Complex Urinary Fistulas of the Posterior Urethra and Bladder

24

Steven B. Brandes

Summary

The management and reconstruction of complex rectourinary and vesicoperineal fistulas are some of the most difficult problems to treat in urology. To decide on the proper management, a detailed knowledge of the fistula etiology, integrity of the anal and external urethral sphincters, functional status of the bladder, extent of rectal radiation damage, size and location of the urinary fistula, and the overall performance and nutritional status of the patient is needed. Few surgeons have had a large experience with such fistulas and this explains why there is no clear standard surgical approach. Treatment needs to be tailored to the specifics of the fistula, the etiology, and the patient. Fistulas that result from radiation therapy are more complex and difficult to reconstruct than those developing after other forms of treatment, with the frequent concomitant problems of urinary and fecal incontinence and/or urethral stricture. Small, nonradiated fistulas are successfully managed by the transanal or York-Mason approach. Complex fistulas that are large, or of radiation or cryotherapy etiology, are often best managed by primary repair, buttressed with a gracilis interposition flap, or by proctectomy and colo-anal pull through, or supravesical urinary diversion. Herein we have detailed the varying surgical methods for fistula repair as well as for salvage.

Introduction

To decide on the proper management of a rectourethral fistula (RUF), a detailed knowledge of the fistula etiology, integrity of the anal and external urethral sphincters, functional status of the bladder, extent of rectal radiation damage, size and location of the urinary fistula, and the overall performance and nutritional status of the patient is needed. Small, nonradiated fistulas often are successfully managed by the transanal or York-Mason approach. Complex fistulas that are large or of radiation or cryotherapy etiology are often best managed either by primary repair, buttressed with a gracilis interposition flap, proctectomy, and colo-anal pull through, or if the bladder and sphincter function is poor, by supravesical urinary diversion.

Fistula Etiology

By definition, a fistula is an extra-anatomic, epithelialized channel between two hollow organs or a hallow organ and the body surface. Acquired RUFs are uncommon and are usually the result of

S.B. Brandes, MD
Division of Urologic Surgery, Department of Surgery, Washington University School of Medicine,
660 S. Euclid, Campus Box 8242,
St Louis, MO 63110, USA
e-mail: brandess@wustl.edu

S.B. Brandes, A.F. Morey (eds.), *Advanced Male Urethral and Genital Reconstructive Surgery*, Current Clinical Urology, DOI 10.1007/978-1-4614-7708-2_24,

trauma, pelvic radiation therapy, iatrogenic injury during pelvic surgery (such as laparoscopic and open radical prostatectomy, prostate cryotherapy, or abdominal perineal resection), or an infectious or malignant tumor cause. Concomitant urethral and rectal injuries from blunt abdominal trauma and pelvic fracture or penetrating missile injury has been reported as a cause (yet, admittedly rare cause) for RUFs. Potential infectious causes of RUF include Crohn's disease, fistula in ano, perirectal infections, or tuberculosis. With the increased usage of brachytherapy and its combination with external beam radiotherapy boost, particularly devastating fistulas can occur. Most of the reported cases in the literature are from radical retropubic (laparoscopic or open) or perineal prostatectomy, with an incidence of 1–3.6 % for the former and up to 11 % for the later. Rectourethral fistulas after brachytherapy are reported in up to 0.4–0.8 % of cases and for brachytherapy plus external beam radiation therapy (EBRT) up to 2.9 % [1]. Such radiation fistulas are more common when being used as salvage therapy or if the anterior rectal wall has been biopsied after RT. Transanal rectal wall or rectal ulcer biopsies (via sigmoidoscope) in the pelvic RT patient are unwise and have a high chance of eliciting a RUF. Reported average time from last RT session until RUF diagnosis is roughly 2 years. Mean time from a rectal procedure till RUF is 4 months. Few surgeons have had a large experience with RUF, and thus, there is no clear standard surgical repair approach. Treatment needs to be tailored to the specifics of the fistula, the etiology, and the patient. Fistulas that result from radiation therapy are more complex and more difficult to reconstruct than those developing after other forms of treatment, with the frequent concomitant problems of urinary and fecal incontinence, and/or urethral strictures.

Rectourinary Fistulas

Signs and Symptoms

The presence of an RUF fistula is typically readily apparent. The most common symptoms are watery stools (in roughly 90 %), urinary incontinence, irritative voiding complaints, and pneumaturia and fecaluria (in roughly 60 %). To a lesser degree, patients present with dysuria, fever, discolored or feculent urine, recurrent urinary tract infections (usually poly-organism), or with an associated metabolic acidosis from systemic absorption (via the colon) of the urine. One of the initial signs of a developing RUF after RT or cryotherapy typically is severe rectal pain, which resolves when the necrotic/ischemic tissue eventually breaks down and the fistula occurs. Although uncommon, pelvic and abdominal sepsis can also be the presenting event (in roughly 10 % of cases).

Diagnosis

Methods used to diagnose a RUF include endoscopic and radiographic means (Fig. 24.1). Cystoscopy is used to determine the degree of radiation damage to the bladder as to capacity and compliance and the location of the fistula in relation to the ureteral orifices and the bladder neck. Proctoscopy is used to determine the level of rectal entry, to identify the fistula, fistula proximity to the anal sphincter, and to rule out other rectal-colon pathology (radiation proctitis, concomitant colon cancer). Other important evaluation methods are examination under anesthesia, digital rectal exam, and retrograde urethrography (RUG) and voiding cystourethrography (VCUG; Fig. 24.2). Computed tomography (CT) of the pelvis is typically fairly sensitive and specific qualitatively for diagnosing a fistula, with the note of air in the bladder (without any prior instrumentation), but not readily for location and size of the fistula. Rectovesical fistulas on CT imaging will typically show a thickened trigone and posterior bladder wall and nonspecific bladder air (without being instrumented). For cases of high index of suspicion but negative studies, an oral charcoal slurry test followed by urinalysis for charcoal can be performed. The Bourne test is also helpful in making a diagnosis. Here, oral contrast is consumed by the patient, or a hypaque enema performed, and the urine collected, centrifuged, and X-rayed. Radioopaque material in the radiograph confirms the presence of a fistula. When the fistula is small, flow through the fistula is typically in "one way,"

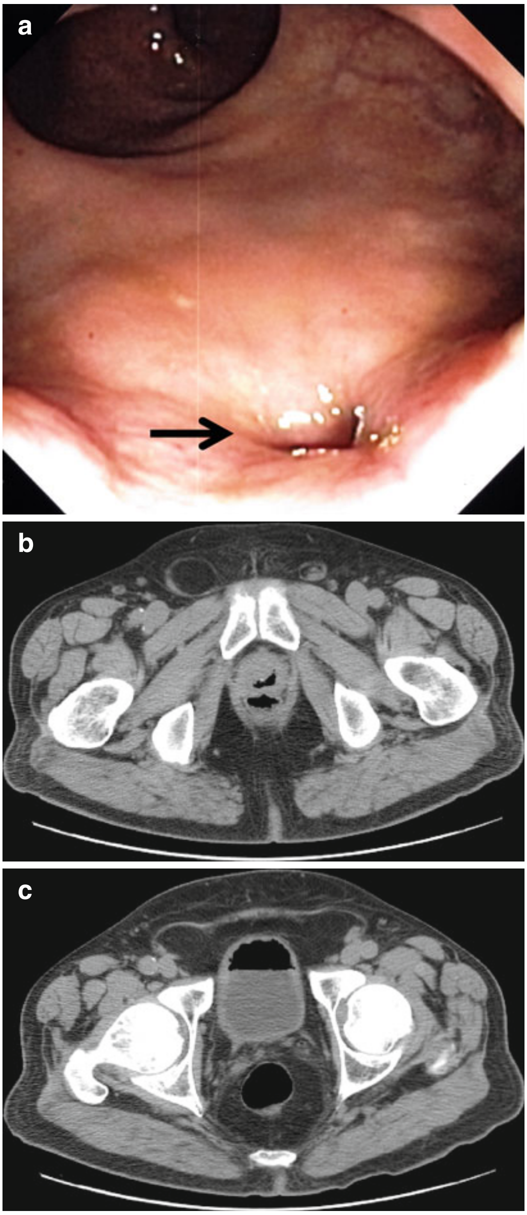

Fig. 24.1 Prostatorectal fistula after cryotherapy for low stage prostate cancer. (**a**) Colonoscope view of fistula (*arrow marks* fistula). (**b**) Pelvic CT of the fistula. Note air in prostate and rectum (noninstrumented system). (**c**) CT demonstrating air in bladder (noninstrumented system)

from the high-pressure to low-pressure system. The low transsphincteric RUF of Crohn's disease or an anterior rectal space infection is difficult to diagnose and often demands magnetic resonance imaging of the pelvis, combined with meticulous transanal examination.

Fig. 24.2 Cystogram demonstrating vesicorectal fistula

Preoperative Assessment and Decision-Making

To decide how to manage and repair RUF, it is essential to preoperatively determine the function of the anal and external urethral sphincters, the presence of a concomitant urethral stricture or bladder neck contracture, the visible and palpable health of the tissue adjacent and near the fistula, and the size and location of the fistula (particularly in its proximity to the ureteral orifices). Another important factor to determine preoperatively is patient nutritional status, performance status, and overall condition. Cigarette smoking will greatly impair the chances for a successful fistula repair and reconstruction. We routinely send such patients to a smoking-cessation program.

The function and capacity of the bladder is also important to determine. Unfortunately, urodynamics is usually difficult, if not impossible, to perform in patients with a large RUF. Although others claim that a Fogarty balloon can be passed to occlude the fistula and then perform a urodynamics study, we have not had success with this technique.

Instead, we typically rely on the visual appearance of the bladder urothelium as a surrogate measure of bladder radiation damage and postfistula repair poor bladder capacity. Urothelium that appears white/blanched or hemorrhagic (friable with multiple telangiectasias) often demonstrates bladder dysfunction and radiation damage. Such visual changes do not portend well for good postsurgical bladder capacity.

Urinary and Fecal Diversion

Indications for Diversion

Patients who present with RUF but without evidence of surrounding inflammation or sepsis, fecal, and urinary diversion are not essential prior to fistula repair and can be delayed till the time of fistula surgery. However, if the patient is particularly symptomatic and suffers from recurrent sepsis, severe rectal pain, or overwhelming urinary and/or fecal incontinence, then fecal and urinary proximal diversion should be performed and the patients nutritionally supplemented. Conversely, if a patient with a radiation RUF has not been diverted before presentation, such patients typically undergo fecal and urinary diversion to prevent sepsis and to reduce inflammation around the fistula track.

In rare and fairly select cases, some small surgical fistulas (up to 25 %) will close spontaneously with just urinary (suprapubic or Foley catheter) and/or rectal diversion and suppressive antibiotics. Such conservative therapies are usually reserved for poor surgical candidates [2].

Moreover, if the rectal sphincter is irreversibly injured or incompetent, an end colostomy is usually the better option for fecal diversion. If a reconstructive procedure is a potential option, a temporary loop ileostomy (upstream segment of bowel), which can easily be performed laparoscopically, is also performed. Laparoscopic loop ileostomy is a quick, less invasive, and readily reversible form of diversion without the need for a staged laparotomy for reversal. For cases of tenuous repair, previous failed attempts at fistula repair, complex (radiation or cryotherapy induced), or large fistulas that cannot be closed primarily and require adjunctive procedures such as a patch graft and/or muscle interposition flap, fecal diversion is generally mandatory for a successful outcome. A general rule of thumb is that if the tissues are friable and the repair tenuous, then temporary fecal diversion should be part of the reconstruction.

Anatomy of the Anal Sphincter and Rectum

An intimate knowledge of the rectal and anal anatomy allows for successful fistula repair, with limited morbidity. The levator ani muscles are divided in a lateral and medial division: the medial division is the puborectalis sling, which forms a muscular sling that arises from the pubic bone and encircles the anorectal flexure. This sling is crucial to maintaining fecal continence. The most caudal part of the sling forms the longitudinally oriented external anal sphincter (Fig. 24.3). The blood supply to the levator ani and the external and internal anal sphincters is the pudendal artery, while the nervous innervation comes from the pelvic plexus, from the S2–S4 nerve roots. The nerves and vasculature to the rectum are enclosed within a fascial capsule, known as Waldeyer's fascia. The ventral aspect of Waldeyer's fascia is more commonly known as Denonvilliers fascia.

Specific Reconstruction Methods

As to evidence that there is no one correct method and that there is uncertainty as to what the best approach for repair is, there are numerous surgi-

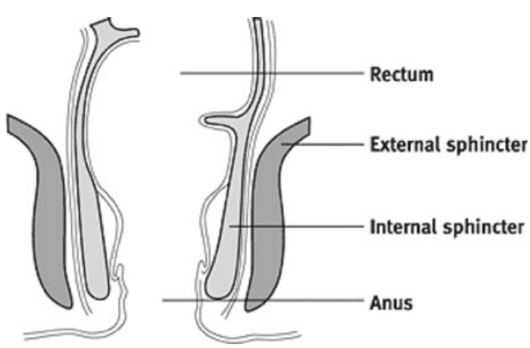

Fig. 24.3 Muscles of the anal sphincter

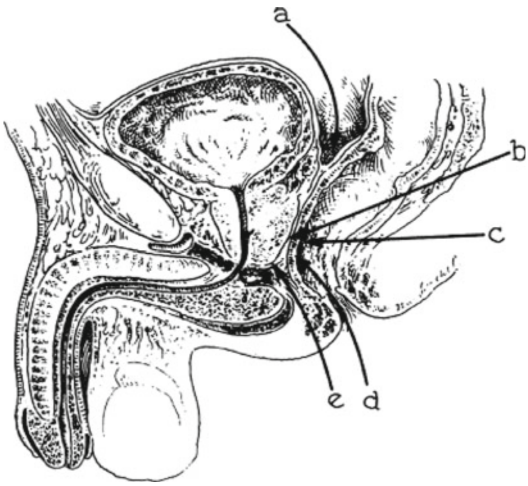

Fig. 24.4 Approaches for repair of rectourethral fistulas. (*a*) Transabdominal. (*b*) Kraske laterosacral. (*c*) Posterior transsphincteric (York-Mason). (*d*) Transanal. (*e*) Perineal (From Wood [3])

cal procedures detailed for fistula repair. The surgical technique selected is largely dictated by the surgeon's preference as well as the size, location, and etiology of the fistula (Fig. 24.4).

Transanal Rectal Advancement Flap

A sliding rectal advancement flap performed transanally is an effective method for small non-radiated, low-lying prostate-rectal fistulas [4]. The procedure is very well tolerated and relatively minimally invasive. Reported success rates range from 75 to 100 %. The patient is placed jackknife prone, the anus dilated, and a speculum and/or Lone Star retractor used to expose the fistula in the anterior wall of the rectum. The tissue surrounding the fistula (lateral and distal) is de-epithelialized. A "U"-shaped incision is made in the rectal wall to create a full-thickness rectal wall flap that is advanced distally to cover the fistula and sutured to the edges of the caudal denuded rectal mucosa (Fig. 24.5). The fistula is closed primarily with interrupted absorbable polyglactin (Vicryl) sutures. No suture lines are overlapping. We have had particularly good success with this technique for surgical fistulas after open or laparoscopic radical prostatectomy. As a relatively minimally invasive procedure, proximal fecal diversion is typically not performed. For failures, the advancement flap can be repeated along with a diverting loop ileostomy and urinary diversion. The other option for failures, which is preferred, is the anterior transperineal approach, buttressed with gracilis muscle flap.

Posterior-Sagittal Approach

For fistulas that are too low to approach from the abdominal incision and too high to access from below, the posterior-sagittal approach was described in the late 1800s. Kraske popularized this technique, where a posterior midline incision is made extending to the left paramedian aspect of the coccyx and sacrum, that often required coccygectomy and sacrectomy. Here, the rectum is swept laterally to avoid dividing the anal sphincter.

York-Mason Repair

The York-Mason technique is a posterior, midsagittal, trans-anosphincteric approach to RUF repair [5]. It is the most reported and widely used repair method. It is often not necessary to perform concomitant fecal and urinary diversion at the time of the fistula repair. In general, York-Mason repairs are useful and successful in small postsurgical fistulas (especially those that follow radical prostatectomy) that are too proximal and thus hard to reach with a sliding rectal flap. York-Mason is not suitable for large, complex (radiation, cryotherapy, etc.) fistulas that may require an interposition muscle flap, concurrent urethral reconstruction, or patch grafting. Other relative contraindications for the York-Mason are prior anorectal dysfunction or impaired wound healing (e.g., after RT or in patients with HIV). In the properly selected patient, York-Mason had good success without severe bowel dysfunction or fecal incontinence, except for a higher incidence of impaired flatulence control.

The key to preventing fecal incontinence is a midline transsphincteric incision and careful tagging of the sphincteric muscle, followed by an anatomical restoration of the rectal wall. The patient initially is cystoscoped and a wire and subsequent catheter placed across the fistula. The patient is then placed prone, jackknife, the buttocks taped laterally, and an incision made from the tip of the coccyx to the anal verge (Fig. 24.6, inset). The posterior anal sphincter is divided and each layer

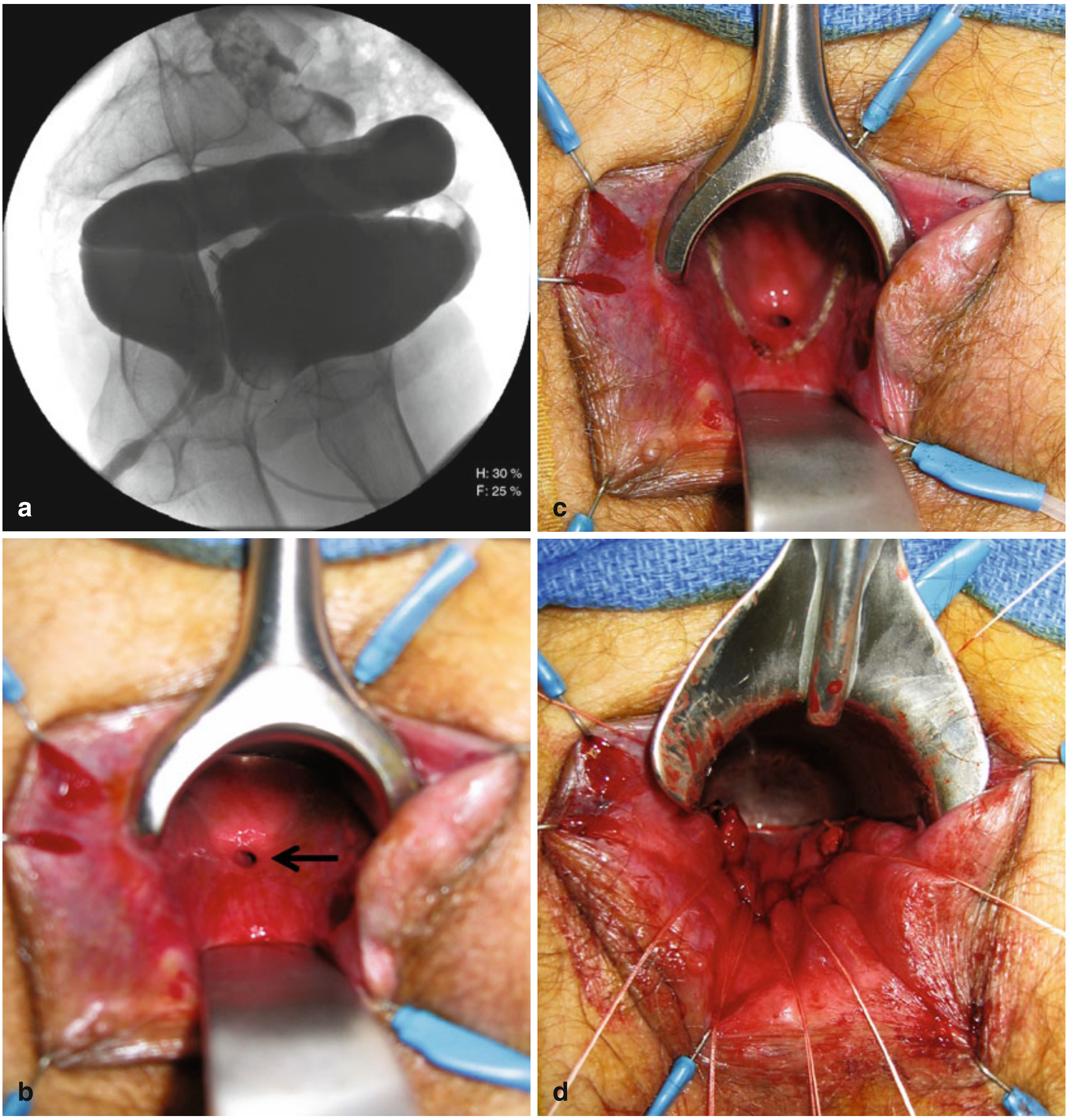

Fig. 24.5 Bladder neck-rectal fistula after salvage radical prostatectomy for post-HIFU local recurrence. (**a**) Hypaque enema demonstrating bladder filling. (**b**) Transanal view of fistula (*arrow*). (**c**) Sliding flap marked out. (**d**) Sliding rectal flap advanced distally and sewn into place with interrupted sutures

is carefully tagged for subsequent reconstruction. The anterior rectum and fistula are well exposed once the posterior rectal mucosa is divided (Fig. 24.6). The main advantage to the York-Mason approach is that it allows rapid access through unscarred tissue and provides a wide working space to operate in. The posterolateral rectal innervations, urinary continence, and potency are consistently preserved by staying in the midline and avoiding the lateral pelvic and pararectal space. The fistula is sharply excised, and the rectum and urinary tracts are separated and undermined. After closure of the fistula in the urethra, a full-thickness rectal wall flap is developed and sutured down in a "vest over pant" method. In so doing, the suture lines do not overlap. Alternatively, a fish-mouth-shaped excision of the fistula followed by primary closure can be made. The rectum is closed in two layers

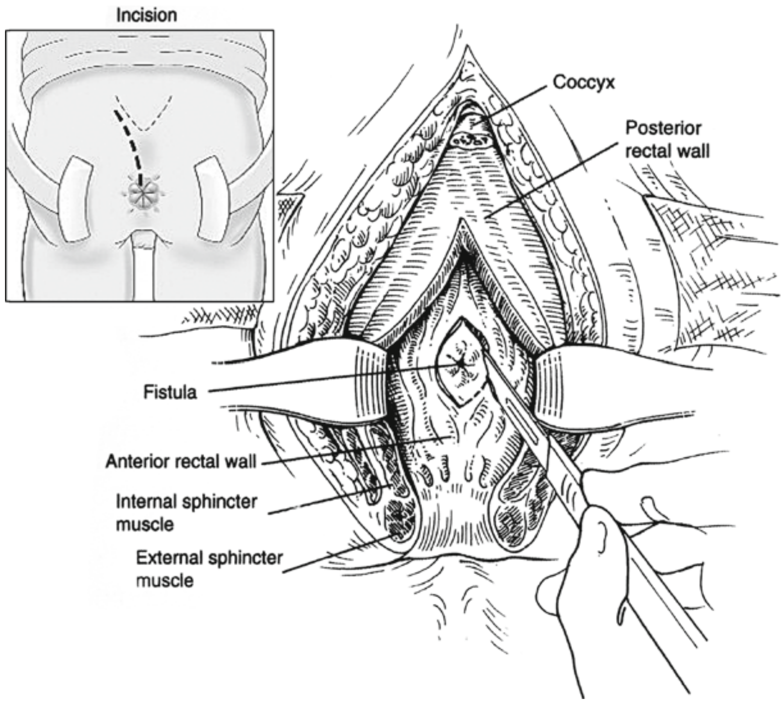

Fig. 24.6 York-Mason posterior transsphincteric approach (Modified from Jones et al. [4])

with absorbable interrupted sutures. Each of the paired anal sphincter sutures is then tied and the rectal wall and the sphincteric muscle components carefully restored. A presacral drain is left in place for 2 days. Urethral catheterization is maintained for 3 weeks or until cystourethrography demonstrates no leak. This approach, in the properly selected patient, has a low recurrence rate and demonstrates that anal sphincter can be divided and not result in fecal incontinence.

Large and Complex Fistulas

For large prostatorectal or perineal urinary fistulas in radiated field, salvage prostatectomy sounds at first like a good idea. However, in our hands, we have found that salvage prostatectomy typically results in vesicourethral anastomotic stricture and/or severe urinary incontinence. Therefore, we prefer either to repair such urinary fistulas by the methods detailed in this section or to perform an exenterative pelvic surgery with concomitant ileal or colo-conduit, or at times, a continent catheterizable stoma/neobladder [6].

Transperineal Approaches

For repair of RUF, we prefer to use an anterior perineal approach augmented with a gracilis muscle flap for bulk and vascular tissue interposition. Obviously, fistula size, etiology, location, failed prior attempts of repair, and concomitant urethral or bladder neck stricture determine the specific procedure.

Transsphincteric Anterior Approaches

We have found the transsphincteric method of Gecetler [7] to be successful for small fistulas of postsurgical (after open or laparoscopic prostatectomy) or trauma (pelvic fracture) etiology and/or when a simultaneous urethral stricture and reconstruction is planned. A normal anal sphincter and lack of any anorectal pathology is essential. The patient is placed in the lithotomy position with stirrups. The patient is cystoscoped and the fistula cannulated with a wire, which is subsequently pulled out the rectum and used as a guide for Fogarty or Foley placement through the fistula, via the rectum. An incision is made in the midline perineum from the scrotal base to the anal verge. The transverse perinei, the perineal body, and the anal sphincter (through both the external and internal anal sphincter and rectal wall) are divided in the posterior midline, in the same manner as a York-Mason. Each of the components of the internal and external anal sphincter is carefully tagged with sutures in pairs for subsequent anatomic reconstruction of the sphincters (Fig. 24.7). A bulbar or membranous urethral stricture can be repaired at this time either by excision with primary urethral anastomosis (for a short stricture) or by a substitution method of graft or flap (for longer, more complex, strictures). The fistula is repaired primarily of with a free graft, followed by a buttress of a gracilis muscle flap, transferred from the posterior medial thigh (Fig. 24.8). The sphincters are reconstructed and the rectum closed in two layers with absorbable polyglactin suture. Catheters are maintained for a minimum of 3 weeks, or until the cystogram shows no leak. Anal sphincteric control of solid stool takes roughly 3 weeks, whereas control of liquid and gas typically takes 6 or more weeks. If a fecal diversion has been performed, we usually delay reversal for at least 3 months after fistula repair, when cystoscopy and/or urethrography demonstrates a healed rectal and urethral lumen and the anal sphincter is intact and functional.

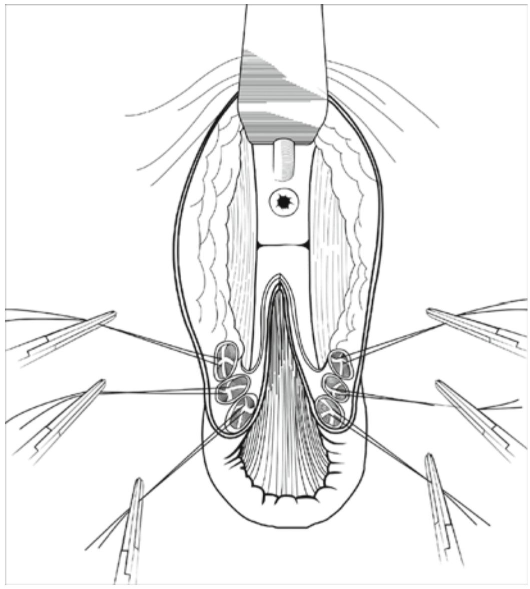

Fig. 24.7 Transsphincteric anterior approach to a RUF (after Gectler). Note tags on divided anal sphincter

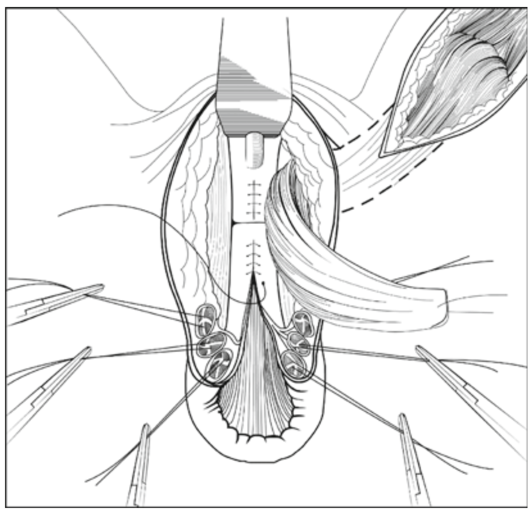

Fig. 24.8 Gracilis interposition flap to repair fistula

Anterior Perineal Approach

In general, the anterior perineal approach buttressed with gracilis muscle is our preferred method for repairing RUF (Fig. 24.9) [8]. The patient is placed in the lithotomy position, and a classic inverted "U" incision (perineal prostatectomy-like incision) is made in the perineum (Fig. 24.9a). A transverse incision is made 3 cm anterior to the anal verge and then carried medial to the ischial tuberosities and posteriorly to lie lateral to the sphincter at 3 and 9 o'clock. The ischiorectal fossa is then dissected out bilaterally bluntly and with electrocautery. The central tendon is isolated bluntly and then divided (Fig. 24.9b). Dissection is then performed between the longitudinal rectal fibers on the ventral aspect of the rectal wall and the external anal sphincter. A finger in the rectum helps control the depth of dissection. The longitudinal fibers of the rectum are followed to the rectourethralis muscle, which attaches to the rectum to the posterior GU diaphragm. The rectourethralis is then divided. A plane is dissected between the rectum and the prostate and bladder to the level of the peritoneal reflection. The dissection starts superior to the anal sphincter and is then carried down onto the rectum. By avoiding any lateral or posterior dissection, the innervation

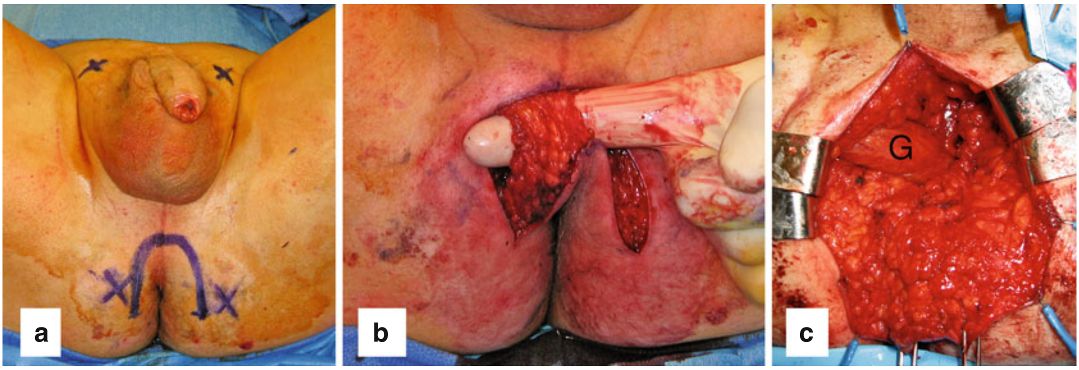

Fig. 24.9 Rectourethral fistula. (**a**) Exposure in lithotomy position by inverted "U" incision. "X" marks ischial tuberosities. (**b**) Transection of central tendon as is done with perineal prostatectomy. (**c**) Gracilis flap from right thigh shown mobilized and placed as an interposition flap and fistula coverage

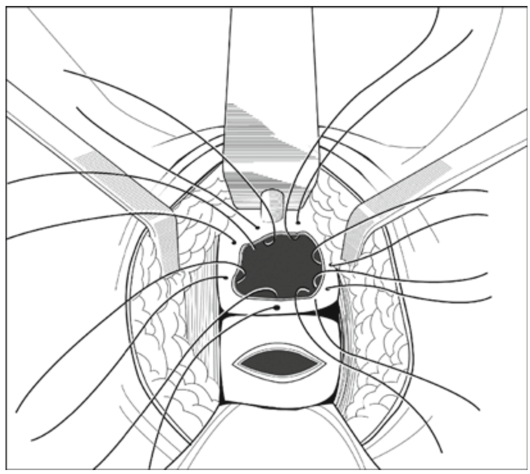

Fig. 24.10 Perineal approach and exposure of prostate-rectal fistula. Note wide separation of the prostate and rectum and stay sutures placed in the prostate to "parachute" a buccal graft

of the anal sphincter is preserved. A Lowsley prostatectomy sound (retractor) can be placed in the urethra and into the bladder to help localize and palpate the prostate and the fistula. A blue colored Foley catheter (modified into a council with a distal hole) placed into the bladder over a guide wire greatly facilitates dissection. Often times, the Lowsley can be difficult to place because the pelvis/prostate are often fixed. Otherwise, under cystoscopic guidance, a wire and subsequent small council tipped catheter is placed across the fistula. If the fistula is small (<12 FR), it can be dilated with sounds until a size that a small catheter can be placed across. The rectum, urethra, and prostate are widely separated (Fig. 24.10). The rectum is widely mobilized and preferentially closed transversely in two-layered closure to prevent anal stenosis. The fistula margins are typically debrided till a supple margin. The hole on the urinary side is closed primarily with interrupted suture, if the fistula is small. When the defect is too large to be easily closed primarily, a tailored buccal graft is placed on the urethra or prostate fistula defect. It is important to quilt the graft to the gracilis muscle first and then sew the whole complex – both muscle and graft together to cover the fistula. In this way, you insure good apposition of the graft and muscle – and this promotes better graft take, rather than sewing the graft in first.

When there is a concomitant stricture of the membranous urethra, the urethrotomy can be extended ventrally from the level of the fistula and through the stricture. Into the defect (stricturotomy) a muscle flap augmented buccal graft or only flap is typically placed. The proximal graft is covered with a well-vascularized gracilis muscle flap, while the proximal bulbar areas can be covered by the corpus spongiosum (as in a spongioplasty; Fig. 24.11). The grafts are fenestrated and quilted/sutured to the gracilis muscle. In so doing, the muscle acts as the vascular bed for the graft. The muscle flap is the main reason that the fistula repair is successful, by separating the rectal and urethral suture lines, filling the

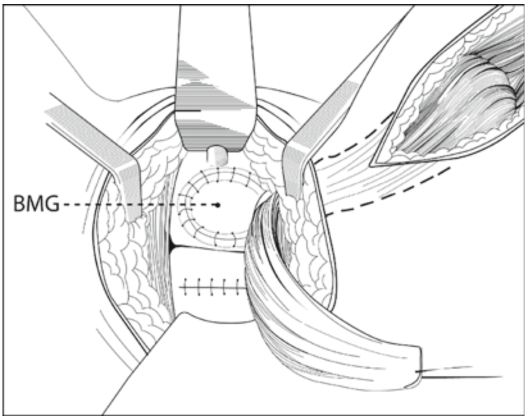

Fig. 24.11 Completed buccal graft to prostatic fistula. On the right is a gracilis muscle flap mobilized as an interposition flap and to provide buccal graft vascularity. *BMG* buccal mucosal graft

Table 24.1 Gracilis muscle flap characteristics

Function	Adducts the thigh and flex the knee
Origin	Ischium and inferior ramus of pubis
Insertion	Medial tibia
Nerve supply	A branch of the obturator nerve (L2, 3, 4)
Size	4–8 cm wide; length = patient's inner thigh length
Blood supply	Single artery of profunda femoral artery
Artery	Small; <1–2 mm
Vein(s)	2 venae, 1 often larger than the artery (1.5–3 mm)
Pedicle length	Usually no more than 4 cm

dead space, and interposing well-vascularized nonradiated tissue that can act as a host bed. The transperineal approach with muscle flap interposition has a reported success of roughly 84 % (for radiated/ablation fistulas) and close to 100 % for nonradiated fistulas [9]. The transperineal approach is best suited when the rectum and perirectal tissues are not overly damaged and will allow adequate healing and primary closure of the rectum.

Potential complications of this method can be significant and include minor fecal soiling (up to 25 %), anal stenosis (4 %, managed by periodic dilation), and urinary incontinence (29–75 %). In severe cases, the urinary and fecal outlets are devastated, resulting in permanent urinary diversion (up to 16 %) (FN 11) and fecal diversion (colostomy) in 16–31 %, with 31 % for radiated/ablation fistulas [2, 9–11]. For stress urinary incontinence, this can be successfully managed by a staged, transsphincteric artificial urinary sphincter. However, urge incontinence, because of a small contacted radiated bladder, is very refractory to conservative treatments, such as anticholinergics. Such patients will require adjunctive procedures such as augmentation cystoplasty or exenterative procedures and urinary diversion. In our recent review of our last 17 patients with RUF, we concluded that in patients that are pelvic radiation naïve, small RUF can successfully be managed by rectal sliding advancement flaps [12]. However, complex RUF in patients treated with pelvic radiation at times may be better served by exenterative surgeries due to severe underlying bladder and sphincter dysfunction. Therefore, proper patient selection is the key. Although it is often difficult to determine preoperative bladder capacity or sphincter function, this is essential to determine the optimal surgery so that social urinary continence can be achieved.

Gracilis Muscle Flap

The gracilis muscle is long and thin, tapering from its widest point superiorly to a tendinous insertion on the medial knee inferiorly. It acts as a thigh adductor and a flexor of the knee joint, but when mobilized causes no significant donor functional loss. It is an expendable muscle since the adductor longus and magnus totally replace the function of adduction of the thigh. The medial thigh scar is slightly posterior to the midline and relatively inconspicuous. The consistent vascular anatomy and relative ease of dissection make this muscle an excellent choice for perineal and urethral reconstruction. See Table 24.1 for a summary of gracilis muscle flap characteristics.

Anatomy

The origin of the gracilis muscle starts with a tendinous aponeurosis to the ischiopubic ramus and distally inserts into the adductor tubercle (medial

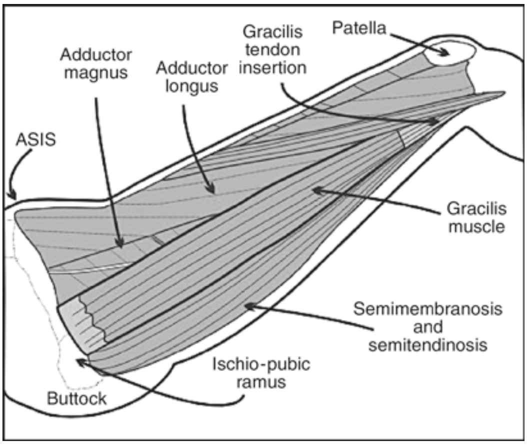

Fig. 24.12 Gracilis origin on ischiopubic ramus and insertion distally on medial tibia at adductor tubercle. Muscle lies on adductor magnus (Courtesy Rudolf Buntic)

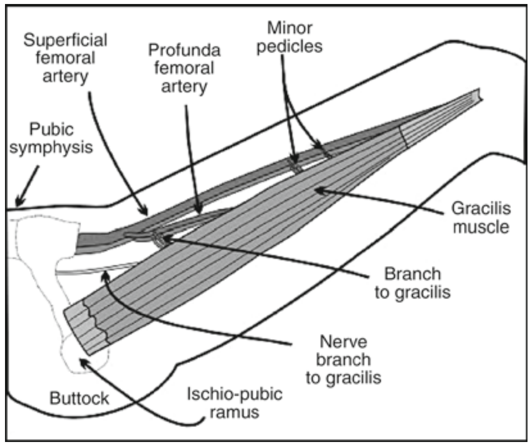

Fig. 24.13 Gracilis muscle blood supply. Note main pedicle from profunda femoral artery and secondary minor pedicles distally (Courtesy Rudolf Buntic)

condyle) of the tibia. Depending on patient leg length, the gracilis muscle is approximately 24–30 cm in length and roughly 6 cm wide, proximally, and 4 cm, distally. The width of the muscle can be extended by splitting the investing epimysium, which will increase the width an additional 30–50 %. The muscle lies on the adductor magnus along most of its course, with the adductor longus superiorly and the sartorius inferiorly (Fig. 24.12). The muscle is innervated by the anterior branch of the obturator nerve (motor function) and the medial cutaneous nerve of the thigh (for sensory function). The nerve enters the muscle slightly more cephalad and superior to the upper aspects of the vascular pedicle. A long leash of nerve can usually be dissected free (up to 6–7 cm). Under loupe magnification, the nerve can even be dissected intraneurally, so that the muscle can be split into smaller anterior and posterior segments, if so needed.

Vascular Anatomy

The gracilis is a type 2 muscle (after Mathes and Nahai), with a single dominant and several secondary minor vascular pedicle(s). The primary pedicle is very consistently located about 8–12 cm (mean, 10 cm) distal to the bony origin. The main arterial supply is the medial circumflex femoral, which is a proximal branch of the profunda femoral vessels in most cases, running between the adductor longus and magnus muscles and then enters the undersurface of the gracilis. The artery is surprisingly small in comparison to most muscle flaps, with an external diameter of less than 1 mm in pediatric patients and ranging from 1 to 2 mm in the adult. It has two veins, often smaller than the artery, although occasionally one is larger. On rare occasions, the gracilis is supplied by two arteries and with an origin from the adductor pedicle. The medial circumflex femoral pedicle usually measures 6–7 cm (occasionally up to 10 cm) in length and emerges between the adductor brevis and the adductor longus, with small branches to both muscles. The artery enters the gracilis and branches into multiple branches, which pass proximally and distally along the muscle. The distal secondary pedicles to the muscle are relatively insignificant arterial branches, which can be routinely sacrificed without worry of compromising the viability of the muscle (Fig. 24.13).

Surgical Dissection

The patient is typically placed in the lithotomy position, and the entire lower extremity is prepped and draped and positioned with the leg abducted and the knee flexed (Fig. 24.14). It is wise to prep out both legs since one gracilis muscle may have insufficient bulk to cover the fistula repair. However, we prefer to use the left gracilis to pre-

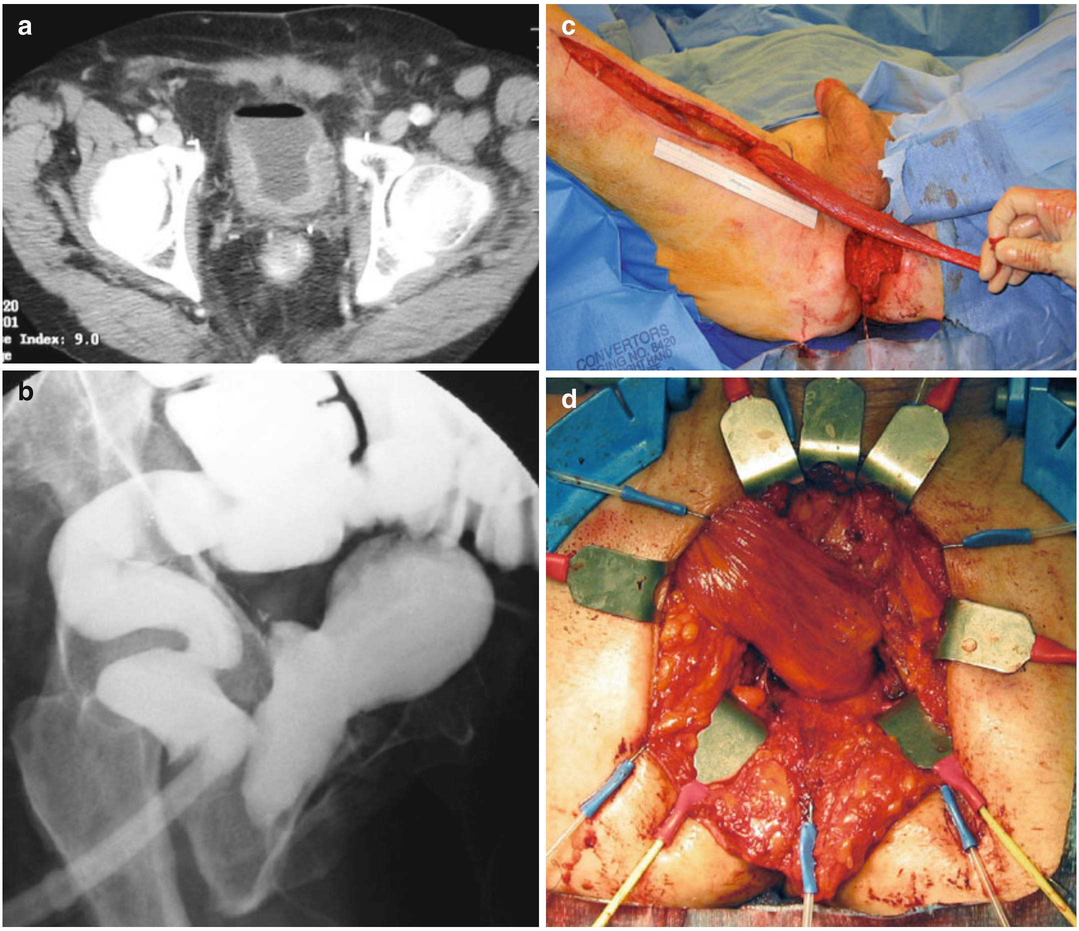

Fig. 24.14 Prostatorectal fistula. (**a**) CT of pelvis. Note typical air in bladder and thick wall bladder base from chronic infections. (**b**) Hypaque enema noting bladder filling. (**c**) Gracilis mobilized from right inner thigh. Note muscle length and mobility. (**d**) Completed gracilis flap to fistula site

vent the patient from experiencing problems with pushing the brake/accelerator pedals while driving, should the patient have residual deficits from harvest of the muscle. The gracilis can also be harvested in the prone position (Fig. 24.15). The muscle location is marked by first drawing a line from the pubic tubercle to the medial tibial condoyle of the knee. We then measure from the inguinal crease distally and place a mark on the skin at 8–10 cm. This marks the likely insertion site of the vascular pedicle. The incision (roughly 8 cm in length) is then made three fingerbreadths posterior and parallel to this line and distal to the pedicle insertion. The incision site often appears to be overly posterior to the untrained eye. Unless the patient is obese, the muscle can be palpated through the skin by pinching the skin between the thumb and index finger at the 10-cm mark. The muscle is easily identified at the base of the wound after the subcutaneous fat and muscular fascia are divided. On the anterior border of the muscle, the vascular pedicle and nerve can be identified 8–10 cm distal to the ischiopubic ramus entering the deep surface of the gracilis (Fig. 24.16). Early identification of the pedicle enables the dissection to proceed more rapidly. Since the vessels to the gracilis are so small, we prefer to use a handheld Doppler to help confirm their location. The proximal dominant pedicle is preserved, but not skeletonized, so as to avoid

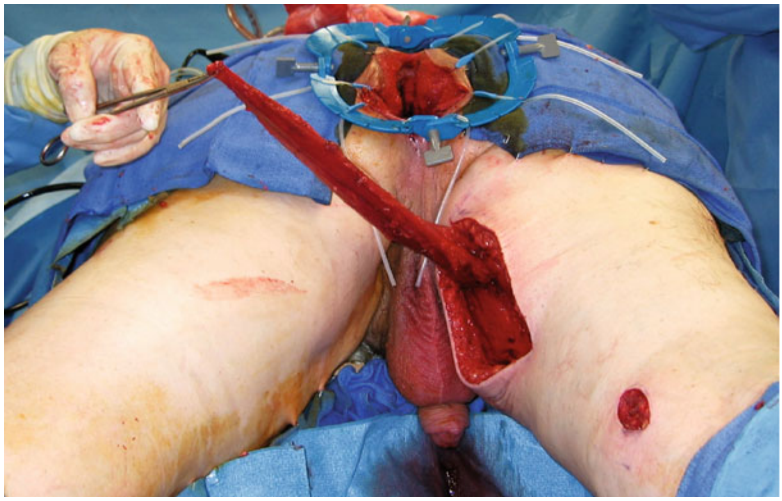

Fig. 24.15 Gracilis muscle mobilized in the prone position. Note main incision and small distal counter incision

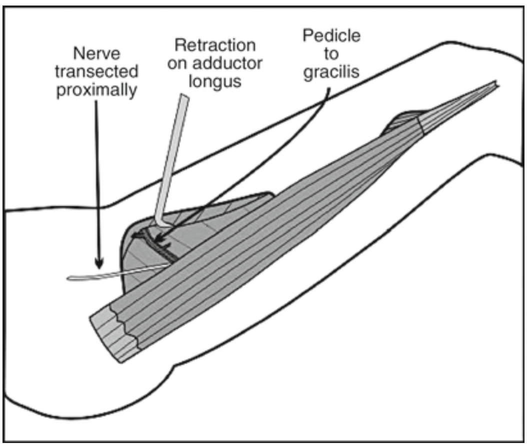

Fig. 24.16 Adductor longus freed and retracted away from underlying magnus to expose pedicle. Note vascular pedicle and nerve (Courtesy Rudolf Buntic)

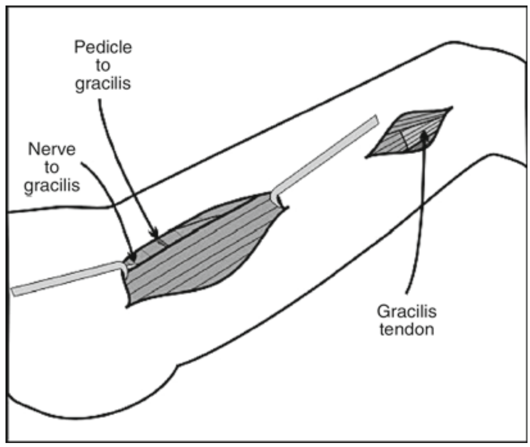

Fig. 24.17 Distal counterincision to identify and dissect free the gracilis tendinous insertion (Courtesy Rudolf Buntic)

vascular spasm and injury. A Penrose drain is placed around the muscle and used as a handle to facilitate dissection. A small counterincision is then performed over the distal leg to identify and dissect free the tendinous insertion (Fig. 24.17). With a combination of electrocautery and blunt finger dissection, the gracilis muscle can be freed up from its attachments to the adductor magnus, while the adductor longus is retracted away from the magnus. A small sponge on a stick is used to further dissect out the distal aspects of attachments to the muscle. It is much easier to do the blunt dissection first with the muscle held at two points (origin and insertion) and then, secondarily, transect the gracilis tendon. A 0 Vicryl stay suture is placed around the tendon, and traction and countertraction are applied between the muscle belly and the tendon to verify that the correct structures were dissected out prior to transection of the tendon with electrocautery. The gracilis tendon can be easily distinguished by being distinctively long and its insertion on the medial tibial tubercle, as part of the coalescence of the tendons of the gracilis, sartorius, and semitendinosus muscles (pes anserinus) (Fig. 24.18). It is not to be confused with the semimembranosus tendon which is thicker, more posterior, and shorter than the gracilis tendon.

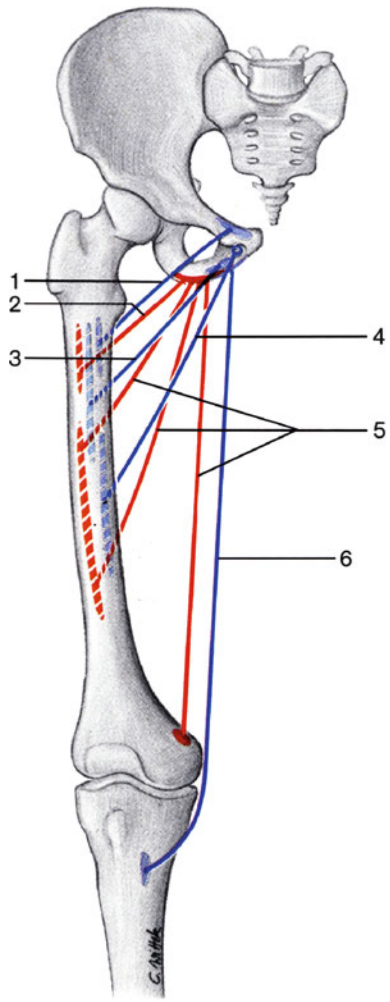

Fig. 24.18 Course of adductor muscles demonstrating origin and insertions. *1* pectineus, *2* adductor minimus, *3* adductor brevis, *4* adductor longus, *5* adductor magnus, *6* gracilis, note long and distal tendon insertion onto tibial condyle (From Rohen et al. [13])

The distal gracilis is then pulled through the medial incision. In doing so the secondary pedicles underneath the intact skin are avulsed – however, the vessels are very small and typically vasospasm off and do not bleed much.

Alternatively, both incisions can be joined to form a single large exposure. The distal accessory pedicles are difficult to discern and vascular control is easily achieved with electrocautery. Electrocautery is used to create a hiatus between the perineum and the thigh to transfer the muscle into the perineum. The muscle is then rotated 180° and tunneled into the perineum, taking care not to twist the muscle to prevent avulsion or occlusion of the primary vascular pedicle. The flap is then sutured to the perineal defect.

The thigh incisions are closed in three layers, with the skin by running a subcuticular stitch and then Dermabond. At the end of the case, we typically place a closed suction drain for a couple of days to help drain any blood or lymphatic fluid. Once the skin is closed we also place a loosely wrapped ACE bandage around the thigh and knee. Patient ambulation usually begins postoperative day 1 or 2. Some patients may ambulate with a limp, but this typically resolves after a few days.

Limitations

The use of the gracilis muscle can have limitations. The gracilis length is directly proportional to the length of the leg. Therefore, in patients with shorter legs, the use of the gracilis flap for the repair of rectourethral fistulae in higher locations may be limited, because the distance from the primary pedicle (constant location) to the distal end of the muscle (variable length) limits the segment of the muscle that can be rotated into the wound. The gracilis muscle is typically long enough to reach the prostatic urethra, but not the bladder. For vesicorectal fistulas, a gluteal maximus flap works well and easily reaches. Occasionally, one gracilis muscle provides insufficient bulk to cover the defect; in such cases, the contralateral gracilis muscle can be harvested and brought into the wound.

Transabdominal Approaches

The transabdominal approach uses an omental or rectus muscle flap for repair or a colo-anal sleeve pull through procedure (after Park's or Turnbull-Cutait). The other advantage of the transabdominal approach is that a simultaneous fecal diversion can be performed. Limitations of transabdominal are that the pelvis can be deep and narrow and make exposure poor, particularly because most rectourethral fistulas are below the level of the levator ani.

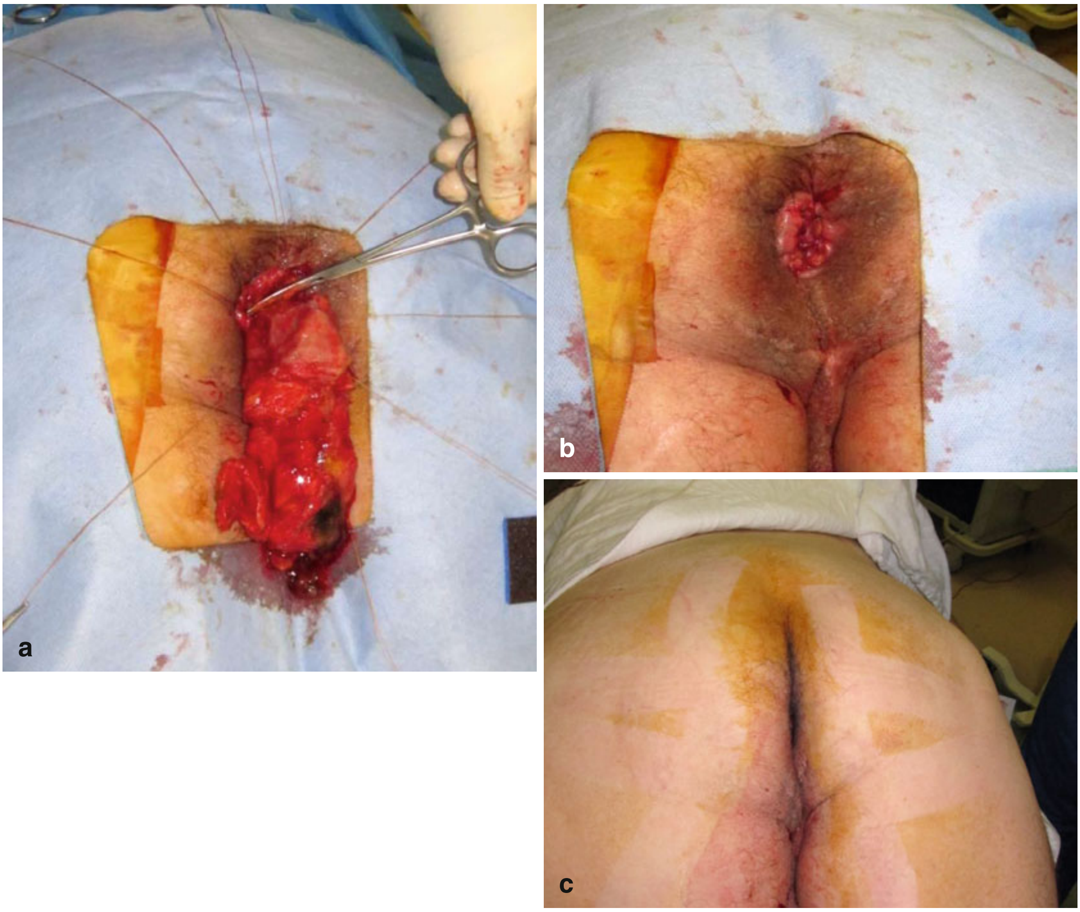

Fig. 24.19 (**a**) Colo-anal pull through at post-op day 5. Hemostat notes the level that the colon will be transected. Note the circumferential preplaced sutures at the dentate line (**b**) Exteriorized colon transected and the colon sutured in place. (**c**) Gluteal cleft postsurgery

Furthermore, abdominal surgery is more morbid and more of a cardiovascular stressor than perineal surgery. Fistulas that are rectovesical or vesicoperineal can be more easily exposed abdominally than rectourethral fistulas.

Abdominoperineal Approach (Turnbull-Cutait Colo-Anal Pull Through)

When the rectum is extensively damaged by radiation that will not allow primary rectal closure due to severe radiation proctitis or extensive tissue loss, these fistulas are often better managed by proctectomy and pull through of healthy rectum. The patient is initially placed in the prone jackknife position and a proctectomy and buccal graft closure of the urinary fistula performed. The patient is then positioned supine and a midline abdominal incision made. The rectosigmoid colon is divided intra-abdominally as is the distal rectum at the dentate line (preserving the anal sphincter). The proximal sigmoid colon is then pulled through to cover the patched or repaired fistula and in so doing provides an excellent vascular bed to insure healing and take of the graft and suture lines are not overlapping. The sigmoid is left emanating from the anus is moist gauze (Fig. 24.19a). In a delayed fashion (days later), the segment of exteriorized colon is transected and the colon is sutured to the dentate line (by preplaced sutures from the first stage), with the mesentery facing the urethral side (Fig. 24.19b, c). By doing such a delayed pull through operation, there are no overlapping suture lines. After a few days, the distal colon has adhered in place, and then the anastomosis is performed.

Rectovesical and Urinary-Perineal Fistulas

Rectovesical fistulas are typically cephalad and difficult to reach perineally. Furthermore, the gracilis flap oftentimes will not be long enough to reach or is tethered by a high or distal vascular pedicle. We place such patients jackknife prone (Fig. 24.20). Open the perineum and the intragluteal fold. Such fistulas typically occur after abdominoperineal rectal resection (APR). Such patients have often received neoadjuvant pelvic radiation and chemotherapy. Often, a coccygectomy will need to be performed for exposure. Under cystoscopy, the fistula is cannulated and a Fogarty or small Foley is placed across and secured. Oftentimes, the fistulas are cephalad and involve the bladder – and thus under the sacrum. Here, a sacrectomy may be needed for exposure. Removal of S4 and S5 is often sufficient for exposure and avoids the morbidity of removal of S3 (Fig. 24.21a–c). To fill the dead space, a paddle of de-epithelialized skin and subcutaneous fat based on a pedicle of the gracilis muscle can be used. However, the gracilis is often too short to reach, so an inferior gluteus maximus muscle flap can be mobilized to fill the space instead, once detached from ileal-sacral ridge (Fig. 24.21d, e). *See* Chap. 18 by Zinman in this volume for more details on the gluteal muscle flap. The rectovesical fistula typically drains into a radionecrotic cavity, which then fistulizes to the perineum. Once the radionecrotic cavity is exposed, it should be curetted of its poorly vascularized tissue.

When the dead space to fill is large, tissue transfer methods to fill the gap are a rectus abdominal muscle flap, bilateral gracilis (gracilis with a de-epithelialized myocutaneous paddle), or by omentum (when it is robust), which is extensively mobilized off the transverse colon and greater curvature of the stomach to lengthen it. Another management option is a proctectomy and closure of the defect or supravesical urinary diversion.

Complex Urinary Fistulas in Patients with Poor Performance Status or Limited Life Expectancy

Patients with complex urinary fistulas and urinary incontinence need to have a decent performance status to undergo a major surgical reconstruction and repair of the fistula. Patients who have multiple comorbidities and, thus, poor surgical candidates with limited life expectancy have limited options for managing their urinary fistulas. Typically a suprapubic tube is initially placed to divert the urine away from the urethral-rectal or urethral-perineal fistula, as long as the internal urinary sphincter is intact. However, if the bladder neck is open or the urinary fistula is in the bladder, then the only noninvasive method to proximally divert the urine is bilateral percutaneous nephrostomy tube placement. Although in most cases the nephrostomies can divert the urine, in some instances the majority of the urine still travels down the ureters. An effective and durable method for managing such urinary fistulas and incontinence is bilateral percutaneous nephrostomy tube placement, followed by trans-ureteric embolization of the distal ureters with a combination of Gianturco coils (steel coils) and Gelfoam (gelatin sponge; Fig. 24.22).

We recently reported our 12-years experience with 29 patients (23 women and 6 men; mean age 59 years, SD 16) with complex urinary fistulas from the bladder or urethra that were refractory to nephrostomy drainage alone [14]. One patient had a history of severe perineal trauma, and the remaining 28 had a history of cancer. None of the patients were surgical candidates because of severe comorbidities or had a limited life expectancy. Seventeen fistulas occurred in the setting of previous surgery. Twenty patients had received adjunctive pelvic

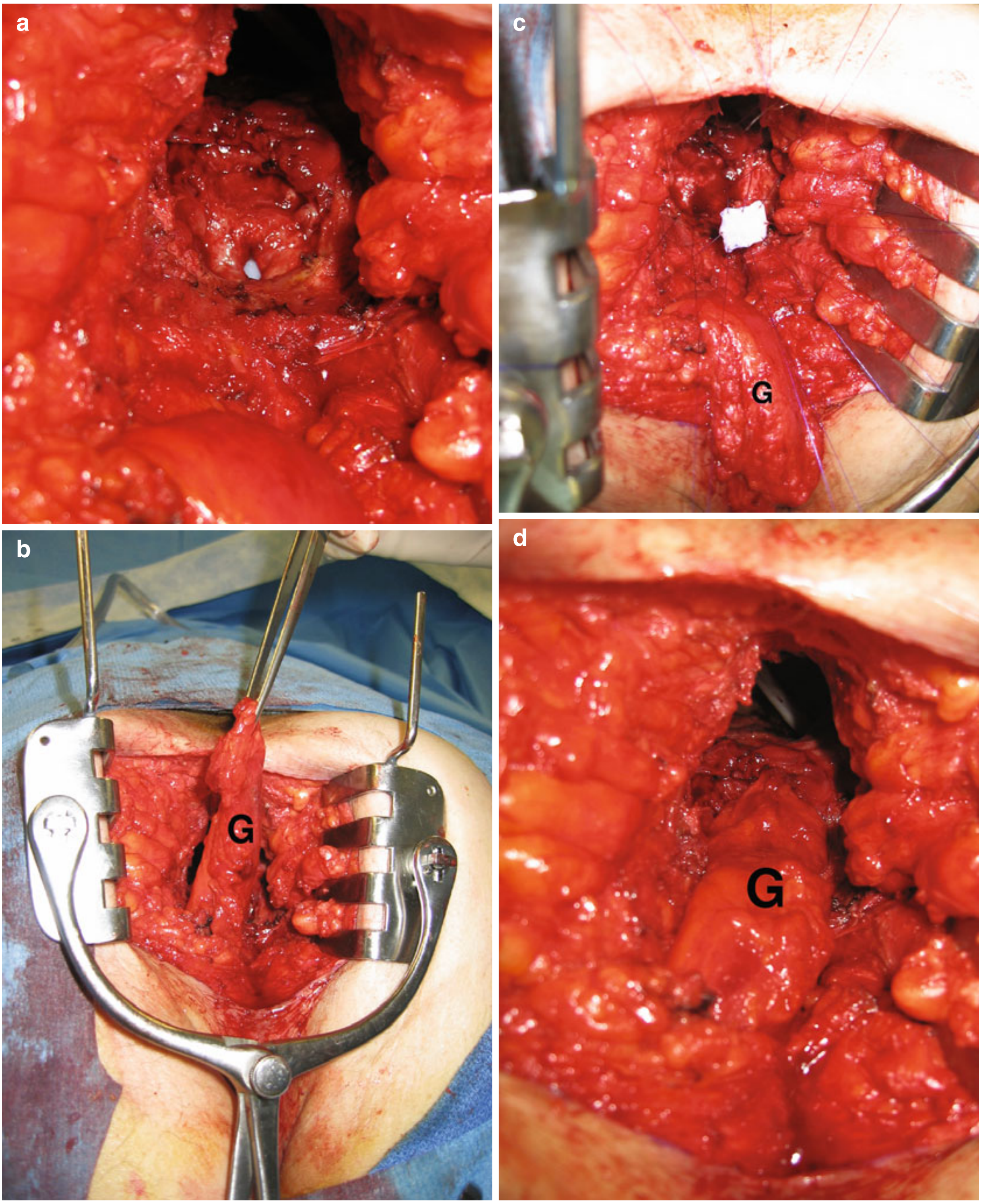

Fig. 24.20 Prostatoperineal urinary fistula after abdominoperineal resection and pelvic radiotherapy. (**a**) Prostatic fistula exposed via paracoccygeal incision in prone position. (**b**) Gracilis muscle mobilized into perineal wound. Note "bear claw" retractor for excellent exposure. (**c**) "Parachuting" in the buccal graft to the prostatic fistula. "G" denotes gracilis muscle flap. (**d**) Gracilis flap in place over buccal graft

irradiation, and 11 had had chemotherapy. In all, refractory urinary incontinence was managed by embolization of 52 ureters. Patients were then managed by long-term nephrostomy drainage until death or definitive reconstructive surgery.

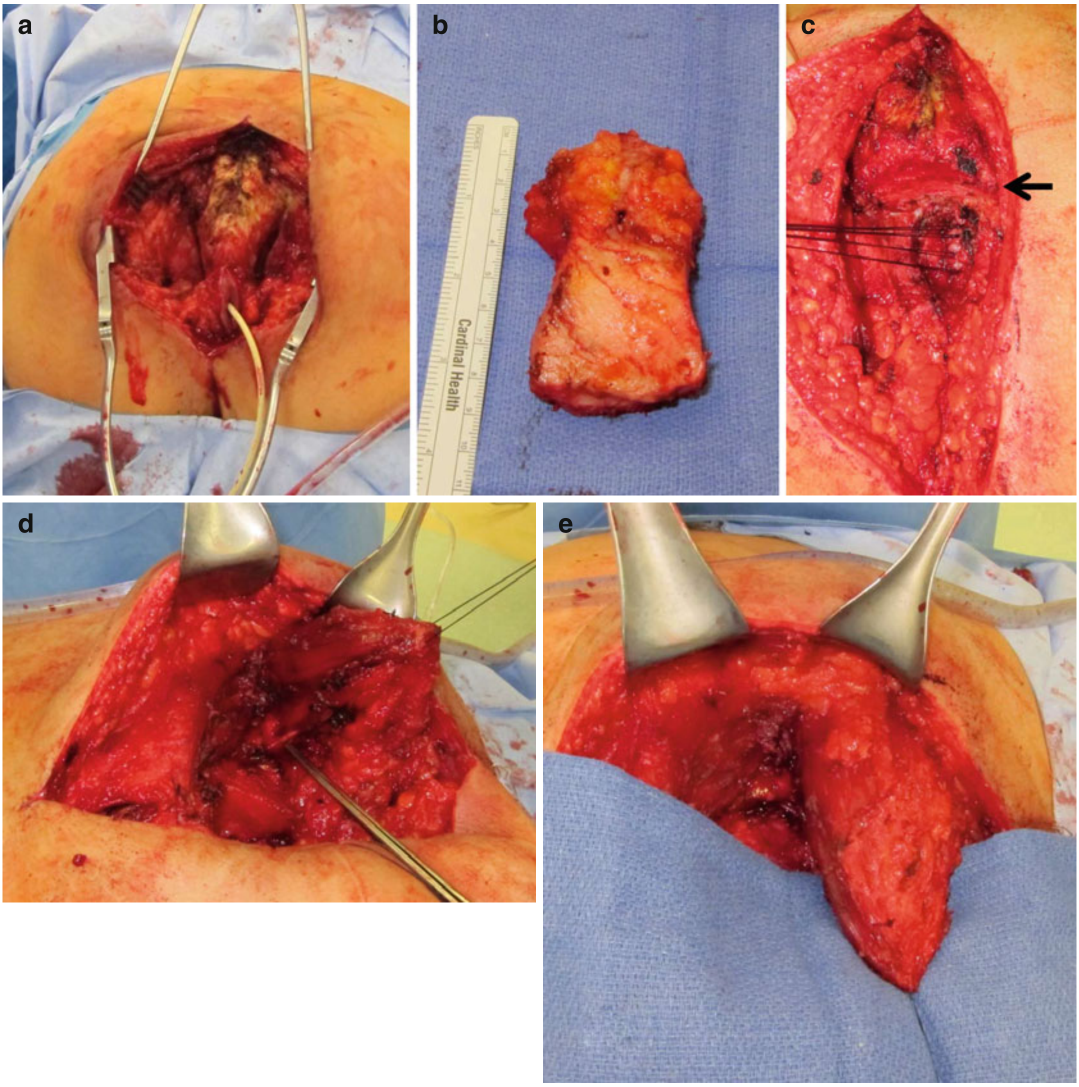

Fig 24.21 (**a**) Sacrum exposed in jackknife position. Note Foley catheter in fistula. (**b**) S4,5 sacrectomy. (**c**) Fistula closure. Note cut edge of sacrum (*arrow*) and excellent exposure. (**d**) Inferior gluteal maximus mobilized. Debakey points to inferior gluteal artery. (**e**) Note mobility of split gluteal muscle

Embolization Technique

In brief, the procedure is done with the patient under local anesthesia and conscious sedation. A nephrostomy tube is placed into both kidneys before embolization. Each nephrostomy tube is replaced at the time of embolization with an access sheath of comparable outer diameter (Fig. 24.22a). A nephrostogram is performed and a 4- or 5-French end-hole catheter advanced coaxially into the distal ureter. A nest of 0.9 mm stainless-steel coils (Gianturco coils, Cook, Bloomington, IN) is created with various sizes of 5–12 mm in diameter (Fig. 24.22b). Between 4 and 12 coils are typically needed to occlude the ureter. In some cases, gelatin sponge pledgets (Gelfoam) were also sandwiched among the coil nests to hasten lumen occlusion. An antegrade nephrostogram is then taken to confirm occlusion of flow at the level of the coils (Fig. 24.22c). The access sheath is then

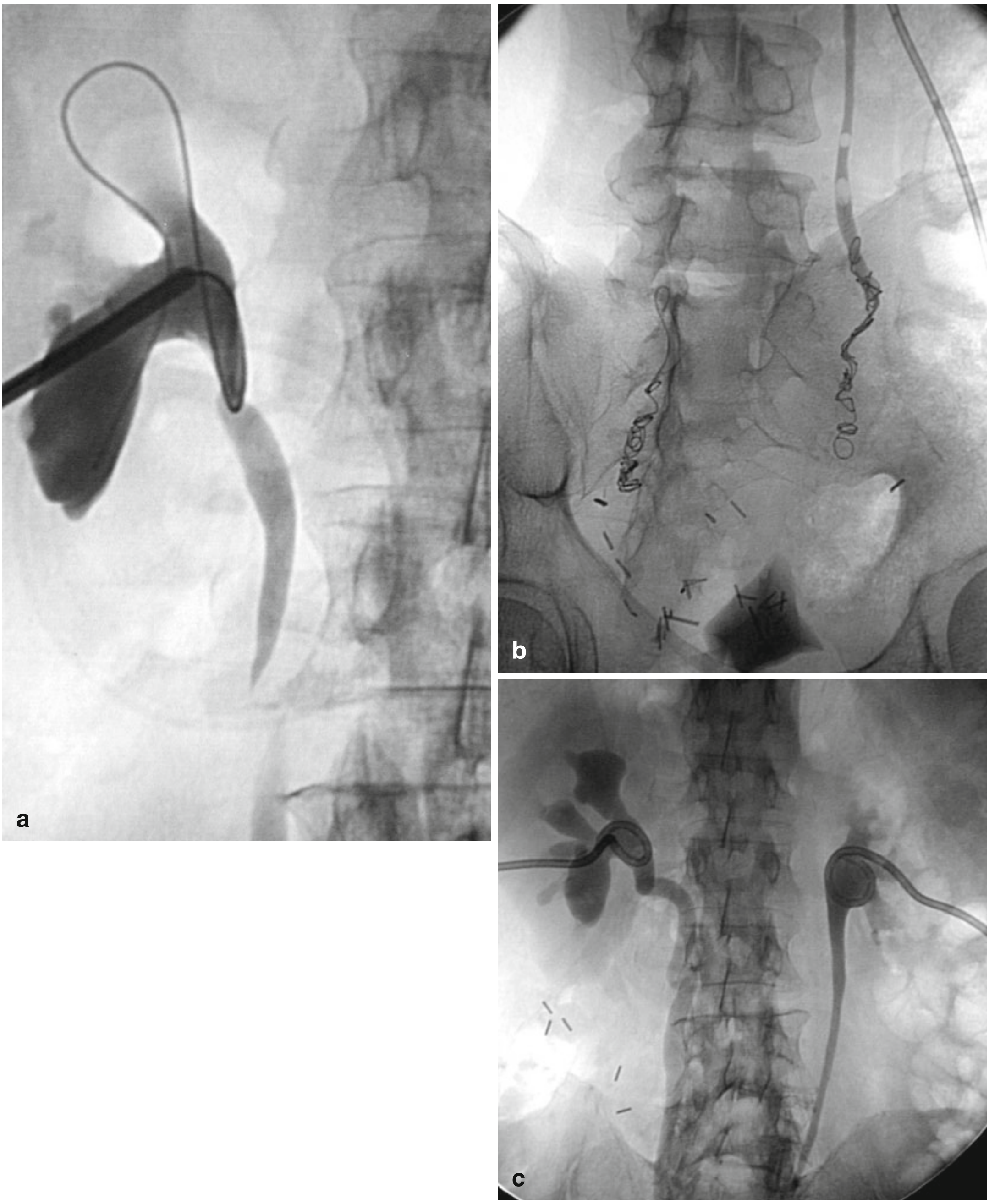

Fig. 24.22 Ureteral embolization for refractory urethrorectal fistula, urinary incontinence, and poor performance status. (**a**) Access sheath placed percutaneously into renal pelvis. (**b**) Deployed Gianturco coils into distal ureters. Left nephrostogram notes obstruction. (**c**) Nephrostomy tube placement after ureter embolization

replaced with a 10- or 12-French (depending on surgeon preference) nephrostomy tube and placed to gravity drainage. Subsequently, nephrostomy catheters are exchanged, typically every 8 weeks. The advantages of this procedure are the ease of using an existing nephrostomy tract and the ready availability and familiarity with the necessary equipment.

Embolization Costs and Outcomes

The results with stainless-steel coils are superior to those obtained with cyanoacrylate glues or detachable ureteric balloons. The procedure is also relatively inexpensive. At our institution, steel coils cost roughly $25 (USA) each and nephrostomy tubes cost roughly $50 (USA). The total material cost is thus $150–350 (USA) per embolized renal unit. The other equipment used for the procedure is commonly available in most interventional radiology suites. With a mean follow-up of 43.8 (38) months, occlusion was successful in all cases, with complete or near-complete (<1 pad/day) dryness within 3 days. No repeat embolizations were required and there were no significant complications. Twenty-three patients died from cancer at a mean of 8.1 ± 11.5 months after embolization. Four patients were alive, three having had staged surgical urinary diversions (colonic or ileal conduit) at a mean of 6 months after ureteric embolization. Ureteric embolization is a viable option for managing complex lower urinary tract fistula in patients with a poor performance status. Moreover, it can be used as definitive management in patients with a limited life expectancy (<1 year).

Editorial Comment

The primary distinction of radiation versus post-surgical fistulas cannot be overemphasized. We have routinely employed the York-Mason approach for postsurgical fistulas with excellent outcomes. We begin with cystoscopy, stent placement (if the fistula occurs in proximity to one or both ureters), cannulization of the fistula with a ureteral catheter over wire, and then urethral catheterization. We then reposition from lithotomy to jackknife position. When performing trans-anorectal fistulectomy, one must not excise too widely since this may create a large trigonal defect which will prove difficult to close. We use fibrin sealant and a free graft of buttock fat over the urinary closure, which is then covered by a rectal advancement flap.

One of the important considerations in the surgical treatment of radiation-induced rectourethral fistulas is the status of the prostatic remnant. Cavitation is often noted such that only a thin shell of residual prostatic tissue exists. Many can be repaired via a perineal approach with a buccal mucosa graft and gracilis flap. In some cases, subtotal prostatectomy with urethroprostatic anastomosis may be performed.

Those patients who have received combined modalities of treatment, such as radiotherapy followed by cryotherapy, often have extensive necrosis and/or calcification of the remaining prostate. These patients tend to experience the sequelae of chronic inflammation and recurrent infection when the residual prostate is unhealthy in appearance. In such severe cases, concomitant salvage prostatectomy or cystoprostatectomy with ileal conduit should be performed at the time of fistula closure.

We have shifted from a perineal approach to a retropubic approach over the years due to enhanced surgical exposure and the facilitation of concomitant prostatectomy or cystoprostatectomy. Most patients prefer to have orthotopic reconstruction via a fistula repair or salvage prostatectomy. Estimation of bladder capacity can be difficult in fistula patients but is important in determining the reconstructability of the lower urinary tract.

—Allen F. Morey, MD

References

1. Lane BR, Stein DE, Remzi FH, Strong SA, Fazio VW, Angermeier KW. Management of radiotherapy induced rectourethral fistula. J Urol. 2006;175: 1382–7.
2. Zinman L. The management of the complex recto-urethral fistula. BJU Int. 2004;94:1212–3.
3. Wood TW. Middleton: single-stage transrectal transsphincteric (modified York Mason) repair of rectourinary fistulas. Urology. 1990;35:27–30.
4. Jones IT, Fazio VW, Jaqelman DG. The use of transanal rectal advancement flaps in the management of fistulas involving the anorectum. Dis Colon Rectum. 1987;30:919–23.
5. Renschler TP, Middleton RG. 30 years of experience with York-Mason repair of recto-urinary fistulas. J Urol. 2003;170:1222–5.

6. Moreira SG, Seigne JD, Ordorica RC, et al. Devastating complications after brachytherapy in the treatment of prostate adenocarcinoma. BJU Int. 2004;93:31–5.
7. Gecelter L. Transanorectal approach to the posterior urethra and bladder neck. J Urol. 1973;109:1011–6.
8. Zmora O, Potenti FM, Wexner SD, et al. Gracilis muscle transposition for iatrogenic rectourethral fistula. Ann Surg. 2003;237:483–7.
9. Vanni VJ, Buckley JC, Zinman LN. Management of surgical and radiation induced rectourethral fistulas with interposition muscle flap and selective buccal mucosal onlay graft. J Urol. 2010;184(6):2400–4.
10. Ghoniem G, Elmissiry M, Weiss E. Transperineal repair of complex rectourethral fistula using gracilis muscle flap interposition – can urinary and bladder function be preserved. J Urol. 2008;179(5):1882–6.
11. Samplaski MK, Wood HM, Lane BR, Remzi FH, Lucas A, Angermeier KW. Function and quality of life outcomes in patients undergoing transperineal repair with gracilis muscle interposition for complex rectourethral fistula. Urology. 2011;77(3):736–41.
12. Ferguson GG, Brandes SB. Surgical management of rectovesical fistulas: an evaluation of treatments at Washington University. J Urol. 2007;177:28A.
13. Rohen JW, Yokochi C, editors. Color atlas of anatomy. New York: F.K. Igaku-Shoin Medical Publishers; 1993.
14. Shindel AW, Zhu H, Hovsepian DM, Brandes SB. Ureteric embolization with stainless-steel coils for managing refractory lower urinary tract fistula: a 12-year experience. BJU Int. 2007;99:364–8.