be made. Wedmid et al. published a series of 6650 robotic prostatectomies performed at six institutions [3]. They found only 11 rectal injuries (0.17 %), of which only four progressed to a recto-urethral fistula. Three of the four RUF were unidentified rectal injuries at the time of prostatectomy. Only one of the rectal injuries identified and repaired intraoperatively developed into a RUF. The three patients presenting late required bowel diversion and delayed repair.

Use of radiotherapy for the treatment of prostate cancer has increased dramatically as new techniques are developed and accepted by patients and physicians. External beam radiation therapy (EBRT) was used to treat 20 % of men in the CaPSURE (Cancer of the Prostate Strategic Urological Research Endeavor) database between 1993 and 2001 [4]. The use of brachytherapy increased from 4 % to 22 % during the same time period. Multimodality therapy is also increasing. In those with high-risk features, radiation is frequently recommended following radical prostatectomy in the adjuvant or salvage settings. Additionally, patients with high-risk disease being treated for cure may choose to undergo combined brachytherapy and EBRT. This increased use of XRT has invariably led to increased rates of radiation induced RUF. Contemporary series report that more than 50 % of RUF are caused or complicated by radiation and/or ablation techniques [5, 6]. These risks are magnified further in men undergoing combined external beam and brachytherapy [7]. That being said, RUF formation after radiation therapy remains infrequent, with incidence rates reported from 0 to 0.6 % after EBRT and 0.3–3 % after brachytherapy [5, 8–10].

Radiotherapy may contribute to RUF formation in a variety of ways. Radiation causes both direct and indirect cellular damage through its ionizing effects [11]. Indirect cytotoxicity occurs secondary to the release of oxygen free radicals, altering normal DNA biology and protein synthesis. Direct effects occur when the photon itself damages DNA or tissue proteins. Acute effects of radiation are primarily tissue edema and inflammation with a reduction in cell proliferation. This lack of proliferation may lead to ulceration, bleeding and infection. Subacute and chronic phases are dominated by ischemia and fibrosis. Microvascular damage leads to tissue ischemia, promoting necrosis, fibrosis and worsening ulceration, all of which contribute to radiation induced RUF formation [12]. Effects of radiation are dose and tissue dependent. Higher doses delivered (as with combined brachytherapy and EBRT) will result in higher risk of normal tissue damage and urinary complications. Additionally radiation effects are remarkably tissue dependent. Tissues with high rates of metabolic activity, such as urinary and gastrointestinal epithelium, are most sensitive to the effects of radiation. They are also fixed midline structures that are more difficult to exclude from the radiation fields when treating pelvic malignancies.

The risk of RUF following radiotherapy invariably increases with urethral manipulation, whether endoscopic, open or percutaneous. Men with rectal bleeding following XRT, especially after brachytherapy, should be cautioned against anterior rectal wall biopsy or cautery. This has been shown to induce RUF formation and bleeding usually subsides on its own without intervention [10, 12]. Urinary obstruction is possible after both EBRT and brachytherapy; however, it is more often described with the permanent implant. Rates of obstruction requiring transurethral resection of the prostate (TURP) following brachytherapy range from 0 to 8.3 % [10]. These patients are at high risk for RUF if a complete resection is performed secondary to insufficient blood supply to the prostatic urethra and poor urethral healing [12]. The bladder neck should be spared in these men, if possible, to preserve adequate urethral perfusion. The risks during outlet procedures are not limited to TURP. Experience suggests that RUF formation may be even more likely following prostate laser photovaporization in post-radiation patients. This may be secondary to less control with depth of tissue penetration during laser photovaporization procedures, though RUF rates in this population are not well reported.

PSA recurrence following definitive radiotherapy is not uncommon. CapSURE database analysis found up to 63 % of men developed recurrence a mean 38 months following XRT. In the subset with presumed local recurrence, local salvage treatments may be offered. Salvage radical prostatectomy is most often performed at select high volume centers; however, despite surgeon experience, morbidity with this procedure remains high. Gotto et al. presented a large series of salvage radical prostatectomies and noted a significantly increased risk for RUF compared with primary RP regardless of the type of XRT the patient had previously received [13]. Overall, surgical complications were found in more than 50 % of men.

Cryotherapy is becoming a more commonly performed salvage treatment in the USA secondary to the relative ease of performing the procedure in the salvage setting and the perceived reduced risk of morbidity compared with salvage RP. Although improvements have been made in later generation devices to reduce complications, salvage cryotherapy has been shown to induce RUF formation in 0–3.4 % of men [14]. This risk remains despite performing focal compared to whole gland salvage [15]. Other salvage options following failed EBRT, including brachytherapy and high-intensity focused ultrasound (HIFU), appear to have similar urethrorectal complications. Brachytherapy after EBRT failure leads to RUF formation in an average 3.1 % of men and fistula complications after HIFU approach 4 % [16–18].

Presentation

Iatrogenic rectourethral fistulas secondary to radical prostatectomy typically present within 2–3 weeks following surgery [2, 19]. Radiation induced fistula generally develop in a delayed fashion and typically present between 2 and 3 years following completion of XRT [5, 12]. Clinical symptoms can be variable, though the most commonly reported symptoms are pneumaturia and anal urinary leakage. Those without overt symptoms of a RUF may present with recurrent urinary tract infections and the index of suspicion must be high in those with a history of a radical prostatectomy, especially if a rectal injury was known to occur during RP. In addition to symptoms commonly found with iatrogenic surgical fistulas, radiation induced fistulas may lead to hematuria, rectal bleeding and pelvic pain. Massive rectal bleeding and necrotizing fasciitis have also been reported with RUF [20].

Fecaluria, a traditional hallmark of urorectal fistulas, is less commonly seen with RUF compared with colovesical fistulas from diverticular disease or malignancy. This is thought to be secondary to the relative high pressure within the urethra compared with the rectum during voiding, leading to rectal urine leakage rather than fecaluria [21]. For this reason, fecaluria is a poor prognostic sign in men with RUF as this would suggest a larger fistula at presentation. It has similarly been suggested that those without fecaluria may be more likely to close spontaneously with urinary diversion with or without colostomy [2].

Diagnosis and Evaluation

An example of a diagnostic and treatment algorithm can be found in Fig. 8.1. Exam under anesthesia allows excellent characterization of the rectourethral fistula and helps with the treatment plan. Digital rectal examination can allow palpation of the fistula if the defect is sufficiently large. Proctoscopy and cystoscopy should both be performed to determine the exact location, size and inflammation associated with the fistula. Fistula tract biopsy should be performed in every patient prior to surgery to rule out recurrent or radiation induced malignancy. Patients should also be evaluated for rectal stenosis as this is found commonly after radiation and may complicate attempts at repair if the stenosis is significant [22].

Retrograde urethrogram (RUG) may be may be performed while the patient is under anesthesia or in the office setting. This will aid in further delineating the location and size of the fistulous tract. If done with the patient awake in the office, concomitant voiding cystourethrogram (VCUG) should also be performed (Fig. 8.2). This will provide additional information with regard to bladder neck and posterior urethral pathology,

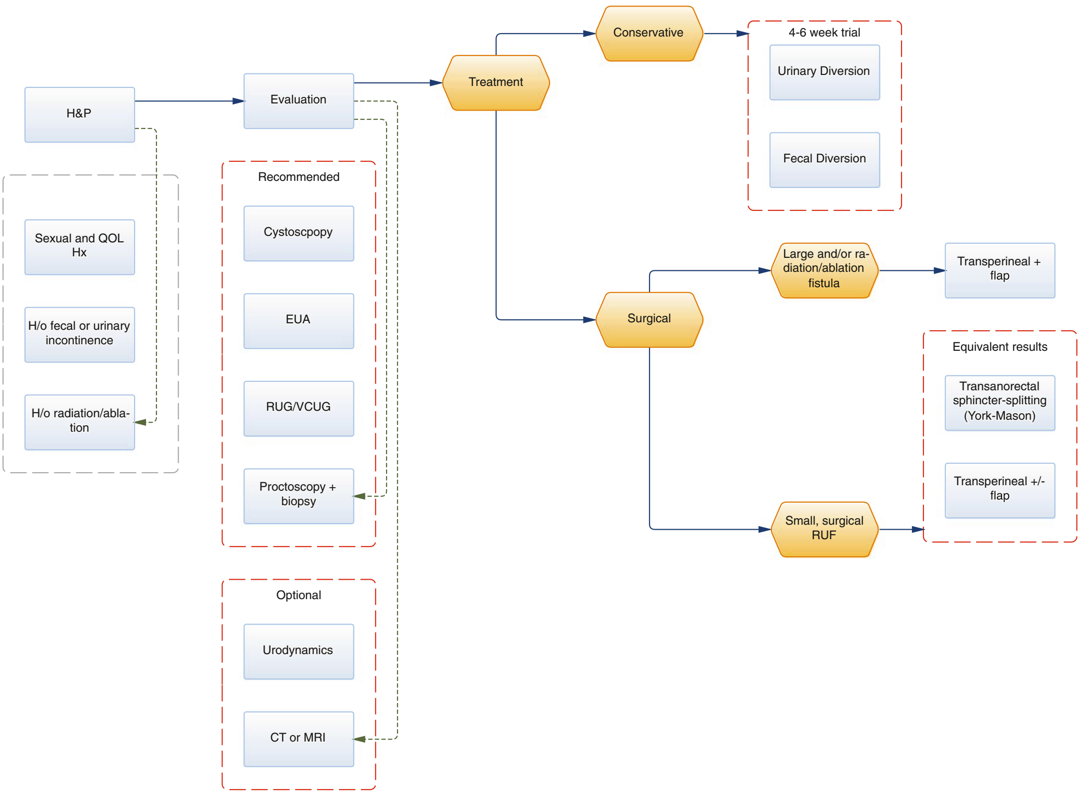

Fig. 8.1 Workup and treatment algorithm for rectourethral fistulas

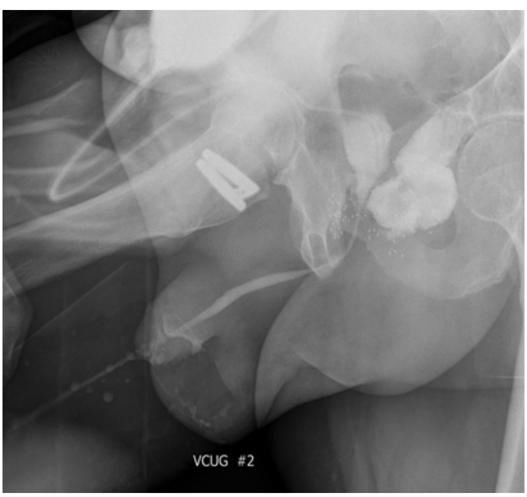

Fig. 8.2 Voiding cystourethrogram demonstrating a rectourethral fistula

such as urethrovesical anastomotic stenosis or prostatic urethral stricture.

Cross sectional abdominopelvic imaging using either computed tomography (CT) or magnetic resonance imaging (MRI) may be indicated in cases where the standard workup is insufficient and the anatomy of the fistula is not clear. This imaging is also helpful in men with prior failed repairs. Some have also suggested that MRI allows demonstration of an intervening cavity between the rectum and urethra, which may aid in surgical planning and patient counseling [21].

Urodynamic testing is occasionally helpful in the evaluation of a rectourethral fistula, though they are often difficult to perform depending on the size of the fistula tract and volume of urine leakage. If they are performed, an assessment of bladder capacity is helpful. Men with radiation induced RUF will frequently also have a reduced bladder capacity. As a consequence, some will be better served with a cystectomy and urinary diversion rather than attempts at fistula repair.

Lastly, men presenting with urorectal fistulas should be evaluated for sexual function and overall quality of life. Erectile function is known to be poor in men with radiation induced RUF [11]. Men considering fistula surgery who have adequate erectile function should be counseled that surgical treatment might result in worsening of their erection quality.

Conservative and Endoscopic Management

Conservative management of rectourethral fistulas generally refers to transurethral or suprapubic urinary drainage in conjunction with a "low residue" diet or temporary colostomy to reduce rectal fecal burden. This regimen is continued for 4–6 weeks and followed by repeat fistula assessment with an office RUG and VCUG. Extending the trial of conservative management beyond 6 weeks for those with a persistent RUF would be futile and those patients should be counseled on surgical options at that time.

Any attempts at conservative management of rectourethral fistulas should reserved for those men with small, surgically induced fistula without associated radiation or tissue ablation injury. This group of patients has the best chance for non-surgical resolution of their fistula. It is likely that rather than a true rectourethral fistula, this situation represents an iatrogenic urorectal communication that has not been present for sufficient time to form an epithelial tract. In this specific scenario, urinary diversion and dietary changes may allow healing to occur before an epithelialized communication becomes permanent.

Several authors have reported positive results using this conservative management technique in surgical RUF. Most recently, Thomas and colleagues reported on 12 patients with a surgically induced fistula who underwent attempts at conservative management with urinary drainage +/− diverting colostomy [2]. Of the 12 men, five (42 %) had resolution of their fistula without surgical intervention. Fecaluria was found to be a negative prognostic sign for fistula resolution with conservative treatment, suggesting that patients with fecaluria have larger and more complex fistulas. Others have also noted some success with conservative measures. Nyam and Pemberton demonstrated at 14 % success rate, and Al-Ali and associates a 46.5 % closure with a similar treatment paradigm [23, 24].

Contrary to an uncomplicated surgical fistula, however, men with a history of radiation or tissue ablation are significantly less likely experience spontaneous closure [5]. These fistulas are complicated by generally being larger in size with inflamed and poorly vascularized surrounding tissue. They also more often present in a delayed fashion when an epithelial tract has had ample time to establish. All of these factors contribute to lack of spontaneous closure.

In addition to urinary and fecal diversion, minimally invasive endoscopic treatments have been attempted for small fistulas. Dolay et al. published a successful case of successful RUF treatment with endoscopic injection of fibrin glue into the fistula tract and rectal mucosal clipping [25]. A similar case report demonstrated success injecting fibrin glue into a complex RUF secondary to rectal Crohn's disease. The fistula resolved and had not recurred at 3 years of follow up [26]. We have also attempted a technique of injecting fibrin glue in men with small and uncomplicated RUF with some success, though small numbers. Fibrin glue theoretically works in these patients by occluding the fistula tract, promoting native fibrin deposition and stimulating fibroblast proliferation. It also stimulates epithelialization and neovascularity, all of which promote fistula resolution. This technique may be an option for those men with uncomplicated fistulas who fail conservative measures and either refuse or are not candidates for a definitive open repair. However, a standardized technique and more robust outcome data are necessary before this minimally invasive treatment option can be broadly recommended.

Open Surgical Management

The vast majority of rectourethral fistulas will require open surgical management. There are several basic surgical principles for optimization of outcomes with fistula repair. No matter which technique is chosen, complete excision of the fistula tract followed by a multilayer, tension free rectal and urethral closure is mandatory. In all but the simplest surgical fistulas, tissue interposition, usually accomplished with a local flap, will improve outcomes. Flaps are especially necessary for any redo procedures or large RUF associated with radiation and/or tissue ablation techniques [6]. Tissue interposition creates a space of separation between the prior fistulous communication and reduces the likelihood of fistula recurrence.

Timing of open repair is often dictated by surgeon preference and experience. It is generally our practice, and that of others, to wait 3 months after a diagnosis surgical fistula with urinary diversion +/− fecal diversion before proceeding with repair [6, 27, 28]. This allows the patient at least an attempt at spontaneous closure and gives time for tissue infection and inflammation to improve or resolve. In men with radiation induced fistulas or RUF following tissue ablation techniques we generally wait 4–6 months as the associated tissue inflammation and tissue necrosis is significantly increased in this group. Men presenting with sepsis or local infection must be adequately treated and fecal diversion is nearly always necessary in this group preoperatively. In those instances we will frequently delay repair slightly longer to allow sufficient tissue healing and resolution of infection.

Preoperative preparation depends on whether the patient has already undergone fecal diversion with a colostomy or ileostomy. If fecal diversion is planned as part of the fistula repair, a full polyethylene glycol mechanical bowel preparation ensures a stool free rectum during surgery. If a fecal diversion was performed prior to fistula repair this is unnecessary. IV antibiotics that cover both skin and gastrointestinal flora are administered within 1 h of incision. Patients with a prior fecal diversion can be fed immediately following surgery. Those undergoing diversion at the time of fistula repair or if electing to undergo repair without a covering fecal diversion should are kept NPO until return of bowel function.

Postoperative care depends on the fistula etiology. Urinary diversion is managed for all patients with a suprapubic tube (SPT) and Foley catheter following RUF repair. The Foley is kept in place for 3–4 weeks and a VCUG is performed at the time of Foley removal confirming the fistula resolution and absence of urethral stricture or bladder neck stenosis. If a fecal diversion is present, this is generally maintained for 3 months following fistula repair. Prior to reversing the diversion, repeat endoscopic and radiographic examination of the urethra is recommended to ensure complete resolution of the fistula tract.

Transanorectal (York Mason and Parks Procedure)

Historically colorectal surgeons rather than urologists performed the majority of rectourethral fistula repairs. As a consequence, surgical approaches utilized for other colorectal surgeries were more commonly used during fistula repair. Although innumerable techniques have been described, transanorectal procedure can broadly be divided into sphincter-splitting approaches (York Mason [29–31]) or more recently the sphincter-preserving transanal rectal advancement flaps (Parks procedure [32]).

Bevan was the first to describe transsphincteric rectal surgery in 1917 for rectal tumors [33]. Its application for the treatment of rectourethral fistulas, however, was not reported until 1969 by Kilpatrick and York Mason [29]. Transanorectal procedures begin by placing the patient in prone jackknife position. The buttocks are spread with adhesive tape. An incision is then made in the midline from the coccyx to the anal verge. The external sphincter is divided with care to place paired sutures at each level of the muscle. These sutures ensure proper sphincter alignment during reconstruction at the completion of the procedure. The rectum is then opened posteriorly along the incision, allowing exposure of the fistula tract. The fistula is sharply excised with a scalpel.

Prospectively catheterizing the fistula tract can be helpful during this portion of the case, but is not mandatory. After the fistula and associated inflammatory tissue has been excised, the rectum and urethra mobilized to allow sufficient separation. A tension free, layered closure of the urethral and rectal defects is then performed with absorbable suture. Three layers of tissue are utilized. The urethra is closed first over a Foley catheter. A substantial layer of anterior rectal wall muscle is approximated second followed by the rectal mucosa, which comprises the third layer. The sphincter is reconstructed and the presacral and overlying tissues cover the defect.

The largest experience with the transanorectal modified York Mason approach to RUF repair was presented in 2012 by Hadley and colleagues from the University of Utah [34]. Fifty-one patients at their institution underwent this approach to fistula repair over their 40 year experience. Only seven patients had radiation-induced fistulas with the remainder surgical fistulas. To date they have only experience five fistula recurrences with a greater than 90 % success rate. One of the failures was salvaged with a repeat York Mason procedure. The remainder underwent permanent urinary or fecal diversion. A summary of outcomes from this and other select series using this technique can be found in Table 8.1.

The other less commonly used transanal technique for RUF repair is a sphincter-sparing rectal advancement flap, or Parks procedure [32]. This approach is also performed in the prone jackknife position and involves transanal fistula exposure without incising the rectal sphincter or mucosa. Exposure is achieved with fixed anal retractors. Once the tract has been identified, a U-shaped broad based flap of rectal mucosa and muscle is raised. The apex of the U is situated through the fistula tract and the tract is excised. The defect is then closed in three layers: urethral mucosa approximated over the Foley catheter, rectal wall/muscle and rectal mucosa.

The rectal advancement technique is less commonly used, even by colorectal surgeons, secondary to reduced exposure and difficulty with fistula excision and repair. Garofalo et al. published a 20-year experience with rectal advancement flaps for RUF repair [35]. Over that time period only 12 men underwent attempts at fistula treatment utilizing this technique. At a mean follow up of 31 months, eight patients (67 %) were free from RUF recurrence. More recently, Joshi and associates presented their results with five patients using this technique [36]. All five men are asymptomatic without fistula recurrence at a median 11 months, though one did require a second procedure after failure of the initial attempt (80 % success at first attempt).

Although initially the mainstay of rectourethral fistula surgery, sphincter-splitting and preserving transanal fistula repairs are now much less frequently utilized. Sphincter preserving procedures are only useful in those men with small, distal, non-irradiated RUF in whom a more minimally invasive approach seems optimal. This approach is severely limited in its exposure and has no place in the treatment of larger fistula or those with associated radiation or tissue ablation injury. Additionally, while the urethra may be closed using this technique, rectal flap advancement is the primary means for fistula resolution. This ignores the presumption that the pressure gradient favors flow from the urethra into the rectum rather than vice versa [21]. That being said, morbidity following a transanal procedure is low and it does not preclude a transperineal salvage should the initial attempt at closure fail.

Sphincter-splitting transanal approaches are performed more commonly than sphincter-preserving ones and have demonstrated comparable outcomes to transperineal repairs (88 % overall operative success) [42]. However, this approach is limited in its versatility. Treatment of concomitant bladder neck stenosis or urethral stricture is not possible with a transrectal approach and interposition flaps can be more difficult. Ideal candidates are those with small-moderate sized fistulas (<2 cm) without a history of prior radiotherapy or tissue ablation. Men with larger fistulas or those with other complicating factors who undergo a transrectal repair are known to be at a significant disadvantage, demonstrating reduced operative success compared to small, non-radiated fistulas [34].

Table 8.1 Select large rectourethral fistula series and outcomes [5, 6, 23, 24, 28, 34–41]

					Treatment approach					Tissue flap usage					
Study	Year	Total RUF patients	H/o XRT or tissue ablation, *n* (%)	Temporary fecal diversion, *n* (%)	Resolution with conservative treatment, *n* (%)	Transanal, sphincter sparing, *n* (%)	Transanorectal, sphincter-splitting, *n* (%)	Transabdominal, *n* (%)	Transperineal, *n* (%)	Any, *n* (%)	Gracilis, *n*	Omentum, *n*	Other, *n*	Successful surgical RUF closure, *n* (%)	Mean follow up, months
Hadley et al.	2012	51	8 (16)	20 (39)	–	–	51 (100)	–	–	2 (6)	2	–	–	46/51 (90)	NR
Garofalo et al.	2003	23	3 (13)	16 (70)	4 (17)	14 (61)	3 (13)	2 (9)	–	–	–	–	–	13/19 (68)	31 ± 33.4
Joshi et al.	2011	5	–	3 (60)	–	5 (100)	–	–	–	–	–	–	–	4 (80)	11 (4–24)
Al-Ali et al.	1997	30	–	30 (100)	14 (47)	1 (3)	11 (37)	3 (10)	1 (3)	2 (12.5)	–	2	–	14/16 (87.5)	66 (18–132)
Rouanne et al.	2011	10	–	10 (100)	–	–	10 (100)	–	–	–	–	–	–	10/10 (100)	24 (18–28)
Kasraeian et al.	2009	12	2 (17)	6 (50)	–	–	12 (100)	–	–	–	–	–	–	9/12 (75)	22 (2–73)
Vanni et al.	2010	74	39 (53)	73 (98.6)	–	–	–	–	74 (100)	74 (100)	68	–	6	68/74 (92)	20
Voelzke et al.	2013	23	13 (57)	21 (91)	–	–	–	–	23 (100)	7 (30)	2	–	5	18/23 (78)	13 (3–39)
Ulrich et al.	2009	26	14 (54)	26 (100)	–	–	–	–	26 (100)	26 (100)	26	–	–	26 (100)	22 ± 14
Ghoniem et al.	2008	25	17 (68)	25 (100)	–	–	–	–	25 (100)	25 (100)	25	–	–	25 (100)	28 (3–132)
Wexner et al.	2008	36	20 (56)	36 (100)	–	–	–	–	36 (100)	36 (100)	36	–	–	28 (78)	NR
Lane et al.	2006	22	22 (100)	20 (91)	5 (23)	–	1 (4.5)	15 (68)	1 (4.5)	4 (24)	2	2	–	15/17 (88)	29
Nyam et al.	1999	16	7 (44)	7 (44)	3 (18.75)	2 (12.5)	2 (12.5)	3 (18.75)	6 (37.5)	3 (23)	NR	NR	NR	9/13 (69)	80 (8–180)

In the last 15–20 years, the proportion of men presenting with symptoms of a RUF who have previously been radiated has increased dramatically. Prior to 1997, 4 % of RUF were complicated by radiation whereas more than 50 % present with that history today [5, 6]. Thus, finding an ideal patient for a transanorectal procedure is becoming increasingly difficult. Additionally, although it has not been reported in the literature, concern for anal incontinence with a sphincter-splitting procedure is pervasive, especially with surgeons less familiar with this approach. For these reasons, some have argued that a transperineal approach to fistula repair is more adaptable to any situation and should be the procedure of choice for both uncomplicated and complicated fistulas [21].

Transperineal

A perineal approach to repair of rectourethral fistulas is becoming increasingly common and now represents the preferred technique for RUF surgery. Perineal exposure is something most urologists are comfortable with, given its use in a variety of urologic surgeries, including urethroplasty, incontinence procedures, urethrectomy, and others. In addition to addressing the RUF, this technique allows the treatment of concomitant bladder neck and urethral pathology in the same setting and is ideally situated for raising local flaps for tissue interposition.

The perineal approach to RUF repair begins with the patient in dorsal lithotomy or exaggerated lithotomy position. We most often utilized exaggerated lithotomy as this allows two surgeons to comfortably operate standing side-by-side, but this is a matter of surgeon preference. An inverted "U" or lambda incision is made in the perineum. The Jordan-Simpson perineal Bookwalter retractor or similar perineal retractor is helpful for exposure. The transverse perinei muscles are divided and the perineal body is completely incised. This allows the urethra to be elevated and a surgical plane developed in close proximity to the anterior rectum all the way up to the peritoneum. The rectum and urethra are widely mobilized and the fistula is divided and exposed.

Closure of both the rectum and urethra depend on the size of the fistula and resulting tissue defect. The rectum should always be closed in horizontal layers to avoid iatrogenic rectal stenosis. Larger fistulas may require more thorough rectal mobilization to close tension free, whereas smaller fistulas require less mobility. Small urethral defects are easily approximated over a Foley catheter in two layers. If the fistula is sufficiently large such that a primary closure is not possible, a tissue interposition is required. We prefer a buccal mucosa graft (BMG) onlay in this scenario, which allows closure of nearly any size urethral defect. When using a BMG, a vascularized bed is necessary to support the graft [43]. Depending on the location of the graft, this is most often accomplished with a gracilis muscle flap, but ischiocavernosus muscle, Singapore flap, levator muscle, or other healthy local tissue flap may be used. In addition to reducing the chance for recurrent RUF, the flap functions to fill the cavity with healthy tissue to promote imbibition and inosculation of the graft.

A significant advantage of the perineal approach is its versatility for men with concomitant urethral strictures or urethrovesical anastomotic stenosis. Urethral strictures can be approached in the same fashion as a primary urethroplasty with a few important distinctions. We generally favor non-transecting techniques for repair of urethral strictures in this setting to preserve urethral vascularity and promote healing. The proximal bulbourethral blood supply is often, if not always, sacrificed or damaged prior to or during fistula repair. For this reason, retrograde distal arterial supply from the dorsal and cavernosal arteries is exquisitely important. Bulbomembranous strictures can be managed with a ventral urethrotomy, extending the fistula tract through the strictured region. A longer BMG is then placed ventrally with a gracilis muscle flap for support. For strictures distant from the site of the fistula this technique is not feasible and we favor urethral mobilization and a dorsal urethrotomy and BMG onlay technique. Men with concomitant urethrovesical anastomotic stenosis may be managed with urethral mobilization, excision of the stricture segment and complete revision of the urethrovesical anastomosis. An inferior pubectomy may be required in these patients for adequate visualization of the bladder neck for repair. Alternatively an abdominaoperineal approach may be chosen, but we have not found this necessary in the majority of cases.

The largest series of transperineal RUF surgery was published by Vanni et al. in 2010 [6]. They retrospectively reported on 74 patients who underwent RUF repair at their institution. Of the 74 patients, 35 were non-radiated surgical RUF and 39 were radiation induced fistulas. An interposition flap was used in all patients, including a gracilis muscle flap in 92 % and a range of other flaps in the remainder. Urethral strictures were concurrently treated with BMG onlay in 11 % and 28 % of men in the radiated and non-radiated groups, respectively. At a mean follow up of 20 months, 100 % of the non-radiated men and 84 % of the radiated men were free of fistula recurrence in a single stage. Thirty-one percent of radiated patients required permanent fecal diversion secondary to permanent rectal damage or a noncompliant anal sphincter.

Several other centers have published results with transperineal repair of RUF (Table 8.1). Mundy and Andrich reported on 40 patients utilizing this technique (23 surgical, 17 radiation fistulas) [21]. A purely perineal approach was used in all surgical fistulas, however for radiation induced fistulas an abdominoperineal approach was performed in 14 of the 17 men. This allowed the fistula surgery to be combined with a salvage radical prostatectomy in eight men. With a minimal of 1 year follow up on each patient, 100 % of patient had resolution of their fistula, though some did require prolonged catheter drainage before complete healing of the urethra on urethrography.

More recently, Voelzke and associates reviewed their outcomes with a perineal approach to RUF repair in 23 patients. Different from the dorsal lithotomy position used in most perineal surgery, they opted for a prone jackknife position in 15 of the 23 men. Their rationale for this technique alteration was to reduce the exposure limitations, which are inevitable with the anterior pubic arch. As with transsphincteric procedures, however, this position limits ability to easily perform a gracilis muscle interposition flap. In this series a flap was utilized in only 7 of the 23 patients. At a mean 13 months of follow up, they found 100 % success rate in the surgical fistulas and 61.5 % with the radiation/ablation fistulas.

Transperineal approaches to RUF repair have many advantages over transrectal, sphincter-preserving or splitting procedures. This technique allows concurrent treatment of both urethral strictures and bladder neck contractures, both of which are found commonly in RUF patients, especially those with a history of radiation. Recent publications report a 25–30 % risk for concomitant bulbomembranous or bladder neck strictures in men with a radiation induced RUF [6, 28]. With patients already in the appropriate position for repair of that pathology it can be performed in the same setting without need for unnecessary repeat surgery through a complicated surgical field. The perineal approach is also the easiest with which to perform tissue interposition flaps, specifically the gracilis flap that is most commonly used. While it is possible to use a gracilis flap in the prone position, this may require harvesting the flap ahead of time with subsequent patient repositioning, adding time and potential complications to an already difficult procedure [28]. Finally, a perineal approach in the lithotomy position offers the opportunity to easily progress to an abdominoperineal procedure if a salvage prostatectomy or other concurrent procedures are necessary.

Gracilis Muscle Flap

The need for tissue interposition during RUF surgery is debated. Some high-volume centers argue that in uncomplicated small surgical fistulas a flap is unnecessary [21, 28]. Others suggest that flaps offer an important protection against fistula recurrence, even in a patient with a straightforward RUF [6]. Most would agree, however, that for radiation or ablation induced fistulas, tissue interposition reduces the risk for recurrence and is strongly recommended.

The gracilis muscle peninsular flap for use in rectourethral fistula repair was initially described by Ryan et al. in 1979 [44]. Since the initial description it has been widely accepted and now represents the most common flap used during RUF surgery. It has been consistently proven to offer excellent outcomes compared with other local tissue flaps [6, 27, 37, 38]. While no randomized trials exist, small comparative studies do show an advantage with the addition of a gracilis flap interposition compared with no flap for RUF repairs [23]. A primary reason for widespread acceptance of this flap for perineal surgery is its versatility. It can be harvested from one or both legs without significant morbidity or loss of function. It is consistently present in patients regardless of age or gender, and it easily rotates into the perineum without tension. Finally, the proximal pedicle off the profunda femoris is hardy and flap necrosis is rare as long as an adequate tunnel is created.

The gracilis muscle is a long (25–30 cm), thin muscle originating at the ischiopubic ramus and inserting on the medial condyle of the tibia (Table 8.2). The predominant vascular pedicle is supplied by the medial circumflex femoral artery, which is a branch of the profunda femoris on the proximal aspect. The pedicle can usually be found about 10 cm from the gracilis muscle origin. Distal pedicles are small branches off the superficial femoral artery and can be sacrificed without concern for flap compromise. One or two vessels comprise the primary venous drainage and usually accompany the artery.

Table 8.2 Gracilis muscle characteristics

Function	Medial hip rotation and adduction, knee flexion
Size	4–8 cm width; 25–30 cm length (depending on leg size)
Arterial supply	Medial circumflex femoral artery (branch of profunda femoris)
Origin	Ischiopubic ramus
Insertion	Medial tibial condyle

With the patient in lithotomy position, the muscle belly can be palpated between two fingers at the medial thigh approximately 10 cm from the ischiopubic ramus, marking the approximate point of the primary vascular pedicle (Fig. 8.3a). A medial thigh incision is made from this point distally towards the site of insertion. The incision can either be extended all the way to the tendinous insertion or alternatively a counter-incision can be made at that point. The dominant vascular pedicle is prospectively identified early, such that distal dissection can proceed quickly. A vascular Doppler can be used to aid in locating the vessel if it is difficult. Once the artery has been safely marked the muscle is circumferentially controlled with a Penrose drain for retraction (Fig. 8.3b, c). The distal attachments can be bluntly freed with selective use of electrocautery. With the muscle mobilized to its insertion, the proper tendinous attachment is confirmed with gentle traction on the muscle while palpating the tendon. It can then be incised with cautery. The gracilis muscle is then rotated back 180° through the thigh incision towards the perineum (Fig. 8.3d). Care must be taken not to twist the flap and occlude the arterial supply. A generous subcutaneous tunnel is created from the thigh incision into the perineal incision; the muscle is transposed and sutured in place (Fig. 8.3e). The thigh is closed in layers and a closed suction drain is left for several days. A compressive wrap on the leg may be placed to reduce the risk for hematoma formation.

Though not well documented in the literature, complications following gracilis muscle harvest appear to be minimal and the procedure well tolerated. The gracilis muscle functions to medially rotate and adduct the hip as well as flex the knee. After the muscle is harvested the adductor longus and magnus replace the functionality and motor defects have not been reported [38]. There is a small risk for hematoma formation with gracilis harvest, especially if a minimal incision is attempted with counter-incision over the insertion site. This requires

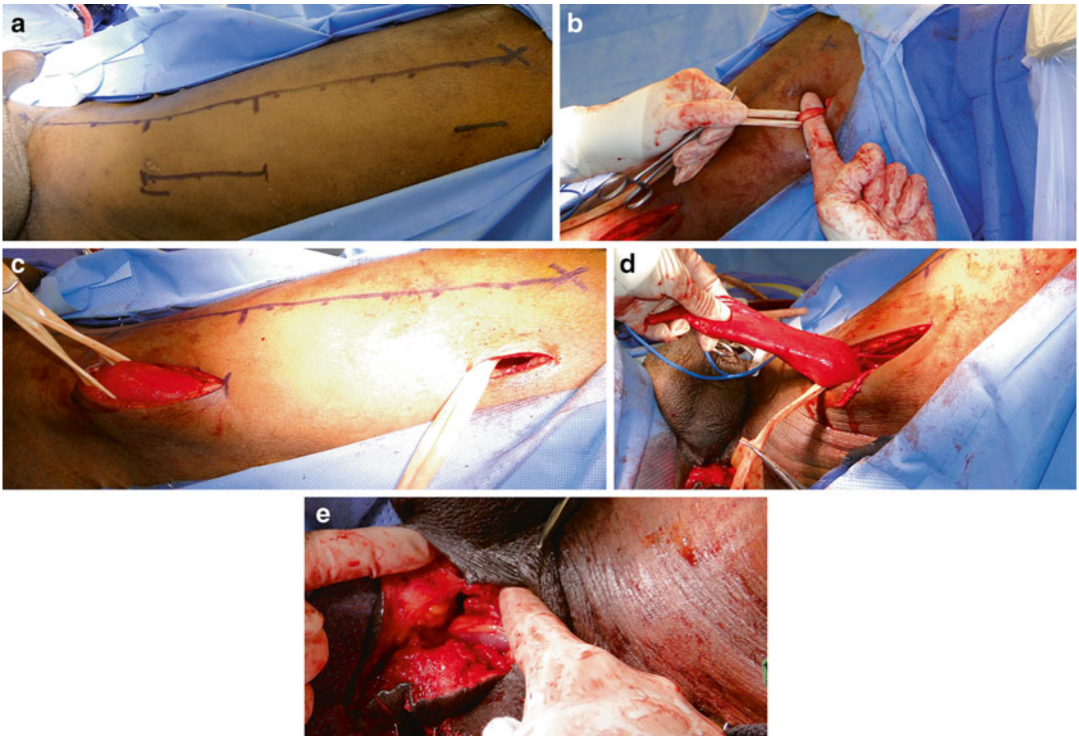

Fig. 8.3 (**a**–**e**) Intraoperative photos during gracilis flap harvesting. Preoperative skin marking demonstrate the approximate location for the dominant vascular pedicle (**a**). A skin incision overlying the muscle belly allows dissection of the muscle with a counter incision for transection of the tendon (**b**, **c**). The muscle is rotated 180° (**d**), tunneled and sutured in place in the perineum (**e**)

blind dissection and vessels may not be adequately controlled. The postoperative compressive wrap should help to reduce this risk.

Minimally Invasive Surgical Management

Minimally invasive approaches to rectourethral fistulas are in their infancy and have been described only in case reports and small series of three to four patients. Sotelo and colleagues published their results with two patients performing a purely laparoscopic fistula repair [45]. One patient developed a fistula after a low anterior resection for rectal cancer and was managed with a simple laparoscopic prostatectomy and fistula closure. The neurovascular bundles were used for tissue interposition. Another patient developed a RUF after radical prostatectomy with the fistula near the urethrovesical anastomosis. This fistula was managed with a laparoscopic, transvesical approach. The tract was excised, rectum closed and an omental flap was interposed. No fistula recurrences were reported.

Gozen and colleagues have also reported on two patients undergoing laparoscopic RUF repair. In both cases, a laparoscopic prostatectomy was performed followed by rectal closure and urethrovesical anastomosis. A peritoneal flap was used in one patient and a tunica vaginalis flap in another for interposition. No recurrences were noted at more than 8 months follow up.

Laparoscopic surgery is now widely accepted for many urologic procedures. Its use in rectourethral fistula repair, however, is only beginning to be described. While a technique utilizing robotic assistance has never been published, this technology certainly has the potential to make a laparoscopic fistula repair less daunting. However, the merits of a minimally invasive approach to RUF repair has not, and may never be, adequately articulated. Morbidity associated with either transperineal or transrectal fistula surgery is minimal, the risk for postoperative ileus is low, and there is no risk for damage to intra-abdominal structures. None of these can be stated confidently with laparoscopic approaches for fistula closure. Experienced laparoscopic surgeons must describe consistent results and a reliable technique before it can be accepted as an option in the fistula armamentarium.

Conclusions

Rectourethral fistulas today are most often a rare complication from the treatment of prostate cancer. When they do occur, however, patients suffer significant morbidity with negative effects on quality of life. Contemporary large series of RUF report a dramatic increase in the complexity of men presenting with RUF. While most RUF were formerly surgical fistulas without associated radiation injury, patients with RUF presenting today are frequently caused by or complicated by a history of radiation and tissue ablation techniques. Unfortunately, these complex fistulas are often larger, more difficult to treat, and have proven to have worse outcomes following surgical correction compared with uncomplicated RUF. Liberal use of tissue interposition flaps, such as the gracilis muscle flap, as well as judicious application of fecal diversion will optimize patient outcomes. While the vast majority of patients can be successfully cured, men with end-stage bladders and large complex fistulas may be best managed with cystectomy and urinary diversion and should be counseled on that option.

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