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Anorectal Abscess and Fistula

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Key Concepts

- Successful management of anorectal abscesses requires an in-depth knowledge of pelvic floor anatomy and potential spaces through which sepsis can spread.
- The spaces occupying the anus and their anatomic landmarks will define the nomenclature of abscesses—perianal, perirectal, supralevator, and postanal space.
- Drainage of most abscesses can be performed in the office without drains or setons. If a fistula is encountered it should only be addressed if the anatomy in relationship to the sphincters is clearly identified.
- Necrotizing soft tissue infections are life-threatening emergencies that require aggressive surgical debridement and management of the offending anal gland.
- Fistulas will complicate a significant proportion of perirectal abscesses and are classified based on their relationship with the anal sphincter complex.
- Physical examination is often the only modality needed to determine the fistula track and selection of treatment, and preoperative imaging (MRI, US) is typically unnecessary except for patients with multiple external openings, when the internal opening cannot be identified, or for recurrent cases.
- Goodsall's rule, while being helpful, is accurate in about 60 % of cases and is more accurate for posterior fistulas.
- Fistulotomy is the most successful of the surgical treatments, but is also associated with the highest rates of continence disturbances—several non-cutting techniques have been described—all of which have limitations and varying degrees of success.

Introduction and Epidemiology

> It is difficult if not impossible to accurately assess the incidence of anorectal abscesses because they often drain spontaneously or are incised and drained in a physician's office, emergency room, or surgicenter.
>
> *Herand Abcarian* [1]

While seemingly a benign process, an anorectal abscess can produce significant distress and long-term morbidity. Delay in diagnosis, mismanagement of the disease, or failure to recognize the diagnoses can result in multiple procedures, increased cost, and protracted suffering. Further, confusion regarding the interplay between anorectal abscesses and fistula-in-ano may lead to inappropriate management. As such, it is important that treating clinicians have a good working knowledge of the diagnosis and management or refer the patient to a specialist.

Although the true incidence and prevalence are elusive, data from the operative management of anorectal abscesses provides a floor from which to extrapolate. The incidence of abscess is reportedly between 0.4 and 5 % of patients undergoing operative management [2, 3] translating to 8.6–20 patients per 100,000 population [4, 5], and yielding between 68,000 and 96,000 cases of anorectal abscess each year in the USA [1]. Patients are males at a 3:1 ratio, with both sexes presenting at a mean age of 40 years (range 20–60 years) [6]. Although often asked by patients, there is minimal data to suggest that inadequate hygiene, anal-receptive intercourse, altered bowel habits, diabetes, obesity, or race are associated with increased risk of abscess formation.

Pathophysiology

Anatomy

Management of anorectal abscess requires an in-depth knowledge of pelvic floor anatomy and associated potential spaces whereby purulent material can travel (see Chap. 1). A succinct description of the pelvis (funnel in funnel) illustrates the internal sphincter surrounded by the pelvic floor apparatus (external sphincter, levator ani, and puborectalis), and separated by the intersphincteric plane. The anal canal represents a connection between the anal verge and anorectal junction, with a length of 2–4 cm. At the anal canal's midpoint lies the dentate line, represented by undulating longitudinal folds of columnar

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endothelium (columns of Morgagni) proximally, and smooth squamous epithelium distally (anoderm). Between the columns of Morgagni, which number between 6 and 14, are unevenly distributed anal crypts whereby anal ducts empty. Importantly, ducts may extend into the internal sphincter, the intersphincteric space, or through the internal sphincter into the external sphincter [7, 8]. As a consequence of these extensions, select anorectal spaces are at risk for transmission of bacteria with subsequent formation of abscess.

The perianal space (Fig. 14-1a) lies immediately around the anal verge, with medial extension to the dentate line and lateral extension to the subcutaneous fat of the buttocks. This space is further connected to the rectal wall above the external sphincter by way of the intersphincteric space. The ischiorectal/ischioanal fossa is a pyramidal shaped potential space between the perineum and levator ani. It is bordered medially by the levator ani and external sphincter, with the obturator internus muscle and fascia along the ischium as its lateral border (Figure 14-1b). Anteriorly it is confined by the transverse perineal muscles. From a posterior standpoint, the ischiorectal fossa is bordered by the gluteus maximus and sacrotuberous ligament. Bilateral ischiorectal fossae are connected via the postanal space, under the anococcygeal ligament (Figure 14-1b). Above the anococcygeal ligament and below the levator ani, these fossae are continuous with the deep posterior anal space. Above the levator ani, between the pelvic wall and rectum, lies the supralevator space. Because this space is superiorly bordered by the peritoneum, abscesses may form from intersphincteric sources that track superiorly, or abdominal sources that track from the peritoneal cavity.

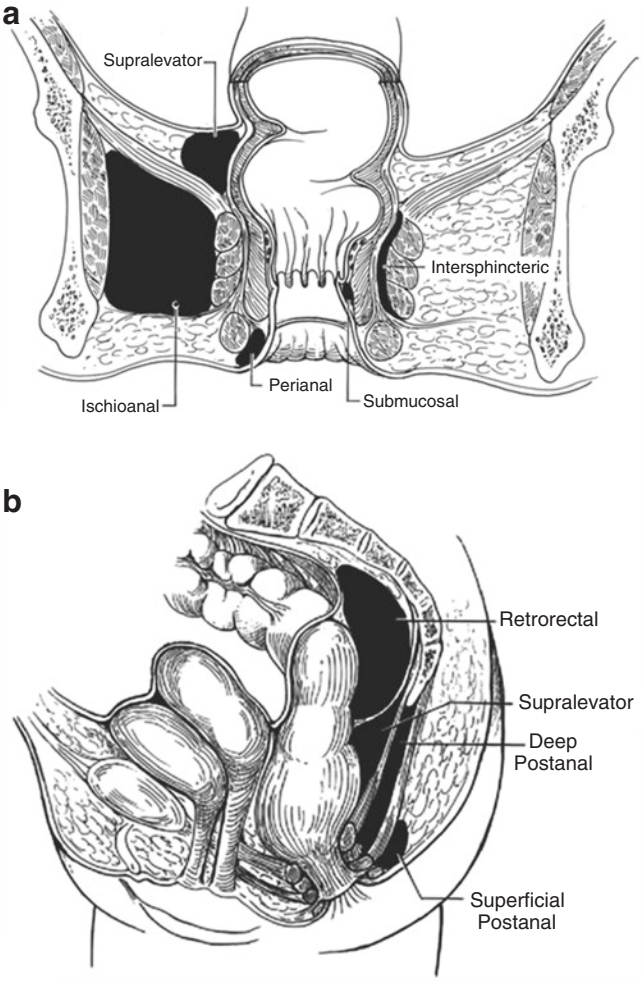

FIGURE 14-1. Anorectal spaces: (**a**) coronal section; (**b**) sagittal section. Vasilevsky CA. Anorectal abscess and fistula-in-ano [168] © 1997 David Beck, MD, with permission.

Etiology

Currently identified as vestigial organs with minimal role outside production of odiferous substances, anal crypts are considered the primary source for development of perianal abscesses [9]. The cryptoglandular theory underlying anorectal abscess formation was initially proposed by Eisenhammer [9] and later advocated by Parks [10]. They hypothesized that obstruction of a crypt by foreign body or perianal debris led to abscess formation due to stasis within the ducts. Predisposing factors for the development of cryptoglandular abscesses, which account for 90 % these infections, include liquid stool entering the anal duct, trauma, tobacco abuse, and cystic dilation of the duct resulting in poor emptying. The remaining 10 % are the result of specific disorders such as inflammatory bowel disease (IBD), trauma, and malignancy (Table 14-1).

Classification

Each anorectal abscess is classified based upon the potential space it inhabits (Figure 14-2). In general, perianal and ischiorectal abscesses are the most common, accounting for over 80 % of all diagnoses [11]. However, some implicate intersphincteric abscesses as the most common, with the ability to spread in any direction [5]. As expected, supralevator abscesses are the least common. The proverbial "horseshoe abscess" describes a process whereby bilateral disease occurs via connection through the intersphincteric, supralevator, or ischiorectal spaces. Recognition of this process is necessary to prevent undue operative intervention and patient suffering.

Evaluation

History and Symptoms

The patient with an anorectal abscess presents most commonly with acute pain in the perianal or perirectal region. Pain usually prompts an evaluation in the emergency room or physician's office. The pain is usually worsened with

TABLE 14-1. Etiology of anorectal abscess

Nonspecific
Cryptoglandular
Specific
Inflammatory bowel disease
Crohn's disease
Ulcerative colitis
Infection
Tuberculosis
Actinomycosis
Lymphogranuloma venereum
Trauma
Impalement
Foreign body
Surgery
Episiotomy
Hemorrhoidectomy
Prostatectomy
Malignancy
Carcinoma
Leukemia
Lymphoma
Radiation

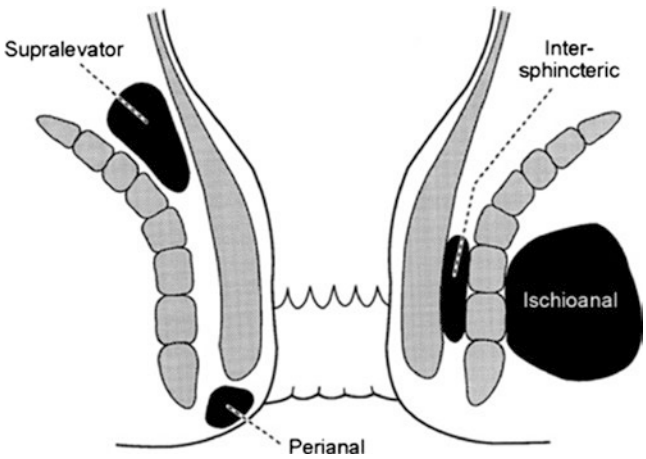

FIGURE 14-2. Classification of anorectal abscesses [169] © 1997 David Beck, MD, with permission.

sitting and defecation. For patient with chronic rectal pain, consideration should be given to an intersphincteric abscess. Further, associated symptoms of urinary dysfunction may distinguish the abscess as supralevator. For supralevator abscesses, pain may be described as a "dull ache" in the pelvic region or lower back. Of note, other symptoms include fever, chills, swelling, erythema, spontaneous drainage, and malaise. Rectal bleeding is unlikely in the majority of patients. Past medical history can alert the clinician to other possible causes of rectal pain including fissure, hemorrhoids, levator spasm, sexually transmitted infections, tuberculosis, human immunodeficiency virus (HIV), IBD, malignancy, and trauma. Given the possibility of surgical intervention, determining sphincter function and any history of fecal incontinence is important in these patients.

Physical Examination

Physical examination remains the single most important diagnostic study in patients with suspected anorectal abscess. In the prone position, external evaluation will reveal classic signs of infection including erythema, induration, fluctuance, pain, and spontaneous drainage. When completing an examination, ensure evaluation of the contralateral side to determine the existence of horseshoe extensions. For patients with an intersphincteric or supralevator abscess, external review is unlikely to reveal definitive signs. However, upon digital rectal exam, fluctuance or extreme discomfort should alert the clinician to this diagnosis. In this setting, if an internal opening is palpated, purulent drainage may also be noted. Unfortunately, pain oftentimes precludes an adequate rectal exam. When the diagnosis is in doubt, consideration should be given to performance of an exam under anesthesia with anoscopy and possible flexible sigmoidoscopy. In case of suspicion for supralevator abscess, or in patients with complicated medical history, further imaging may be warranted.

Imaging

Classically, imaging was rarely useful in the management of anorectal abscess. Some advocated for barium enema in young patients or those with recurrent fistula disease to rule out inflammatory bowel disease. However, modern techniques including computer tomography (CT), magnetic resonance imaging (MRI), endoanal ultrasound (EAUS), and transperineal sonography (TP-US) are especially helpful in the diagnosis of complicated anorectal abscesses and fistula-in-ano.

Computed Tomography (CT)

The use of CT for anorectal abscess is controversial [12]. However, such imaging is indicated in any patient in whom the diagnosis of anorectal abscess is unclear, those with complex suppurative anorectal conditions, anyone with significant comorbidities in which missing the diagnosis would prove harmful, or as a possible substitution for surgical evaluation. It can also be considered in patients with perianal Crohn's disease to assist delineation of rectal inflammation from anorectal abscess [13]. While high-resolution scanners are important for detailed images, just as important are the techniques utilized to maximize visualization. Triple contrast is often required, to include per os (PO), intravenous (IV), and *per rectum* (PR) modes. Slices of 2.5 mm are used

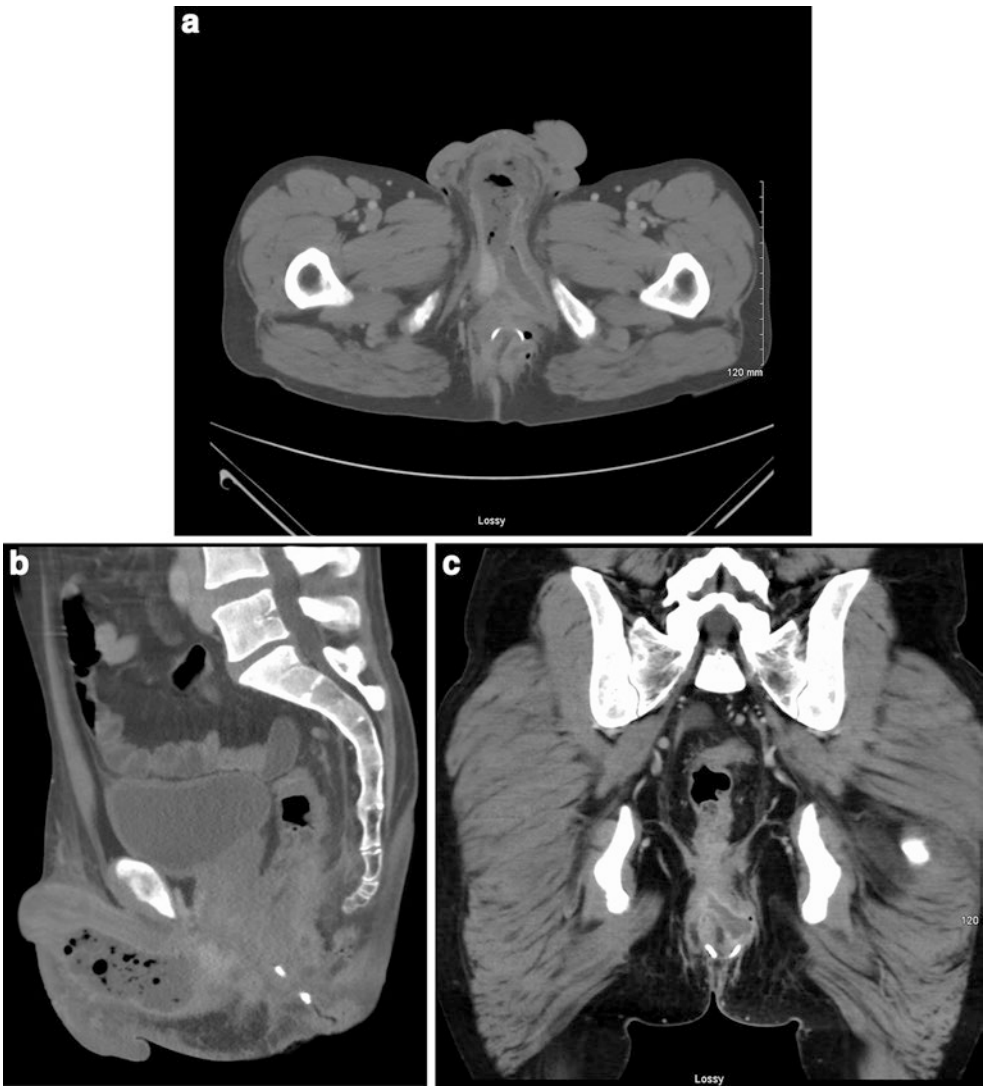

FIGURE 14-3. Computed tomography of complex anorectal abscess extending anteriorly towards scrotum. Axial images (**a**), coronal image (**b**), sagittal image (**c**).

to allow for appropriate reconstruction in sagittal and coronal planes (Figure 14-3a–c). When completed correctly, an abscess appears as an oval-shaped fluid collection with an enhancing wall, with or without demonstration of air. Additionally, fistulous tracts are readily identified by a tubular, air/fluid-filled structure that arises within the anal sphincter [6].

Magnetic Resonance Imaging

MRI for evaluation of anorectal abscess is uncommon, occurring more frequently in complex fistula-in-ano disease. Groups suggest the use of pelvic MRI for any recurrent of incompletely drained abscess to assist identification of horseshoe/postanal, supralevator, and other complex abscesses [14]. However MRI has limited value in the diagnosis of anorectal abscess in the acute setting.

Endoanal Ultrasound

Familiar to most colorectal surgeons, endoanal ultrasound utilizes a probe with 2D or 3D capabilities at a frequency of 5–16 MHz. Similar in discomfort to anoscopy, this technology allows effective characterization of abscesses and fistulae with reported accuracy of 85 % [13]. Normal EAUS demonstrates the interface between the cap and the submucosa (mixed echogenicity), internal sphincter (hypoechoic), intersphincteric space (hyperechoic), and external sphincter (mixed echogenicity) [15]. The probe is covered in a protective sheathing with all air removed, and gently inserted past the puborectalis before slow removal. Fluid is identified by hypoechoic, compressible ovals between or within specific planes. Limitations of this technique include user dependence, limited distance of detection from probe (extrasphincteric, supralevator abscesses), and requirement of intraluminal deployment, which may be precluded by discomfort in acute perianal sepsis.

Transperineal Sonography

A lesser known technique in the colorectal field, TP-US can be quite accurate in diagnosis of fluid collections, internal opening, and even existence and course of a fistulous track. Most importantly, in experienced hands it distinguishes perianal from perirectal abscess and sepsis. Using techniques similar to delineation of vascular structures, patients are evaluated in the left lateral decubitus position. In a comparison of TP-US and MRI, the former was more accurate for superficial fluid collections, while the latter was more accurate for perirectal infection. Overall, concordance between MRI and TP-US was 0.82 for diagnosis of perianal abscess, suggesting a significant advantage for this modality in the acute setting [16]. Clinicians with access to this technology should consider its use in applicable patients to help delineate fluid collection, fistulous tracts, internal openings, and reduce costs compared to MRI and CT studies.

Treatment

Role of Antibiotics

The surgical principles for management of abscesses, in general, hold true for the perianal and perirectal region, with prompt drainage and debridement being the cornerstone. Antibiotics are indicated when associated cellulitis is present, in patients who fail to improve following appropriate drainage, and those with immunosuppressed states. However, medication is rarely adequate in the absence of incision and drainage and at best does nothing to prevent subsequent fistula formation and at worse may increase the risk. In a randomized control trial evaluating treatment of anorectal abscess with and without antibiotics, the risk of fistula formation was unrelated to antibiotic usage. Fistula formation was, however, related to location of the abscess with an eight times higher risk associated with ischiorectal location, and a three times higher risk with intersphincteric compared to the perianal location [17]. (Isolated situations whereby antibiotics may be successful in this setting involve management of perianal Crohn's disease, and will be covered elsewhere.) Coverage is directed towards *Escherichia coli, Enterococcus species*, and *Bacteroides fragilis* in immunocompetent patients, and *Neisseria gonorrhoeae, Chlamydia trachomatis,* cytomegalovirus, and herpes simplex virus in immunocompromised patients [18]. Consider wound culture only in high-risk patient populations, and individuals with recurrent or non-healing disease [13].

Incision and Drainage

The appropriate setting for abscess drainage depends on the location of the abscess and the experience of the clinician. Simple, superficial perianal or ischiorectal abscesses requiring external drainage at the skin level are amenable to bedside drainage in the office, emergency room, or hospital ward. A simple rule of thumb recommends "outward" drainage whenever an abscess enters, or passes through, skeletal muscle (i.e., levator ani, external sphincter) [19]. All others should be drained internally through the rectum/anus. Standard procedure includes appropriate positioning, use of antiseptic prep, and local anesthesia of choice combined with 1:200,000 epinephrine. Starting with a local field block around the abscess prior to injection of skin overlying the point of maximal tenderness often provides more effective analgesia than injection of the cavity alone. The choice of elliptical incision, or cruciate incision combined with excision of skin flaps, prevents early closure and recurrence (Figure 14-4). When possible, the incision is made as near the anal verge as possible to limit the length of any potential fistula. Additionally, the predominant incision should run parallel to the external sphincter muscle fibers. Packing is not required in this scenario, and its absence yields quicker healing with less pain [20].

Patients requiring internal drainage, those with recurrent or bilateral disease, and those with large abscesses at risk for inadequate bedside drainage, should undergo operative drainage. For abscesses of significant size, consider multiple counter incisions with interposition of setons or Penrose drains to accelerate healing. Drains are removed at 2–3 weeks postoperatively when the base of the cavity has granulated and shrunk. Further candidates for internal drainage include (1) submucosal abscess, (2) intersphincteric abscess, (3) supralevator abscess from intersphincteric fistula, and (4) supralevator abscess from pelvic disease [19]. The diagnosis of intersphincteric fistula should be entertained in patients with pain out of proportion to exam findings. Definitive management involves incision of the internal sphincter along the length of abscess, with or without marsupialization of the wound edges. Individuals with delayed recurrence greater than 2 weeks likely have a fistula, and thus require EUA for delineation and control of fistula track.

Supralevator abscesses require delineation of the track by imaging before surgical correction is undertaken. When the inciting source is intra-abdominal, transrectal drainage is indicated in most scenarios. However, abdominal drainage can be considered depending upon ease of access and directionality of the abscess cavity. When the source is intra-abdominal, percutaneous management may prevent creation of a fistulous track through the levator plate via improper ischiorectal drainage, and is often more successful than transrectal drainage. The scenario of supralevator extension from ischiorectal abscess due to a transsphincteric fistula requires ischiorectal drainage. For instances where a supralevator abscess forms as an upward extension of an intersphincteric fistula, internal drainage via incision of the internal sphincter is best (Figure 14-5).

Bilateral abscess disease, or "horseshoe" abscess, requires operative drainage to delineate and control the source. This difficult-to-treat entity most commonly arises from a deep

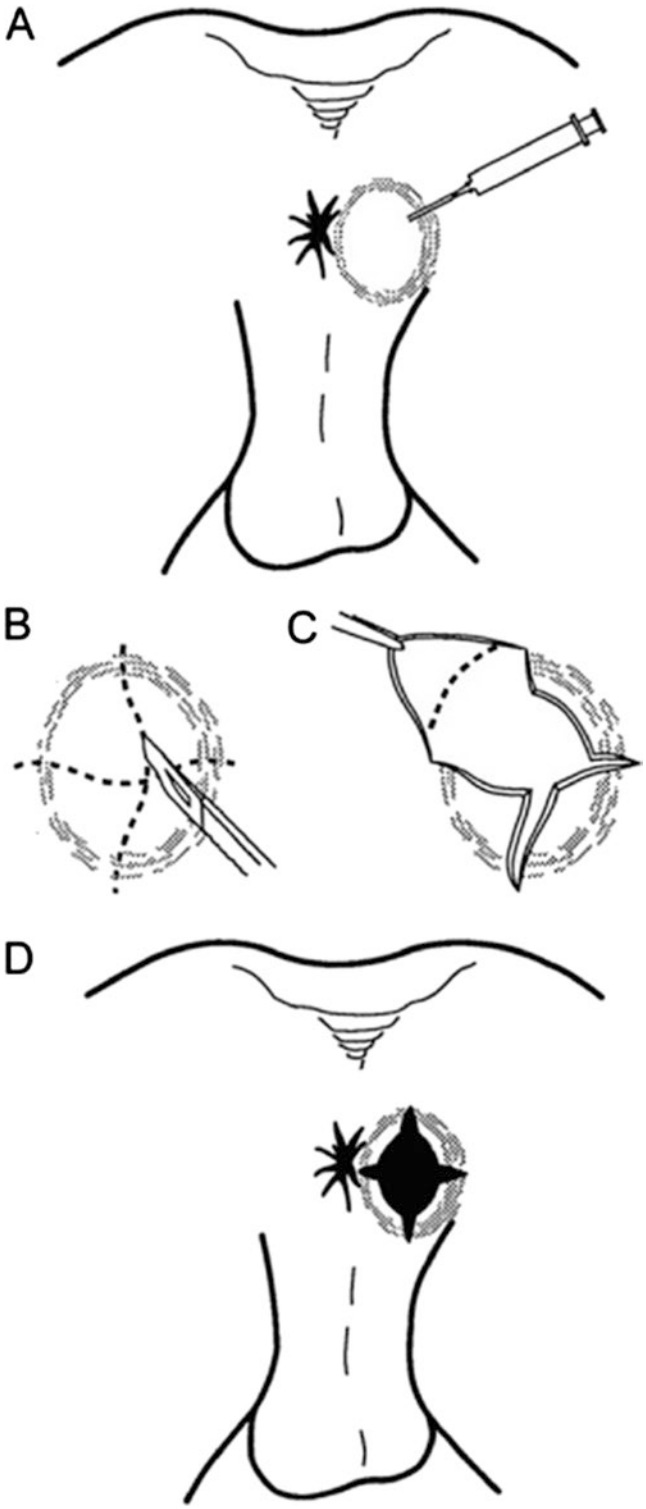

FIGURE 14-4. Drainage of abscess: (**a**) injection of local anesthesia, (**b**) cruciate incision, (**c**) excision of skin, (**d**) drainage cavity.

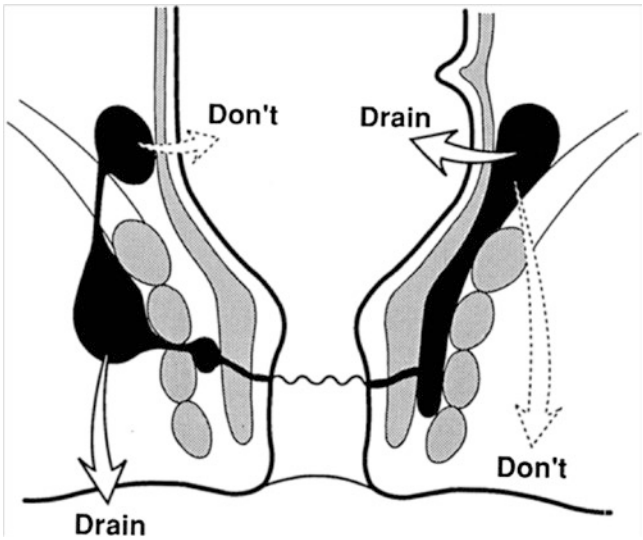

FIGURE 14-5. Drainage of a supralevator abscess.

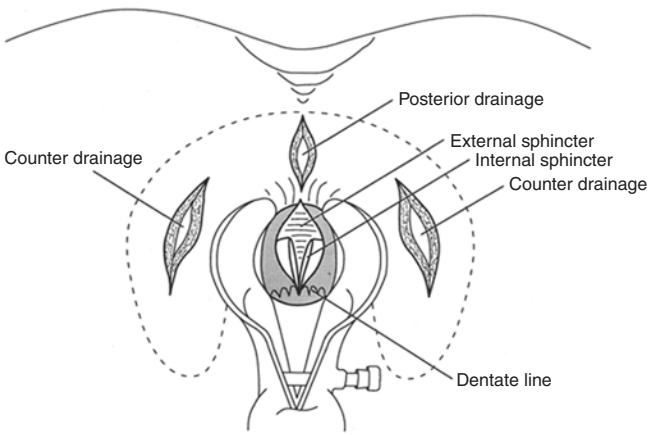

FIGURE 14-6. Drainage of a horseshoe abscess.

postanal space abscess. Many patients present with history of prior drainage procedures, and thus may have complex tracts. Options for management include the Hanley or modified Hanley procedures, consisting of open posterior drainage through the anococcygeal ligament, posterior midline incision of the internal sphincter and inciting anal duct, and open drainage of bilateral ischiorectal fossae to control lateral tracks (Figure 14-6) [21]. Modifications to this procedure include limiting drainage to internal sphincterotomy followed by elliptical incisions over bilateral ischiorectal fossae. If necessary, a seton (cutting or non-cutting) is placed in the posterior midline, with subsequent definitive management taking place at a later time (Figure 14-7). More recently, management of deep postanal space abscess was described using an intersphincteric technique. The intersphincteric space is dissected in the posterior midline until identification of the anal duct source, with subsequent continuation into the deep postanal space for drainage and curettage. Benefits included minimization of procedures necessary when using the loose seton technique, reduction in risk of incontinence compared with the cutting seton technique, and ease of learning for the surgeon [22].

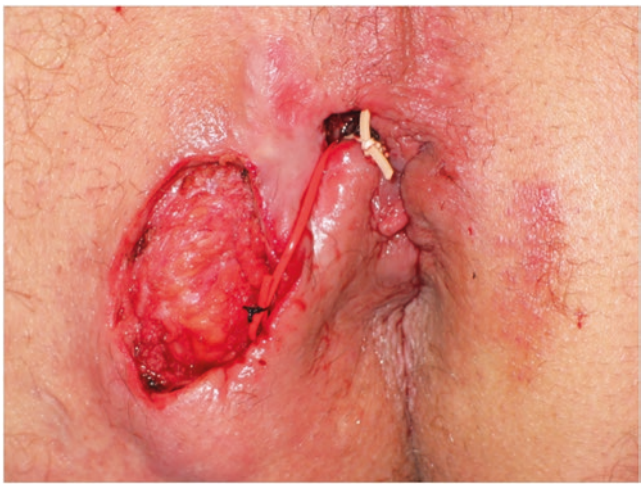

FIGURE 14-7. Horseshoe fistula managed with drainage and seton.

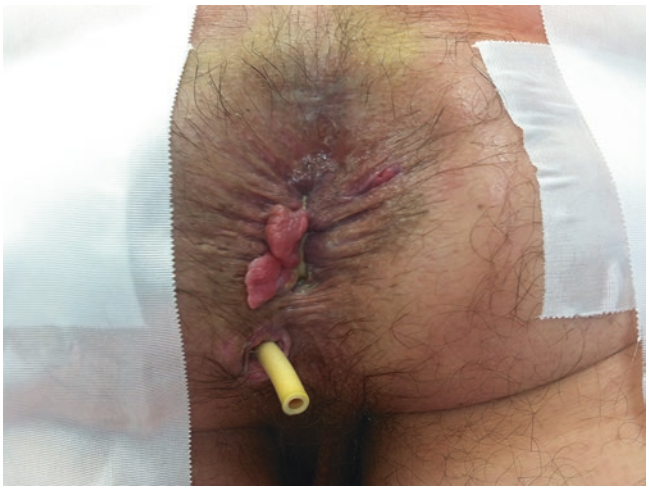

FIGURE 14-8. Pezzer catheter in an ischiorectal fossa abscess.

Catheter Drainage

Minimization of perianal incisions is possible using the placement of a drainage catheter within the abscess cavity. Appropriate size and external fixation of catheter are necessary to ensure adequate drainage, especially in patients with large abscess cavities, patients with severe systemic illness, and those with underlying comorbidities including diabetes mellitus and morbid obesity. To start, a small stab incision is made in anesthetized skin on the medial aspect of the abscess. A mushroom tip catheter (de Pezzer, Malecot, Cook Medical) between 10 and 14 Fr is inserted to full cavity depth. The external portion of the catheter is cut to length, leaving a 2–3 cm area with which you secure it to the perianal skin using a permanent suture (Figure 14-8). Recommendations differ with regard to duration of treatment, ranging from 3 to 21 days. However, removal prior to cessation of drainage usually results in recurrence, and should be avoided. For non-healing wounds, the catheter is utilized for drain studies to elucidate fistula tracks or other associated pathology.

Drainage with Primary Fistulotomy

Despite a paucity of recent studies on the management of anorectal abscess, controversy abounds regarding the use of primary fistulotomy at the time of abscess drainage. Historically, primary fistulotomy was performed when draining the abscess for source control, thereby increasing the rate of healing without the need for subsequent procedure [11]. In a meta-analysis of six randomized controlled trials, recurrence, persistent abscess/fistula, and repeat surgery were significantly reduced when primary fistulotomy was performed concurrent with abscess drainage (RR = 0.13, 95 % CI 0.07–0.24) [23]. However in the acute setting inflammation may inhibit clear determination of muscle involvement and the pooled relative risk of incontinence at 1 year was 3.06 (95 % CI 0.7–13.45), ranging between 2.03 and 4.77 in sensitivity analysis. This did not reach statistical significance when compared to the fistulotomy group and the study authors concluded that a fistulotomy at the time of abscess drainage was warranted. When an accurate estimate of muscle involvement is confounded by acute changes, thereby increasing the risk of excessive muscle incision, placement of seton may be indicated preventing the unintended consequence of incontinence [24, 25].

Despite these recommendations the risk of incontinence with all of the resultant patient morbidity may limit its application [26]. In fact several reports indicate a high rate of spontaneous healing following effective abscess drainage alone [27, 28] with the incidence of recurrent abscess reported to be 30 % and subsequent fistula formation between 26 and 50 % [23, 29, 30]. This may be even lower if the offending duct is identified and opened, confirming a limited role for primary fistulotomy in selected patients [23, 31].

In an effort to identify the crypt of origin when draining an acute abscess a probe can be carefully inserted into the suspected duct by direct visualization. Adjuncts for locating the duct include manual pressure on the abscess cavity while looking for purulent extrusion, identification of inflammation indicating the culprit duct, or simple blind probing. When identified, gentle probe advancement may elucidate the inciting fistula, but care is required to prevent creation of a false track. Unfortunately, a recent study reported successful internal opening (IO) identification of only 36 % using manual abscess cavity compression, consistent with prior published rates of failure exceeding 65 % [32, 33]. Interestingly, one randomized control trial reported 83 % success using simple abscess compression [34]. Because localizing the offending duct is difficult, and misidentification leads to complications, alternative methods are available. In patients who failed identification by abscess compression, injecting

2 cc of 2 % hydrogen peroxide combined with 1–2 drops of methylene blue into the abscess cavity resulted in localization of the internal opening in 90 % of cases. At median follow-up of 16.5 months, rates of recurrent disease were 2.8 % in those undergoing primary fistulotomy compared with 40 % in patients treated with incision and drainage alone [29].

Unfortunately, there is no clear answer to the question of primary fistulotomy at the time of abscess drainage. In fact, the ASCRS Practice Parameters for management of anorectal abscess advocate, "… weigh[ing] the possible decreased recurrence rate in light of the potential increased risk of continence disturbances" [13]. Surgeons who are inexperienced in the management of anorectal pathology should refrain from searching for a fistula due to higher rates of adverse events and poorer patient outcomes. Healthy patients *without* prior fistulous disease, IBD, or simultaneous anterior fistulas potentially benefit from primary fistulotomy at the time of abscess drainage in the hands of experienced surgeons. Superficial and low transsphincteric (<30–40 % external sphincter involvement) fistulas with minimal sphincter involvement provide the best opportunity for successful fistulotomy at the time of abscess drainage [5].

Postoperative Management

Postoperative care is similar to most anorectal procedures. Local wound care involves sitz baths two to three times daily followed by wound coverage using gauze. Packing is not necessary and should be avoided. Following catheter drainage, a dressing is similarly applied over the catheter end to prevent soiling of clothing. Irrigation of the catheter is not necessary. There is no data to support the use of topical antibiotics. Surgeon follow-up is indicated at 2–3 weeks in patients who undergo incision and drainage, and 7–10 days in those with mushroom-tip catheters. Endpoint for removal is cessation of purulent drainage from the drain, and closure of the wound around catheter. Patients are followed until complete healing of the wound or cavity; especially since recurrence and fistula formation are associated with delay/lack of surgical follow-up. Pain control is obtained with multimodality therapy to include local anesthetic at surgery combined with narcotic and non-narcotic oral medications for home use. Diet is advanced to regular once the patient is aroused from anesthesia, and a bulk-forming fiber supplement is advised for the first month. Activity level may proceed ad lib. Antibiotics are not warranted in the postoperative setting unless cellulitis is present, or in the immunocompromised patient.

Complications

Immediate Postoperative Period

Complications related to abscess drainage and fistulotomy include bleeding and urinary retention. Significant bleeding in the postoperative period following incision and drainage occurs at a rate of 1–2 %. The rate of urinary retention reported in the literature following uncomplicated incision and drainage is 2.3 %, increasing to 6.3 % in patients undergoing fistulectomy/fistulotomy [35]. This compares favorably to the reported incidence of 22 % in patients undergoing hemorrhoidectomy. Universal risk factors for urinary retention in anorectal procedures include age over 50, female sex, and intravenous fluid (IVF) greater than 1 L perioperatively [35].

Abscess Recurrence and Fistula Formation

Rates of abscess recurrence following drainage are estimated at 4–31 %, with a median of 13 % [36]. The only significant prognostic factor for patients presenting with their first abscess without other complicating factors such as IBD was time from disease onset to drainage procedure. Rates of recurrence were higher in those undergoing management more than 7 days after the onset of symptoms [37]. Early recurrence is usually the result of inappropriate technique, early skin apposition, and reformation of the abscess. Insufficient drainage leads to continued inflammation, prolonged healing, and fistula formation [1, 38, 39]. Reasons for semi-acute recurrence include missed loculations, prior intervention with associated scarring, and destruction of natural barriers to infection [26, 40, 41]. Because a large number of recurrent abscesses are due to inadequate treatment in patients who present with spontaneous drainage and receive outpatient care, one group advocated exam under anesthesia for all patients even if the abscess has apparently decompressed [39]. Horseshoe abscesses recur more frequently with a reported incidence between 18 and 50 %, usually requiring multiple operations before healing occurs [42]. The clinician must elucidate site of prior drainage and determine likelihood of horseshoe abscess in order to effectively treat the diagnosis.

Misdiagnosis

When an abscess is not effectively managed despite optimal medical and surgical intervention an alternative diagnosis must be entertained. Pilonidal disease, hidradenitis suppurativa, tuberculosis, herpes simplex virus, HIV, and inflammatory

bowel disease (specifically, Crohn's disease) must be part of the differential diagnosis [39]. While the incidence of pilonidal disease is 1:4000, only a few case reports exist detailing its presentation as an anorectal abscess or fistula [43]. In a study of 100 recurrent anorectal abscesses at a large tertiary care colorectal program, 32 % of patients treated for anorectal abscess actually had hidradenitis, underlying the importance of entertaining alternative diagnoses in patients with recurrence [39]. Incidence of HIV and other infectious sources are difficult to estimate, and will be predicated by the surrounding patient population. Between 5 and 19 % of Crohn's patients will demonstrate perianal manifestations prior to any other symptoms, suggesting a significant opportunity to make an early diagnosis.

Special Considerations

Necrotizing Anorectal Infection (Fournier's Gangrene)

Necrotizing anorectal infections are rare, representing less than 0.02 % of hospital admissions with an incidence between 1.6 and 3.3/100,000 [44]. Males outnumber females at a ratio between 9 and 50:1 [45]. Current estimates of mean age are between 45 and 55 years, which steadily increase as the worldwide population ages. The diagnosis is rarely made in children. Some countries report an increasing incidence; however, there is minimal data to support this conclusion in the USA. Medical risk factors commonly associated with necrotizing soft tissue infections include diabetes, hypertension, elderly age, obesity, immunosuppression (especially when due to malnutrition, liver disease, malignancies), drug use, and recent surgery [46]. As expected, rates of necrotizing fasciitis are increased in patients with perianal disease. Commonly, either long-standing or inappropriately managed perianal disease predates an episode of necrotizing fasciitis. In patients diagnosed with Fournier's gangrene, 50–60 % had underlying anorectal abscess as their inciting source [45].

Diagnosis

Presenting symptoms include severe pain out of proportion to exam, fever, chills, erythema, and induration at the site (Figure 14-9). In polymicrobial and clostridial infections, crepitance is often noted. Unfortunately, necrotizing soft tissue infections progress along fascial planes; thus the extent of disease is easily underestimated. Timing of disease progression ranges from 2 to 5 days. Laboratory values are nonspecific, but indicate disease severity. White blood cell count, creatinine kinase, and lactate are most helpful in estimating severity of infection and confirming the diagnosis.

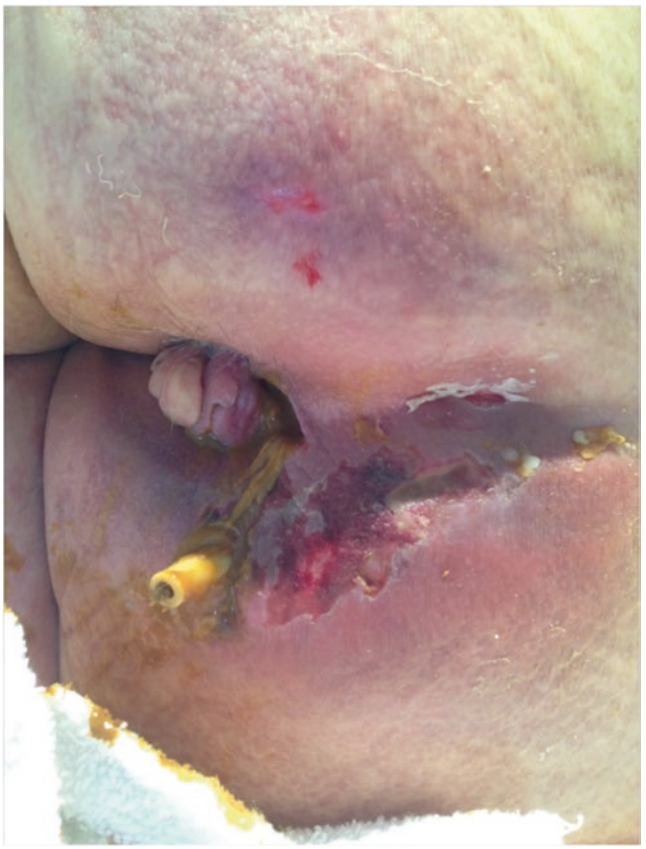

FIGURE 14-9. Necrotizing soft tissue infection in a patient with a supralevator fistula and abscess inadequately drained.

Cultures and gram stain are unhelpful at initial diagnosis, but can guide appropriate postoperative antibiotic therapy. Due to false negatives, bedside biopsy plays a limited role in the diagnosis except in tertiary care centers with experience. When the diagnosis is unclear, imaging is recommended using CT abdomen/pelvis to identify the source and extent of infection.

Treatment

Prompt diagnosis and treatment are necessary to maximize survival. Following diagnosis, treatment involves aggressive fluid resuscitation with crystalloid of choice and initiation of broad-spectrum antibiotics (penicillin g, metronidazole, third-generation cephalosporin, gentamicin). Next, the patient undergoes surgical intervention with wide local excision of affected tissue (Figure 14-10). Due to rapid spread, surgical excision should extend beyond visibly infected tissues. Additionally, the patient should be evaluated on a regular basis in the ICU for any wound changes. It is common to return to the operating room within 24–48 h to re-excise margins, and to ensure appropriate source control.

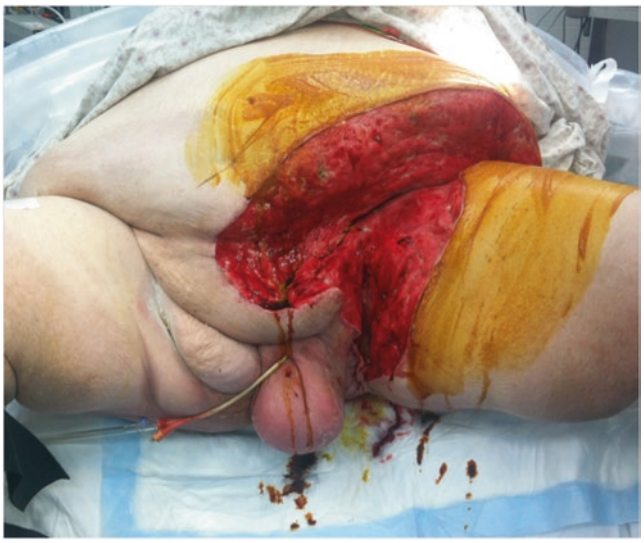

FIGURE 14-10. Extensive soft tissue debridement of necrotizing soft tissue infection starting as an anorectal abscess.

A useful adjunct when anorectal abscess incites necrotizing fasciitis involves the loose-seton technique [47]. Here, multiple radial incisions are made in the external sphincter at its outer margins. The incisions are widened manually, and loose setons placed between every other drainage incision. When combined with standard wide local excision at the outset, trips to the operating room are decreased, as is the overall wound size. Some advocate creation of a colostomy to help with wound care after extensive dissection. While no data currently supports this practice, higher consideration is given to patients with a grossly infected sphincter muscle, and anorectal perforation, or those in an immunocompromised state. Tailoring of antibiotics should occur when culture results return.

Outcomes

Necrotizing fasciitis remains a lethal disease, despite significant advances in diagnosis, surgical care, and supportive management. Mortality rates in the literature span 4–80 %; however, most large studies demonstrate a consistent range of 7–10 %. Death is usually the result of sepsis and sequelae of multi-organ system failure [45]. For survivors, long-term morbidity is dependent upon the extent of wound debridement and recovery of organ systems.

Use of the Fournier's Gangrene Severity Index (FGSI) predicts mortality by combining nine parameters such as temperature, heart rate, and other clinical values. In the sentinel paper, scores >9 predicted probability of mortality at 75 % [48]. Conversely, scores ≤9 predicted probability of survival at 78 %. Since 1995, multiple studies have validated this scoring system [45].

Anorectal Infections in Immunosuppressed Patients

Hematologic Abnormalities in Immunosuppression

In patients with hematologic malignancies, or those treated with myelosuppressive regimens, immunosuppression and low neutrophil count produce an incidence of anorectal sepsis approaching 10 % [49]. Despite the high incidence, diagnosis is often difficult and delayed. This occurs due to low neutrophil counts, whereby non-fluctuant induration with minimal erythema evades untrained eyes, leading to misdiagnosis in half of the patients [50]. If counts increase, normal clinical signs of abscess may occur, allowing for a diagnosis.

Complications of anorectal abscess in hematologically immunosuppressed patients are similar to healthy patients, including recurrence, fistula formation, and incontinence. However, systemic complications of sepsis are more likely in this patient population, including death. When untreated, mortality approaches 60 % [51, 52]. As such, aggressive management is indicated when anorectal sepsis is suspected.

Appropriate treatment of these high-risk patients involves determination of immune status and tailored therapy. Antibiotics are standard of care, aimed at coverage of standard gastrointestinal flora using a local antibiogram. For patients with absolute neutrophil count (ANC) <1000/mm^3, antibiotics are first-line therapy with rates of resolution between 30 and 90 % [49, 53]. Patients with higher neutrophil counts will demonstrate an abscess, which requires incision and drainage. Physical exam is limited in these patients, so imaging studies are indicated for delineation of size, extent, and involved structures. CT scans are rapid, easily obtained, and demonstrate supralevator components with high degree of accuracy. If concern exists for more complex anorectal sepsis, and possible necrotizing infection, MRI provides superior imaging for diagnosis. Using T1- and T2-weighted images, physicians can determine abscess vs. inflammation, adjusting treatment accordingly [50].

The decision on timing of surgical intervention is not always clear-cut. Patients with neutropenia suffer higher rates of morbidity following surgery, and mortality was upwards of 45 % in one study vs. 9 % in those treated only with antibiotics [54]. Published rates of failure in neutropenic patients range between 30 and 37 % [50]. If antibiotic therapy fails based on abscess formation, lack of improvement, or development of necrotizing infection, surgical debridement is indicated. While thrombocytopenia is associated with nonoperative management, fluctuance, erythema, and presence of purulent material indicate patients appropriate for surgical drainage [55]. Due to the high risk of morbidity and mortality in patients with incomplete evacuation of purulent material, operative washout is preferred to bedside management. Postoperative care and management proceed similarly to health patients.

Human Immunodeficiency Virus

There is little distinction between the management of HIV patients and otherwise-healthy individuals with anorectal abscess. However, prompt recognition and treatment are required due to concerns of underlying immunosuppression. In this patient population, alternative diagnoses including sexually transmitted infections and CMV are also common. Further, risk of neoplasm requires biopsy of tissue at the time of drainage.

Anal Fistula

The management of anal fistula cannot be undertaken without a thorough understanding of their etiology, and the anatomy of the anal canal and sphincter complex. The disease represents a wide spectrum of complexity and is often misdiagnosed and poorly treated by surgeons and physicians who lack experience. Complexity has certainly increased in large part due to the unwillingness of patients and surgeons to risk continence when managing fistulas, a fact underscored by the significant increase in the use of non-cutting techniques used to treat anal fistulas during the past 30 years [56].

Etiology

A fistula is defined as an abnormal connection between two epithelial lined surfaces such as a set of organs or vessels, which do not normally connect, e.g., the connection between the distal alimentary tract and the integument. The incidence is believed to be 2 per 10,000/year while the prevalence is not truly known [57]. The etiology of anal fistula is cryptoglandular in 90 % of cases, postoperative or traumatic in 3 %, inflammatory bowel disease in 3 %, as a result of anal fissure in 3 %, and tuberculosis related in less than 1 % of cases.

The cryptoglandular cause of anal fistula refers to the presence of the anal crypts, proposed to originate at the bottom of the rectal columns of Morgagni, which are epithelial lined tracts that penetrate to the submucosa and occasionally into and through the internal sphincter. Despite the use of the term "glandular" it is not always the case that these structures are functional and may be vestigial remnants from embryonic growth. Their frequency and location are varied but tend to concentrate posteriorly and are more commonly found in men [7, 58]. Kratzer and Dockerty examined over 100 anatomical specimens histologically, and found anal glands in 55 % of specimens; in 33 % the ducts penetrated the internal sphincter [59]. Parks evaluated 44 specimens and identified 6–10 glands originating from the anal crypts and held the belief that these were mucous producing. The glands terminated variably into the submucosa, internal sphincter, or intersphincteric groove. He postulated that these glands provided a free channel for infection to pass from the anal lumen deep into the sphincter muscles. He believed that chronic infection in the cystic portion of the gland, if deep to the internal sphincter, would result in a sinus forming to the skin. Though technically due to the epithelial lining of the duct it is in fact a fistula [10].

It is believed that the anal crypts become blocked by inspissated debris or stool. As a result, an infection develops at the anal glands, which extends in a path of least resistance, forming an abscess in the intersphincteric space leading to the development of a fistula [9]. Additionally anal fistula can occur as a result of Crohn's disease, malignancy, trauma, tuberculosis, lymphogranuloma venereum, and actinomycosis. Not all cryptoglandular infection results in the development of a fistula. Scoma et al. performed a retrospective analysis of 232 patients who had undergone a drainage procedure and found that 66 % of their patients subsequently developed anal fistula [60]. They did not classify the type of fistula or abscess in their study making generalizations difficult although 77 % of their patients were male. Hamadani et al. performed a similar review of 148 patients with a mean follow-up of 38 months. The cumulative incidence of anal fistula was 36 % with no differences seen in a multivariate analysis among men vs. women, nonsmokers vs. smokers, perioperative antibiotic use, or HIV status. Age less than 40 was the only significant predictor of fistula formation in their study [36]. Wang et al. reviewed the records of 1342 patients with confirmed anal fistula and matched these cases to a separate cohort of patients referred with other anorectal complaints but without fistula disease. Using multivariate analysis BMI exceeding 25 kg/m^2, prior diabetes, hyperlipidemia, dermatosis, sedentary lifestyle, regular alcohol intake, smoking, non-fistula anorectal surgery, prolonged sitting on the toilet for defecation, and a previous history of enteritis were independently correlated with a risk of anal fistula [61].

It is likely that the true incidence of anal fistula following abscess formation is closer to 30 % and should be suspected in any patient with a recurrent perirectal abscess especially if it occurs at the same site of a previous abscess as fistula-in-ano is thought to be responsible for 40–50 % of recurrent abscesses [39].

Classification

Anal fistula can be characterized as simple or complex. The definition of a complex fistula is not standardized but most authors agree that any fistula that is high transsphincteric or when a fistulotomy would result in incontinence should be considered complex. The definition also includes suprasphincteric, extrasphincteric, all anterior transsphincteric fistulas in women, and those caused by Crohn's disease, malignancy, surgery, and trauma. Roughly 50 % of all fistulas are considered complex giving rise to significant challenges in the treatment of this disease.

Anal fistulas are also classified based on their relationship to the anal sphincter complex. In 1934 Milligan and Morgan suggested a classification of anal fistula based on the position of the internal opening relative to the anorectal ring [62]. This was subsequently modified by Parks et al. (Table 14-2) based on his analysis of 400 cases of treated anal fistula over a 15-year period [63]. He anchored his classification system on the external sphincter due to the importance it played in the surgical management (Figure 14-11a–d).

Table 14-2. Classification of fistula-in-ano

Intersphincteric
Simple low intersphincteric
High blind tract
High tract with an opening in the rectum
High tract with rectal opening, no perineal opening
Extra-rectal extension
Secondary to pelvic disease
Transsphincteric
Uncomplicated
High blind tract
Suprasphincteric
Uncomplicated
Horseshoe extension
Extrasphincteric
Secondary to anal fistula
Trauma related
Pelvic inflammation
Inflammatory bowel disease or other anal disease

An intersphincteric fistula (Figure 14-11a) occurs in 20–45 % of cases [64] and does not penetrate the external sphincter and "ramifies only in the intersphincteric plane." Parks et al. additionally classified seven subtypes of intersphincteric fistula with the most common having a high blind track, which as its name suggests has an extension in the intersphincteric groove cephalad towards the rectum. The other subtypes are less common.

A transsphincteric fistula (Figure 14-11b) occurs in 30–60 % of cases and penetrates the external sphincter below the level of the puborectalis muscle exiting into varying levels within the ischiorectal fossa. A high blind track may also confound a transsphincteric fistula and can end at the apex of the ischiorectal fossa or alternatively pass through the levator plate into the true pelvic cavity. The latter can be felt if a probe is passed from the opening in the perineal skin, the tip of which will be palpable above the anorectal ring through the wall of the rectum. Care should be taken *not* to iatrogenically perforate the rectum or an extrasphincteric fistula will be the result. The significance of this high blind track is the inability to cannulate the internal opening using a probe passed from the perineal skin as it will preferentially follow the high blind track and not the transsphincteric portion, which comes off at a right angle. It may be possible to cannulate the internal opening through the anus with a right-angle probe in order to secure a seton or if feasible perform a fistulotomy. A flexible tip glide wire can sometimes be used when this sharp angulation is encountered but again care must be taken to avoid creating a false passage (Figure 14-12).

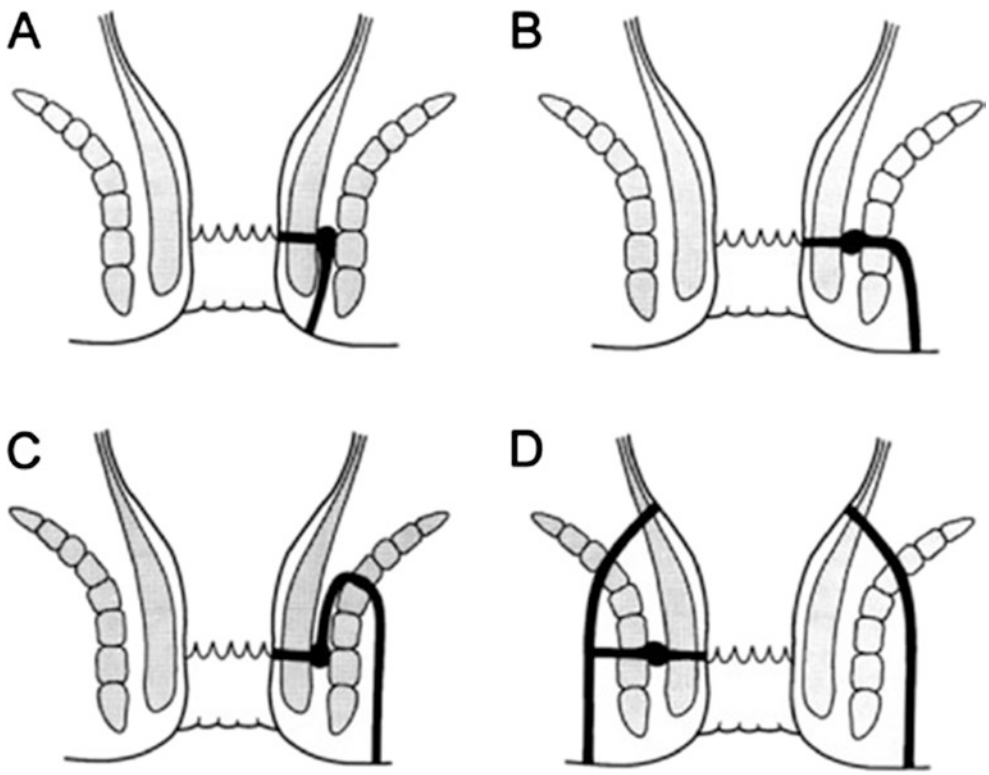

Figure 14-11. Classification of anal fistula. (**a**) intersphincteric, (**b**) transsphincteric, (**c**) suprasphincteric, (**d**) extrasphincteric.

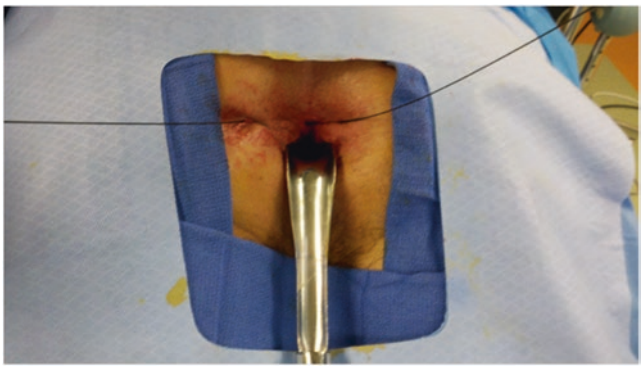

FIGURE 14-12. Flexible glide wire to delineate a transsphincteric fistula with a high blind extension.

A suprasphincteric fistula (Figure 14-11c) occurred in 20 % of cases in the series by Parks et al. but has been reported at a much lower frequency by other authors (<2 %) [64, 65] and in this group the track is over the top of the puborectalis, then downward again through the levator plate to the ischiorectal fossa, and finally the skin. As it passes over the puborectalis it is anatomically in the supralevator space and abscess formation here can be palpated by rectal exam. Abscess formation in this space can result in a horseshoe extension around the rectum.

Lastly extrasphincteric fistula (Figure 14-11d), which only occurs in 2–5 % of cases, passes from the perineal skin through the ischiorectal fat and levator muscles into the rectum. It is outside the external sphincter complex altogether. An extrasphincteric fistula may result from a transsphincteric fistula with a high blind tract that penetrates through the levator plate as described earlier or it may be due to trauma, inflammatory bowel disease, malignancy, or pelvic inflammation that necessitates through the levators to the perineal skin (ruptured appendicitis, terminal ileal Crohn's disease, or diverticulitis are the most common causes).

Submucosal fistulas are likely the result of anal glands that terminate in the submucosa and track just beneath the submucosa not involving the sphincter complex at all. These fistulas may be opened without compromising fecal continence.

Diagnosis

The symptoms of an anorectal fistula will be quite variable based on the location of the external opening, the complexity of the tract, the patient's tolerance, as well as the underlying cause. Fistula that results from cryptoglandular disease will usually be preceded by a history of an anorectal abscess that was drained (either purposefully or spontaneously). Patients will often assume that their symptoms are related to "hemorrhoids" and/or be referred after a biopsy of the external opening by referring physicians. Bleeding is common due to the hyper-granulation tissue that forms on the external

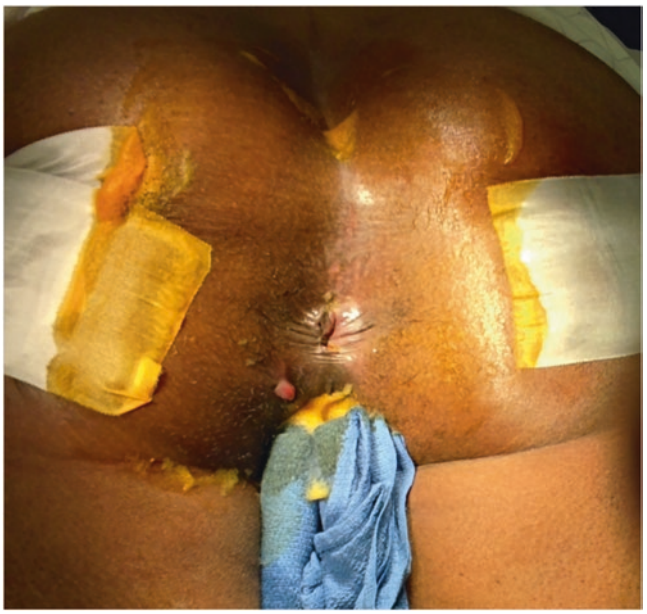

FIGURE 14-13. External opening noted left anterolateral with heaped-up edge.

opening and often irritation of the anal margin skin ensues from chronic moisture or from fecal contact. Pain may be a feature for patients with chronic infection or ongoing inflammation and is often cyclical as a result of spontaneous abscess formation and drainage. Severe pain should be a red flag for another etiology of the fistula such as malignancy or Crohn's disease. If a patient has concomitant gastrointestinal symptoms such as abdominal cramping, bloating, early satiety, or weight loss an associated diagnosis such as IBD or malignancy must be excluded.

Physical exam findings are usually pathognomonic for an anal fistula with an opening on the anal margin skin with heaped-up granulation tissue that is tender and often draining (Figure 14-13). The nature of the drainage can vary and may be serous, purulent, or feculent depending on the fistula. Often the location of the fistula can tell the examiner two things: the location of the internal opening and the depth of the fistula through the sphincter muscles. External openings that arise directly in the posterior midline close to the anal verge are usually submucosal while openings off the midline close to the anal verge are frequently intersphincteric. Low transsphincteric fistulas have been shown to occur more often in the anterior location and are less likely to be preceded by an abscess [66]. External openings in the ischiorectal fossa are usually the result of transsphincteric or suprasphincteric fistula and the examiner should suspect that the external sphincter muscle will be involved. In addition Goodsall's rule can be applied to help locate the internal opening. Goodsall described his observations of anal fistula in a book chapter written in 1900 [67]. He subdivided the anal margin skin into quadrants by two lines intersecting at right angles in the center of the anal aperture. The first was

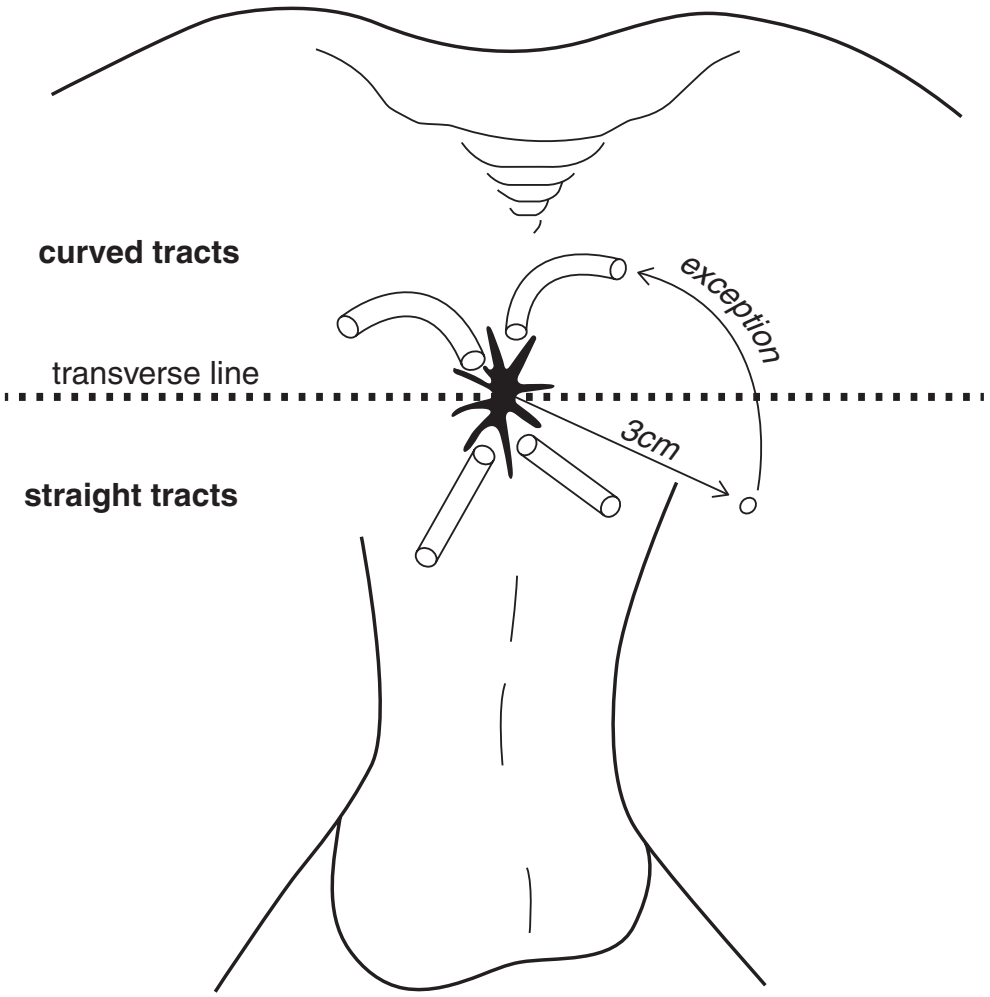

FIGURE 14-14. Goodsall's rule for anal fistula.

drawn connecting the ischial tuberosities and was referred to as the transverse anal line and the second from the coccyx to the pubic symphysis (Figure 14-14). The transverse anal line is of importance as external openings of anal fistulas that are located anteriorly are postulated to drain to an internal opening radially situated while posterior external openings drain to the posterior midline. This observation has proven accurate for external openings situated posteriorly but less so for anterior fistula. Cirocco et al. demonstrated in their retrospective review of 216 patients with transsphincteric fistula that 81 % of all fistulas drained to the midline. They confirmed that posteriorly located fistulas drain to the posterior midline in 90 % of cases (97 % for women, 87 % for men) while 71 % of anteriorly located fistulas drain to the anterior midline [68]. The positive predictive value of Goodsall's rule has been estimated to be 59 % and is more accurate for posteriorly located fistulas [69, 70].

Palpation of the anal canal using the pad of an experienced finger can frequently determine the location of the internal opening by subtle changes in the anoderm [71]. Anoscopy is helpful to exclude inflammatory conditions of the anal canal or other potential causes of the fistula but the internal opening is rarely seen unless pus is draining from it. In patients that have abdominal symptoms or findings in the office concerning for a cause other than cryptoglandular a colonoscopy can be performed. However as a general rule most patients with anal fistula require little if any work-up other than a physical exam.

Preoperative imaging is reserved for patients that present with multiple external openings, those in which an internal opening cannot be identified on physical exam either preoperatively or intraoperative or in cases of recurrence following surgical procedures especially a fistulotomy in which cure would be expected. Increasingly patients presenting with anal pain in the emergency room are undergoing CT scans with rectal contrast that can occasionally demonstrate an anal fistula. However as a rule this is not a helpful test for the evaluation of anal fistula and should not be routinely ordered [72].

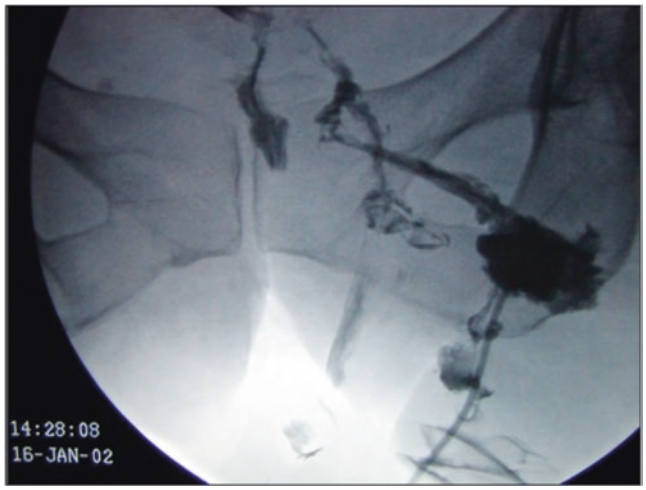

FIGURE 14-15. Fistulography of complex anal fistula (*arrow* on fistula tract).

Fistulography

Water-soluble contrast injected into the external opening under fluoroscopy using a small feeding tube has proved historically to be useful in the evaluation of complex anal fistulas (Figure 14-15). Weisman et al. retrospectively evaluated the utility of fistulography in 27 patients with anal fistula and found that in 13 of the 27 patients (48 %) information obtained from the fistulograms revealed either unexpected pathology ($n=7$) or directly altered surgical management ($n=6$) [73]. However Kuijpers et al. found fistulography to be inaccurate for the detection of internal openings (5/21 patients) and high extensions (9/21 patients) compared to surgical findings [74]. Using a modified technique in which contrast was injected through a Foley catheter inserted into the rectum Pomerri et al. demonstrated an accuracy of 74 % for the detection of internal openings and 92 % for secondary tracks when compared to surgery [75].

Due to the limitation of plane film imaging to delineate anatomic landmarks more recent attempts at fistulography have incorporated CT imaging in combination with contrast injection. Liang et al. prospectively evaluated 18 patients with anal fistula and found that CT fistulography had excellent concordance with intraoperative findings including the identification of the fistula tracks, internal opening, and deep abscesses [72]. They failed to demonstrate that CT fistulography was superior to the intraoperative assessment or compare their findings to other imaging techniques. More data is needed to determine if CT fistulography will be a valid tool to assist in the management of patients with complex anal fistula. However it is likely that fistulography as a diagnostic tool for complex anal fistula will be of limited value given the alternatives available in modern radiology suites or colorectal offices.

Endoanal Ultrasound

Surgeon-performed endoanal ultrasound (EAUS) can be performed in the office as a way to characterize complex fistula and its relationship to the sphincter complex. Fistulas appear as a hypoechoic track, which can be enhanced by the instillation of hydrogen peroxide or a Levovist™ [76]. These agents are injected into the external opening during the ultrasound examination to create air within the tract and increase the hypoechoic signal although the advantage of such agents has not been well established [77, 78]. EUS can also help determine the presence of secondary tracts as well as horseshoe extensions. Muhammed et al. performed a meta-analysis of studies comparing EUS with MRI for the detection and characterization of anal fistula. 240 patients were evaluated in the EUS group. The combined sensitivity and specificity in detecting fistulas were 0.87 (95 % CI: 0.70–0.95) and 0.43 (95 % CI: 0.21–0.69), respectively [79]. EUS performed better in the detection of transsphincteric fistula vs. intersphincteric and suprasphincteric tracts that can be difficult to localize [80, 81]. Buchanan et al. evaluated the utility of EUS compared to *preoperative* clinical assessment in determining the *classification* of anal fistula in 104 patients. EUS was superior to physical exam, which correctly predicted 87 (81 %) vs. 66 (61 %) patients, respectively ($p<0.01$). It was also superior in identifying the internal opening (91 % vs. 78 %), and undrained fluid collections (75 % vs. 33 %) [82]. Nagendranath et al. evaluated the performance of hydrogen peroxide-enhanced EUS in 68 patients undergoing surgery for anal fistula. EUS performed no better than *intraoperative* findings in determining the presence and course of the primary tract. EUS outperformed the surgical findings in detecting the presence of secondary tracts (92.65 vs. 79.41 %; $p<0.001$) and course (91.18 vs. 77.94 %; $p<0.001$) [78]. In 13 patients the findings on the EUS changed the operative approach from fistulotomy to seton placement but the authors do not comment as to the reasoning. Conversely, Toyonaga et al. were able to demonstrate that EUS was superior to *intraoperative* findings in the identification of acute and chronic anal fistula in a prospective series of 400 patients. EUS was superior to physical exam in correctly identifying the fistula track (88.8 % vs. 85.0 %, $p=0.0287$) and horseshoe extension (85.7 % vs. 58.7 %, $p<0.0001$) and in localizing the internal opening (85.5 % vs. 69.1 %, $p<0.0001$) [83]. The concordance with EUS findings intraoperatively has not been demonstrated to improve long-term outcomes of anal fistula surgery [84, 85] but more data is necessary to determine which patients and how often surgeons should perform EUS in the management of anal fistula. The results of these studies are influenced by the expertise and experience of the endosonographer and results may not be reproducible in all surgeons' hands. The images are subject to a high degree of interpretation and standards are not well described. Previous surgery, scars, and

trauma as well as the presence of undrained fluid collections can negatively influence the results of EUS. The presence of an abscess can lead to acoustic shadowing and render the results less accurate [86]. As MRI begins to supplant EUS for the evaluation of rectal cancer it is likely that the expertise in evaluating endoanal ultrasounds will diminish.

Magnetic Resonance Imaging

MRI of the sphincter complex has some advantages in diagnosing anal fistulas. No instrumentation of the anus is required and the exam is not operator dependent. The importance of MRI lies in its ability to demonstrate hidden areas of sepsis and secondary extensions, both of which contribute to the high rate of recurrence after surgery. Furthermore, MR imaging can be used to define the anatomic relationships of the fistula to predict the likelihood of postoperative fecal incontinence.

Two types of coils can be used: the endoanal and the external phased array coils. The endoanal coil was utilized to improve the imaging evaluation of perianal fistulas, but anal insertion is not well tolerated by patients [87]. The external phased array coil has a wider field of view and is better for assessing complex tracts, lateral extension, and fistulas crossing the levator ani muscle. Additionally, MR imaging with phased array surface coils requires no patient preparation or insertion of anything inside the anus. The introduction of the 1.5 Tesla (T) and 3.0-T magnets in the acquisition of images has negated the need for the endoanal coil in the evaluation of anal and rectal disease. A prospective trial comparing the use of the endoanal coil to the body coil found that surgical concordance was better using the body coil (96 % vs. 68 %), presumably due to field of view limitations [87]. The 3.0-T imaging improves spatial resolution and diagnostic accuracy over the 1.5-T magnet [88]. The finer detail helps in detecting and characterizing even small fistula tracks. However, comparative studies with 1.5-T or 3.0-T have not been reported.

On axial T2-weighted images, the internal and external anal sphincters appear as circular structures with low signal intensity. After intravenous administration of gadolinium, the internal and external sphincter can be easily distinguished on T1-weighted images by their different contrast enhancement. The internal sphincter muscle enhances to a higher degree than the external sphincter muscle [89]. On T2-weighted MR sequences, active fistulas and abscesses are hyperintense.

The potential of MR imaging in assessment of anal fistulas was demonstrated in a study of 16 patients with cryptoglandular fistulas, when MR imaging findings were compared with the subsequent findings from examination under anesthesia [90]. The authors concluded that MR imaging is the most accurate method for determining the presence and course of anal fistulas and that it may help reduce recurrence due to inaccurate surgical assessment. These conclusions were confirmed in a follow-up study of 35 patients that reported correct MR imaging assessments in 33 of the patients (94 %), including two cases in which examination under anesthesia failed to identify distant sepsis [91]. In a prospective study of 42 patients with suspected anal fistulas [92], the results of digital rectal examination, dynamic contrast-enhanced MR imaging, and surgical exploration were compared. MR imaging had a sensitivity of 97 % and specificity of 100 % for detection of fistulas. In addition, it allowed identification of more secondary tracks and was more accurate in identification of complex fistulas than either digital rectal examination alone or surgical exploration. Beets-Tan et al. reported that preoperative MR imaging provided important additional information in 12 of 56 patients with anal fistulas (21 %). This was further subdivided as 4 of 17 patients with recurrent fistulas (benefit in 24 %) and 6 of 15 patients with Crohn's disease (benefit of 40 %) [93]. In a larger study of 71 patients with recurrent anal fistula in which MR imaging findings were revealed after initial fistula surgery, the postoperative recurrence rate was as low as 16 % when surgeons always acted on the MR imaging findings, suggesting that areas of infection had been missed. By contrast, the rate of recurrence was 30 % when surgeons only sometimes acted on MR imaging results and 57 % when MR imaging results were ignored. Furthermore, in the 16 patients who required further unplanned surgery, MR images had initially correctly indicated the site of disease in all cases [94]. The results of MR imaging, anal endosonography, and clinical examination were compared to determine the optimal technique for classifying perianal fistulas. It was concluded that MR imaging is the optimal technique for distinguishing complex from simple perianal fistulas [95]. Finally in a small series of patients with supralevator abscess MRI was used to correctly characterize the fistula track as transsphincteric or intersphincteric, a distinction that is important in determining the correct drainage procedure (transrectal vs. transperineal) [14].

Taken together, the results of these studies confirm that MR imaging is an accurate modality for evaluation of perianal fistulas and associated complications. The most cost-effective algorithm for managing all patients with anal fistula has yet to be established but preoperative imaging should be considered when recurrent fistulas are encountered following treatment, in cases in which multiple external openings exist and when the anatomy is unclear either in the office or at the time of surgery.

Treatment

Treatment of anal fistulas has always been difficult and apparently the chief reason for the opening of the St Marks Hospital in England in 1836. The goals however of any surgical treatment are summarized as:

1. Elimination of sepsis.
2. Closure of the fistula track.

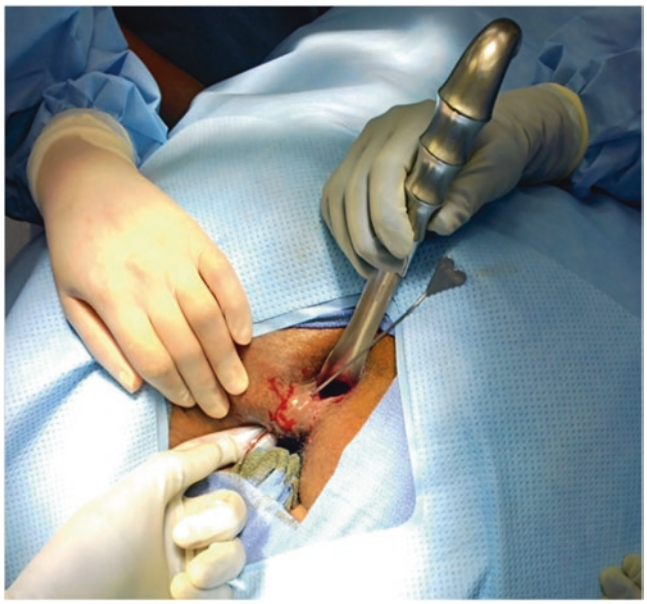

FIGURE 14-16. Probe through the external and internal opening of the anal fistula.

3. Preservation of patient's fecal continence and sphincter function.
4. Minimizing recurrence.

Identification of the external and internal opening is critical and several intraoperative techniques have been described. Physical examination is quite reliable in determining the location of the internal opening in the operating room but if not palpable a catheter can be used to inject either methylene blue or hydrogen peroxide into the external opening with a retractor in the anus. This has been associated with successful identification of the internal opening in 83 % of cases [71].

A gently curved probe inserted into the external opening is an alternative technique for finding the internal opening (Figure 14-16) but care must be taken not to create a false passage and it is better to have an idea of the location of the offending crypt prior to attempts at probing. Chronic tracks will have granulation tissue within them and its absence should raise the suspicion that a false track was created following a fistulotomy.

The ultimate choice of treatment will depend on the amount of sphincter involved in the fistula track with cutting procedures more likely for intersphincteric and low transsphincteric fistula and non-cutting techniques for all others. Patient preference will also influence the procedure choice with most patients opting for sphincter-preserving technique [96]. Surgeons must rely on their experience and comfort for the various non-cutting techniques as the overall quality of evidence to guide decision making is poor [97].

Lay Open Technique (Fistulotomy)

> *For the confident and successful surgical treatment of fistula-in-ano, one must be practiced and skilled in palpating and recognizing the anorectal ring, for whereas, if this ring be cut, loss of control surely results, yet as long as the narrowest complete ring of muscle remains, control is preserved. All the anal sphincter muscles below this ring may be divided in any manner without harmful loss of control.*
>
> *Lockhart-Mummery* [58]

For simple and most distal or intersphincteric fistula, conventional surgical treatment such as lay open of the fistula tract as a complete transection of the tissue between the fistula tract and anoderm is very effective (Table 14-3). Fistulotomy wounds typically heal after 4–6 weeks, which may be shortened by marsupializing the wound edges [98, 99]. This technique may also reduce the incidence of postoperative bleeding [100].

Recurrence and incontinence are the most significant complication and rates vary widely by author. In a retrospective review of 365 patients, Garcia Aguillar reported recurrence in 4 % of patients with intersphincteric fistula, 7 % with transsphincteric fistula, and 33 % for suprasphincteric and extrasphincteric fistulas [101]. Incontinence after surgical treatment of these fistulas also increased with the complexity of the fistula, lowest being for intersphincteric fistula (37 %) and highest for extrasphincteric fistula (83 %). Factors associated with recurrence included type and extension of the fistula, lack of identification or lateral location of the internal opening, previous fistula surgery, and surgeon experience. Incontinence was associated to female sex, high anal fistula, type of surgery, and previous fistula surgery. Visscher et al. reported on 116 patients who had undergone fistula surgery (both cutting and non-cutting) in whom both a fecal incontinence and quality-of-life questionnaires could be obtained. Median follow-up from the first perianal fistula surgery was 7.8 years (range, 2.1–18.1 years). Thirty-nine patients (34 %) experienced incontinence. Surgical fistulotomy, multiple abscess drainages, and a high transsphincteric or suprasphincteric fistula tract were associated with incontinence. As compared to simple fistula (Wexner score, 1.2 [SD, 2.1]), incontinence was worse after surgery for complex fistula (Wexner score, 4.7 [SD, 6.2], $p=0.001$), as were quality-of-life elements, including lifestyle ($p=0.030$), depression ($p=0.077$), and embarrassment ($p<0.001$) [102].

Setons

Setons are used to treat anal fistula when a lay open technique is not possible or not advisable. Most complex anal fistulas and fistulas associated with Crohn's disease are specific examples in which a lay open technique would have significant or complete impairment of fecal continence or

TABLE 14-3. Experience with fistulotomy in treating anal fistula

Author	Year	Surgical procedure	# Patients	Outcome	Follow-up
Kronborg	1985	Fistulotomy	26	Recurrence 11 %	12 Months
Hebjorn	1987	Incision and drainage with fistula surgery	20	Recurrence 10 % Minor incontinence 8.3 %	12 Months
Schouten	1991	Incision and drainage with fistula surgery	36	Recurrence 3 % Minor incontinence 39 %	42.5 Months
Tang	1996	Incision and drainage with fistula surgery	24	Recurrence 0 % Minor incontinence 0 %	12 Months
Ho Y	1997	Incision and drainage with fistula surgery	24	Recurrence 0 % Minor incontinence 0 %	15.5 Months
Ho	1998	Fistulotomy	52	Healing time 10 weeks Minor incontinence 11 %	9 Weeks
Belmonte Montes	1999	Fistulotomy	24	Incontinence 5 %	12 Months
Oliver	2003	Incision and drainage with fistula surgery	100	Recurrence 5 % Minor incontinence 6 %	12 Months
Pescatori	2006	Fistulotomy	52	Minor incontinence 8.3 % Recurrence 8.3 %	10 Months
Atkin	2011	Fistulotomy	180		
Tozer	2013	Fistulotomy	50	Recurrence 7 % Minor incontinence 20 %	11 Months
Hall	2014	Fistulotomy	146	Recurrence 6 %	3 Months

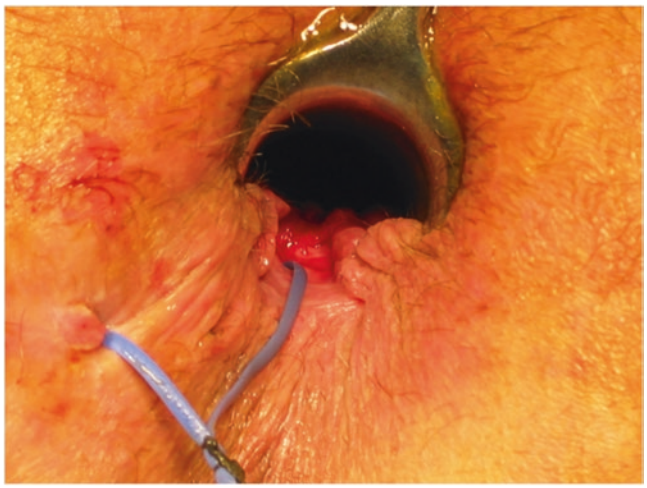

FIGURE 14-17. Seton in an anal fistula.

when healing of the subsequent wound would not be expected to occur (Figure 14-17). A variety of materials have been described for use as setons including wire, non-absorbable suture such as silk, vessel loops, and silastic catheters. Setons can be placed loosely in an effort to promote drainage and fibrosis of the fistula track either as a bridge to a non-cutting repair or as definitive treatment. Alternatively they may be tightened sequentially over time as a cutting seton in an effort to slowly divide the sphincter muscle and preserve continence by allowing a scar to form between the cut ends of the sphincter complex.

With cutting setons, the overlying skin and anoderm are divided at the time of surgery. The seton is then secured tightly around the remaining sphincter complex and is further tightened in the office at varying intervals. A variety of creative ways have been described to facilitate tightening of the seton [103, 104], and intervals vary from days to weeks but in general enough time must lapse for the seton to slowly divide the sphincter muscle. The time to complete healing will depend on the amount of tissue incorporated in the seton and the schedule of visits for tightening and has been reported between 1 month to as long as 1 year [105, 106]. Patients will often experience pain after tightening the seton and must be counseled as to the expected recovery and time frame to healing.

In a meta-analysis of 18 studies including 448 patients who were treated with cutting setons, recurrence rates were reported between 3 and 5 %. Overall fecal incontinence was reported as 5.6 % for patients in whom the internal sphincter was not divided at the initial surgery compared to 25.2 % when it was [107]. In another meta-analysis including 520 patients the average rate of incontinence following cutting seton use was 12 %. The rate of incontinence increased as the location of the internal opening of the fistula moved more proximally in the anal canal. In the studies that described the types of incontinence, liquid stool was the most common followed closely by flatus [108]. In a retrospective review of 112 patients undergoing cutting seton for transsphincteric or suprasphincteric fistulas ($n=84$) and extrasphincteric fistulas ($n=28$) the mean duration the seton was in place was 28.7 days. The mean time to complete wound healing was 9.3 weeks. With a median follow-up of 38.6 months recurrence was noted in one patient (0.9 %). Twenty-seven patients (24.1 %) had continence disorders, including gas incontinence in 21 patients (18.6 %) and liquid stool incontinence in 6 patients (5.4 %). There were no incidents of solid stool incontinence [109].

Non-cutting or draining setons are usually used as a bridge for definitive treatment in an effort to promote fibrosis, decrease the inflammatory response, and aid in identifying the internal opening at the time of the secondary procedure [110]. They can also be left in place to prevent recurrent abscess formation in patients with Crohn's disease or in patients who are not deemed candidates for additional surgery. Setons of any type can fall out due to wear and breaking. Vessel loops tend to be durable and can be left in place for years. If setons are to be left for prolong periods of time they should be loose but not so big that their presence becomes a problem for the patient in terms of hygiene and skin irritation. Setons that are secured in a circular configuration can rotate and the knots can migrate into the fistula track occasionally causing plugging and discomfort. Patient can be advised to twist them occasionally if this happens. The knots themselves can also cause irritation of the contralateral skin if too bulky.

Advancement Flap

Endorectal advancement flap (ERAF) has been advocated as an effective treatment for high transsphincteric or suprasphincteric fistulas. The techniques used are variable but the essential elements include debridement or excision of the fistula tract, mobilization of a vascularized, tension-free mucosal flap, and coverage of the internal opening, which is usually closed with absorbable suture. The procedure can be performed with locoregional anesthesia, but to optimize exposure of the anal canal and lower rectum a spinal anesthetic can be advantageous. A complete bowel preparation with oral purgatives is recommended combined with preoperative antibiotics.

Technique

1. With the patient in prone jackknife position or in lithotomy position, the internal opening of the fistula is exposed—this can be accomplished by everting the anal canal with the Lone Star® retractor system (Figure 14-18a).
2. The internal opening is identified and the crypt-bearing tissue excised.
3. A small rim of the anoderm, below the internal opening, is excised to create a neo-dentate line.
4. The defect in the internal anal sphincter is closed with absorbable sutures (2-0 Vicryl, Ethicon Inc., Somerville, NJ) (Fig. 14-18b).
5. A curvilinear incision is made at the level of the internal opening extending laterally to create a wide tissue flap.
6. Dissection is performed in the submucosal plane consisting of mucosa, submucosa, and few superficial fibers of the internal anal sphincter and then mobilized over a distance of 4–6 cm proximally.
7. The fistulous tract is alternatively curetted or cored out, and the defect in the internal anal sphincter is closed with absorbable sutures.

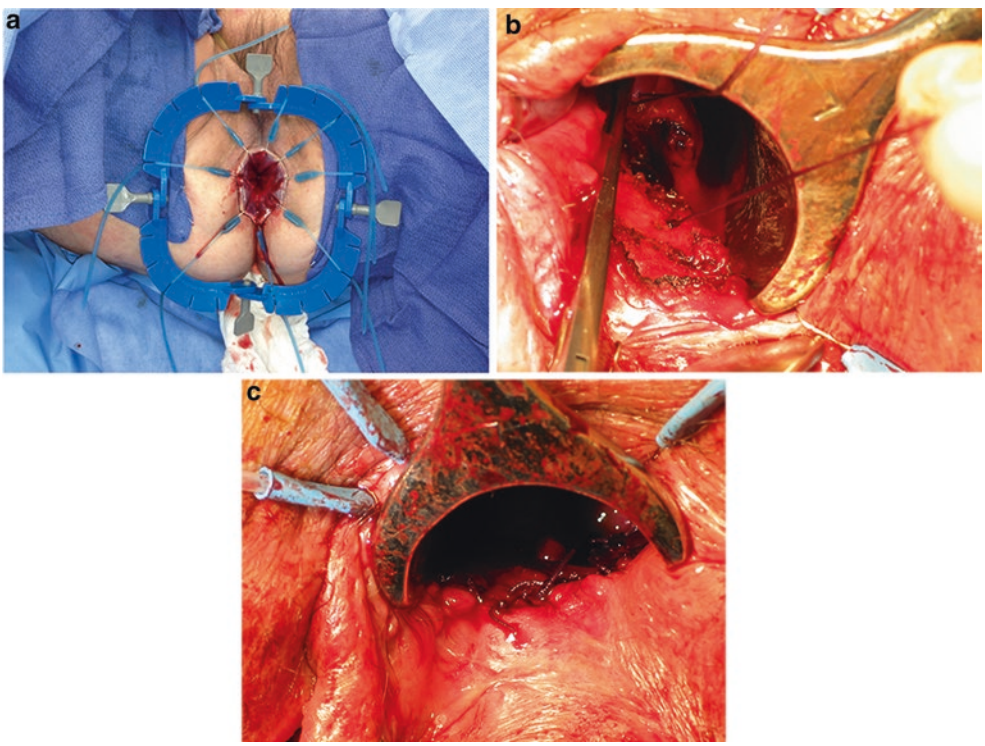

FIGURE 14-18. (**a**) Lone star to ever the anal canal. (**b**) Closing the internal opening. (**c**) Securing the flap.

8. The flap is advanced and sutured over the top of the internal opening with absorbable sutures (Figure 14-18c).
9. Vascular supply of the flap is maintained through the submucosal plexus.

The reported healing rates after flap repair vary between 60 and 100 % [111–119]. Ortiz et al. reported on 91 patients who underwent ERAF with a median follow-up of 42 (range 24–65) months. Eighteen patients had recurrence of the fistula during follow-up, with a median time to relapse of 5.0 (range 1.0–11.7) months. There were no recurrences after 1 year [120]. VanOnkelen et al. reported on a series of 252 patients with a high transsphincteric fistula of cryptoglandular origin that underwent ERAF with a median length of follow-up of 21 months (range 6–136 months). Before the procedure, patients underwent endoanal MRI to depict the course of the fistula tract and to determine the presence and location of associated abscesses. Seventeen patient- and fistula-related variables were assessed to determine their influence on recurrence. The failure rate at 3 years was 41 % (95 % CI, 34–48) [121]. Failure was not influenced by age, sex, smoking, or obesity. Nor was it affected by previous attempts at repair, preoperative seton drainage, presence of associated abscesses, location of the internal fistula opening, or postoperative drainage. 46 % of the patients in this series had a horseshoe extension of their fistula. The presence of a horseshoe extension correlated with successful repair 32.0 % [95 % CI, 23–41] vs. 51.0 % [95 % CI, 40.6–61.4]; $p=0.005$.

Despite these findings there are many studies that demonstrate patient, disease, and technical factors associated with either improved or worse outcomes following ERAF repair of complex anal fistula. Which of these are real and which are not can be difficult to discern due to the heterogeneity of patients and methods studied as well as the paucity of high-quality evidence. Knowledge of the literature as well as experience will facilitate discussion with patients regarding the risk of recurrence and complications rates following ERAF repair of complex fistulas.

One study looked at curettage of the fistula track vs. excision by means of "core out" and found no difference in recurrence [116]. In this same study the postoperative maximum squeeze pressure was reduced in patients who had the core out technique but this was not clinically relevant. The location of the internal opening (posterior vs. anterior) has no impact on outcomes of advancement flap repairs in the published literature even though it can be harder to obtain adequate flap length during posterior dissections due to the angulation of the anorectal junction posteriorly [122]. Preoperative seton placement did not impact outcomes of flap repairs in 278 patients with cryptoglandular fistulas reviewed retrospectively. Setons were in place at least 2 months prior to definitive repair [123]. Repeat anorectal advancement flap after recurrence has been shown to be feasible with overall good outcomes [124, 125], but has been shown to be a risk factor for failure [126, 127]. Success of flap advancement was inversely correlated with the number of prior attempts, and in patients with no or only one previous attempt at repair the healing rate was 87 %. In patients with two or more previous repairs the healing rate dropped to 50 % [126]. The combination of fibrin glue with advancement flap repair has also been associated with worse outcomes when compared to just flap repairs alone [128]. The use of platelet-rich plasma in combination with advancement flap has better outcomes but limited data [129]. Medically induced bowel confinement has not been shown to improve outcomes [130].

Full-thickness flaps have been shown to be superior to partial-thickness flaps in several studies [131, 132]. In one series 34 patients underwent surgery using a partial-thickness flap and 20 a full-thickness flap. Continence was not affected by choice of technique. Recurrence was 35 % and 5 %, respectively.

Patient-related factors that impact outcome include smoking, which both decreases the mucosal blood flow [133] and negatively impacts success of flap repairs [134]. Obesity negatively impacted advancement flap repairs in a study looking at 220 patients with complex anal fistula undergoing advancement flaps. After a median follow-up of 6 months, primary healing rate for the entire cohort was 82 % (180/220). In non-obese patients, recurrence rate was significantly lower than in obese patients (14 % vs. 28 %; $p<0.01$). Moreover, reoperation rate due to recurrent abscess with the need for seton drainage in the failure groups was significantly higher in obese patients when compared to non-obese patients (73 % vs. 52 %; $p<0.01$). Using multivariate analysis, obesity was identified as independent predictive factor of success or failure ($p<0.02$) [135]. Crohn's disease has also been shown to be a risk factor for failure [136].

While anorectal advancement flaps are chosen to preserve the sphincter muscle many reports have demonstrated some degree of fecal incontinence following surgery. Uribe et al. demonstrated significant reductions in maximum resting pressure 3 months after advancement flap repair of complex anal fistula (83.6 ± 33.2 vs. 45.6 ± 18.3, $p<0.001$) and maximum squeeze pressure (208.8 ± 91.5 vs. 169.5 ± 75, $p<0.001$). Before surgery, five patients (8.9 %) reported symptoms of incontinence. After surgery, 78.6 % patients had normal continence, seven patients (12.5 %) complained of minor incontinence, and five (9 %) had major problems with continence [113].

Ligation of Intersphincteric Fistula

The ligation of the intersphincteric fistula track is a sphincter-preserving procedure that can be performed under locoregional, spinal, or general anesthesia. The procedure is appropriate for all patients with high transsphincteric fistulas assuming that a well-formed fistula track has been established. The advantages of the procedure are its simplicity and applicability to most patients with fistula-in-ano (Table 14-4).

Table 14-4. Experience with LIFT procedure

Author	Year	# Patients	Procedure	Follow-up (weeks)	Percent healed (%)	Type of study
Rojanasakul et al.	2007	18	LIFT	4	94	Prospective observational
Shanwani et al.	2010	45	LIFT	7	82	Prospective observational
Ellis et al.	2010	31	bioLIFT	6	94	Retrospective
Bleier et al.	2010	39	LIFT	10	57	Retrospective
Ooi et al.	2011	25	LIFT	6	96	Prospective observational
Tan et al.	2011	93	LIFT	4	92	Retrospective review
Steiner et al.		18	LIFT	6	83	Retrospective
Aboulian et al.	2011	25	LIFT	24	68	Retrospective review
Mushaya et al.	2012	25	LIFT	4	68	Prospective randomized
Abcarian et al.	2012	50	LIFT	15	74	Retrospective
Lo et al.	2012	25	LIFT	2	98	Retrospective
van Onkelen et al.	2012	42	LIFT	12	51	Prospective
Chen et al.	2012	10	LIFT	6	100	Retrospective
Lehmann et al.	2013	17	LIFT	4	47	Prospective
Liu et al.	2013	38	LIFT	26	61	Retrospective
Madbouly et al.	2014	35	LIFT	56	74	Prospective randomized
Ye et al.	2015	43	mLIFT	60	87	Retrospective
Bastawrous et al.	2015	66	mLIFT	21	71	Retrospective

bioLIFT: biological LIFT; mLIFT: modified LIFT

Technique

A preoperative rectal enema is given to patients in the morning of surgery. Patients are placed in the prone jackknife position and regional anesthesia is used. The steps involved in the procedure are as follows [137]:

1. Identify the internal opening by injecting peroxide or saline through the external opening.
2. Incise circumanally in the intersphincteric plane at the site of fistula using a 3–4-cm curvilinear incision.
3. Identify the intersphincteric tract using a soft catheter or Lockhart–Mummery and lacrimal probes.
4. Dissect around the intersphincteric portion of the fistula tract being careful not to injure or disrupt the tract. A right-angle probe can be used for this purpose. Using narrow malleable retractors can facilitate exposure of the intersphincteric plane. A Lone Star retractor can also facilitate this exposure.
5. Hook the intersphincteric tract using a small right-angle clamp.
6. Doubly ligate the tract close to the internal and external sphincter with 2-0 Vicryl (Ethicon Inc., Somerville, NJ), and transect it between the sutures. Some surgeons prefer a transfixation suture.
7. Inject the external opening to confirm that the tract was divided completely.
8. Curette the external portion of the fistula tract.
9. Drain the external opening.
10. Re-approximate the intersphincteric incision wound loosely with an interrupted 3-0 Vicryl (Ethicon Inc., Somerville, NJ).

Variations in this technique include orienting the incision in a radial fashion and performing a partial fistulotomy up to the external sphincter [138, 139]. Other modifications include unroofing the fistula from the internal opening to intersphincteric groove, ligating the fistula tract, but preserving the external sphincter [140]. In an effort to increase the success of this procedure the use of biologics has also been examined including inserting a biologic mesh in the intersphincteric groove or as a plug in the external tract [141–143]. Series are small and conclusions cannot be drawn about the efficacy of these approaches.

Postoperatively patients are maintained on a bulk laxative and can be prescribed oral ciprofloxacin and metronidazole although the benefit of antibiotic in the postoperative setting has not been evaluated.

Abcarian et al. reviewed their experience with all-cause transsphincteric fistula treated with the LIFT technique [144]. Median follow-up was 18 weeks and closure was achieved in 74 % of patients. Success of the procedure was inversely correlated with the number of previous attempts at closure, a finding seen by other authors looking at their outcomes with the LIFT procedure [145]. No changes in continence were reported. Hall et al. reported in their multicenter prospective trial of anal fistula procedures a success rate of 79 % at 3 months of follow-up using the LIFT technique. Hospitals that performed more LIFT procedures had higher rates of healing [115].

In a meta-analysis looking at the success of the LIFT procedure 18 studies were reviewed including 592 patients (65 % male). The most common type of fistula was transsphincteric (73.3 % of cases). The mean healing rate reported was 74.6 %. The risk factors for failure were obesity, smoking, multiple previous surgeries, and the length of the fistula tract. The median length of fistula tract was shorter in the healed group compared with the failed group (4 cm vs. 6 cm, $p = 0.004$).

The mean healing time was 5.5 weeks, and the mean follow-up period was 42.3 weeks. The patient satisfaction rates ranged from 72 to 100 %. No de novo incontinence developed secondary to the LIFT procedure. There is not enough evidence that variants in the surgical technique achieve better outcomes (Bio-LIFT, LIFT-Plug, LIFT-Plus) [146].

A more recent meta-analysis of 24 original articles including 1110 patients was performed which included 1 randomized controlled study, 3 case control studies, and 20 case series. Most studies included patients with transsphincteric or complex fistula, not amenable to fistulotomy. During a mean follow-up of 10.3 months, the mean success rate was 76.4 % while incontinence, intraoperative, and postoperative complication rates were negligible (0 %, 0 %, and 5.5 %, respectively). There was no association between pre-LIFT drainage seton and success of the procedure [147].

In another review of 498 patients undergoing the LIFT procedure success rates ranged from 40 to 95 %, with a pooled success of 71 % (352 of 495 patients; 3 of 498 were lost to follow-up). Follow-up ranged from 1 to 55 months, with a reported mean or median of 4–19.5 months. One hundred and eighty-three patients were formally assessed for continence, out of whom 11 (6 %) had a minor disturbance [148].

When the LIFT procedure does fail several authors have noted that the resultant discharge presents at the intersphincteric incision and endoanal ultrasound has confirmed that these were simple fistulas that were subsequently managed with fistulotomy or local wound care [149, 150]. This has been shown in other studies but not as consistently [151].

Fibrin Glue

Fibrin sealants were introduced in the 1990s as an alternative to more invasive surgical procedures in an effort to shorten recovery, prevent incontinence, and simplify surgery in patients with complex anal fistulas. Hjortrup et al. instilled fibrin sealant into the fistula tracks of eight patients who had failed previous surgical attempts at closure and achieved a 50 % success rate after a single injection [152]. The advantages of fibrin glue are that it is simple and repeatable with no significant learning curve and no division of the sphincter muscle.

Generally fibrin sealants consisted of two components: fibrinogen concentrate and thrombin. Factor XIII is added to stabilize the fibrin monomers. Aprotinin is also added to prevent fibrinolysis. The glue is infused into the fistulous tract with the idea that collagen formation within the tract will stimulate healing. It also stimulates the migration and proliferation of fibroblasts and pluripotent endothelial cells to heal the fistula. Between 7 and 14 days postoperatively, plasmin that is present in the surrounding tissue lyses the fibrin clot as the tract is replaced by synthesized collagen [153].

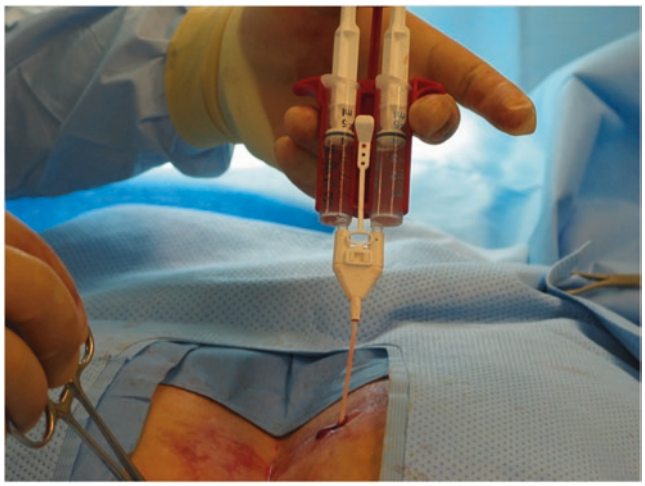

FIGURE 14-19. Fibrin glue injection into an anal fistula.

Technique

1. The patient is placed in the prone jackknife position and anesthesia is introduced (spinal, general, or locoregional).
2. Both openings of the fistula track are identified and mechanically curetted and irrigated with normal saline or hydrogen peroxide.
3. If extensive side branching or undrained abscess is encountered the procedure is aborted and a seton is placed.
4. A double-barreled syringe, containing the two components of the glue, is inserted into the external opening until the tip is seen at the internal opening (Figure 14-19).
5. At this point the internal opening can be variably sutured closed or left opening depending on the surgeon's preference—there is no significant advantage of one technique over the other [154].
6. The syringe is depressed, which mixes the two components as they are injected into the canal while withdrawing the syringe. The tract is filled completely until a bead of glue is seen at the external opening.
7. The glue is allowed to set for 30–60 s to form its stable clot.

Postoperatively, the use of antibiotics and diet restrictions do not seem to confer any benefit to the patient [155], but sitz baths, excessive straining, or vigorous exercise should be avoided to prevent dislodgement of the plug.

The efficacy of fibrin glue injection as a curative procedure remains in question. Success rates vary greatly depending on the etiology and complexity of the fistulas, type of fibrin glue used, and length of patient follow-up (Table 14-5).

Cintron et al. have reported the largest series of patients with perianal fistulas treated with fibrin glue [156]. Seventy-nine consecutive patients in this non-randomized prospective study were treated using one of the three different types of fibrin glue: autologous, Viguard-FS (V. I. Technologies,

Table 14-5. Experience with fibrin glue

Author	Year	# Patients	Success rate (%)	Follow-up (months)
Cintron et al.	1999	26	81	3.5
Cintron et al.	2000	79	61	18
Patrlj et al.	2000	69	74	28
Park et al.	2000	29	68	6
Sentovich	2001	20	85	10
Lindsey et al.	2002	42	63	4
Sentovich	2003	48	69	22
Loungnarath et al.	2004	39	31	26
Zmora et al.	2005	60	53	6
Gisbertz et al.	2005	27	33	7
Singer et al.	2005	75	21[a]	27
Maralcan et al.	2006	36	83	12
Ellis and Clark	2006	28	54	22
Dietz	2006	39	31	23
Witte et al.	2007	34	55	7
Adams et al.	2008	36	61	3
de Parades et al.	2010	30	50	12

Inc., New York, NY), and Tisseel VB (Baxter, Deerfield, IL). The majority of fistulas were transsphincteric and 8 % were secondary to Crohn's disease. The overall success rate was 66 %, with a mean follow-up of 1 year. Healing rates correlated with fistula complexity: intersphincteric 82 %, transsphincteric 62 %, and Crohn's related 33 %. The type of glue used did not affect success rates, and the use of commercial glue over autologous was recommended due to ease of preparation, increased strength in laboratory evaluations, and more consistent bonding. The average time to fistula recurrence was 3.3 months while the latest was seen at 11 months. This led the authors to stress the importance of long-term follow-up.

Many authors have suggested reasons for failure of fibrin glue in the treatment of anal fistula but little evidence exists to support these conclusions. Type of glue used, inadequate removal of granulation tissue, incomplete filling of fistula track(s), and track length have all been postulated to play a role in recurrence or persistence of the fistula [153]. In a meta-analysis of 12 published studies of 378 patients with complex anal fistula overall healing rate was 53 % with a wide variation between studies (10–78 %). The only factor that was found to account for this diversity was fistula complexity, with series including a high proportion of complex fistulae reporting worse outcomes [157].

Long-term follow-up of patients who show healing of their fistula tracks at 6 months demonstrated that few recur. Of 60 patients treated with fibrin glue 32 experienced healing. 23 (72 %) of these patients were available for long-term follow-up and 17 (74 %) remained disease free at a mean follow-up of 6.5 years. Six (26 %) patients had variable degrees of recurrence; four needed further surgical intervention and two were treated with antibiotics only. Recurrent disease occurred at an average of 4.1 years (range, 11 months to 6 years) from surgery, and on several occasions was at a different location in the perianal region. None of the patients experienced incontinence following the procedure [158].

Despite the varied success with fibrin glue treatment there is good evidence that patients experience no disturbances in continence as a result of treatment and treatment with fibrin glue does not preclude subsequent treatments of their fistula using alternative approaches. However the heterogeneity of published data regarding the success of this treatment makes it difficult to recommend as a first-line therapy of complex anal fistula.

Anal Fistula Plug

The concept of "filling" the fistula track spurred further innovation in the use of biological materials and in 2006 Johnson et al. performed a prospective trial in which a piece of Surgisis® (Cook Surgical, Inc., Bloomington, IN), a bioabsorbable xenograft, made of lyophilized porcine intestinal submucosa, was fashioned into a plug and secured into the fistula track of 15 patients with complex fistulas achieving an 87 % closure rate. As with the fibrin glue technique no sphincter division is required, so continence is not impaired. Since this initial study the Surgisis Anal Fistula Plug (AFP) (Cook Surgical, Bloomington, IN) has been introduced as a prefabricated cone-shaped device that can be easily secured into the fistula track. It acts as a tissue scaffold for host fibroblasts to promote healing and ingrowth of tissue into the fistula track [159].

TABLE 14-6. Experience with anal fistula plug

Author	Year	Type of study	# Patients	Success rate (%)	Follow-up (months)
Johnson et al.	2006	Prospective	25	87	3
Champagne et al.	2006	Prospective	46	83	12
O'Connor et al.	2006	Prospective	20	80	10
Ellis	2007	Retrospective	13	92	6
Ky et al.	2008	Prospective	45	55	6.5
Christoforidis et al.	2008	Retrospective	47	43	6.5
Safar et al.	2009	Retrospective	36	14	4.2
Ortiz et al.	2009	Prospective randomized	15	20	12
El-Gazzaz et al.	2010	Retrospective	33	25	7.4
van Koperen et al.	2011	Prospective	31	29	11
Chan et al.	2012	Prospective	44	50	10.5
Cintron et al.	2013	Prospective	73	42	15
Tan et al.	2013	Retrospective	26	13	15
Adamina et al.	2014	Prospective	46	43.5	68

Technique

1. The patient is placed in the prone jackknife position and anesthesia is introduced (spinal, general, or locoregional).
2. Both openings of the fistula track are identified and irrigated with normal saline or hydrogen peroxide.
3. The plug is rehydrated, usually in a 0.9 % normal saline solution for 3–5 min, before insertion.
4. The tapered end of the fistula plug is then tied to the anal side of the seton or silk suture and pulled into the fistula tract through the primary opening until it fitted snugly.
5. The plug is then trimmed flush with the primary opening. A 2-0 Vicryl (Ethicon Inc., Somerville, NJ) suture is used to anchor the plug to the mucosa/submucosa and internal sphincter at the primary opening with a figure-of-eight stitch, completely covering it with mucosa at the completion of the stitch.
6. The excess plug protruding from the external opening is trimmed such that the external opening is partially open to allow drainage and prevent infection.

Since introduction of the AFP, success rates have varied widely between 14 and 87 % (Table 14-6). Several technical and perioperative factors have been ascribed to the failures including the absence of preoperative seton placement, overly aggressive curetting of the fistula track resulting in widening of the track, inadequate fixation of the plug into the internal opening, and the presence of multiple tracks. Data is lacking to recommend one surgical technique over another. In one of the largest series by Citron et al. 73 patients underwent anal fistula plug closure of 72 transsphincteric and 1 suprasphincteric fistula [160]. There were eight fistulas secondary to Crohn's disease. Pre-procedure setons were used in patients at the discretion of the operating surgeon. Otherwise all aspects of the procedure were standardized. In their study the plug extrusion rate was 9 % (7/78). There was no difference in closure rates between primary and recurrent fistulas (primary = 20/53 = 38 % and recurrent 8/20 = 40 %). The overall patient success rate was 38 % (28/73) and the plug success rate was 39.5 % when plug fallouts were eliminated. The fistulas in four out of eight patients with Crohn's disease closed (50 %). There were no intraoperative complications and four postoperative abscesses (4/73; 5 %). Mcgee et al. looked at 41 patients with 42 fistula tracks who underwent AFP closures over a 39-month period. Complete closure was achieved in 18 of 42 (43 %) fistulas at a mean follow-up of 25 months. Closure was not associated with gender, age, tract location, duration of seton, or length of follow-up. Successful closure was significantly associated with increased tract length, because fistulas longer than 4 cm were nearly three times more likely to heal compared with shorter fistulas ((14/23, 61 %) vs. (4/19, 21 %), $p = 0.004$; relative risk = 2.8; 95 % CI 1.14–7.03) [161].

The diversity in study design and outcomes led O'Riordan and his colleagues to summarize the anal fistula plug literature for Crohn's- and non-Crohn's-related fistula-in-ano in a homogenous patient population [162]. Studies were included if results for patients with and without Crohn's disease could be differentiated and reported a mean or median follow-up of more than 3 months. Overall 530 patients were analyzed (488 non-Crohn's and 42 Crohn's patients). The plug extrusion rate was 8.7 % (46 patients). The proportion of non-Crohn's patients achieving fistula closure varied widely between studies, ranging from 0.2 (95 % CI 0.04–0.48) to 0.86 (95 % CI 0.64–0.97). The pooled proportion of patients achieving fistula closure in patients with non-Crohn's fistula-in-ano was 0.54 (95 % CI 0.50–0.59). The proportion achieving closure in patients with Crohn's disease was similar (0.55, 95 % CI 0.39–0.70). The authors noted that the divergent findings make it difficult for surgeons to quote an acceptable success rate during preoperative counseling of patients with anal fistulas considering treatment with the AFP.

A relatively new device for treating anal fistulas is a synthetic anal fistula plug (Figure 14-20) composed of a copolymer (polyglycolic acid:trimethylene carbonate) that is

FIGURE 14-20. Bio A absorbable fistula plug (W.L. GORE & Associates, Newark, DE, Courtesy of Michael Stamos, MD, with permission).

gradually absorbed by the body (Gore® Bio-A® Fistula Plug, W.L. Gore & Associates, Elkton, MD). There is limited data to assess the efficacy of this novel technique. Stamos et al. performed a multicenter prospective trial of 93 patients with non-Crohn's-related complex cryptoglandular transsphincteric anal fistulas treated with this device. The primary end point of the study was the healing rate at 6 and 12 months after plug implantation. 13 patients were lost to follow-up and an additional 21 were withdrawn (19 due to recurrence of their fistula prior to 6 months). Of the 66 patients remaining fistula closure at 6 months was 41 % (95 % CI, 30 %–52 %) which improved to 49 % (95 % CI, 38 %–61 %) at 12 months [163].

Novel Techniques

The use of laser in the treatment of anal fistula was initially described in 2011 in a pilot study by Wilhelm [164]. This sphincter-saving technique uses an emitting laser probe [fistula laser closure (FiLaC™), Biolitec, Germany], which destroys the fistula epithelium and simultaneously obliterates the remaining fistula tract. The procedure also includes the closure of the internal opening by means of an anorectal flap. In this pilot study, 11 patients with cryptoglandular fistula underwent FiLaC™ procedure with an overall success of 81 %. A subsequent study of 35 patients demonstrated healing in 71 % [165].

There is limited evidence for the use of adipose-derived stem cells (ADSC) to treat complex anal fistula mostly in patients with Crohn's disease. Autologous ADSC can be easily obtained with liposuction with minimal adverse effects on the patient. In a multicenter randomized controlled trial, Garcia-Olmo et al. [166] used ADSC to treat complex cryptoglandular, rectovaginal, and Crohn's-related fistulas. Initially they achieved a 71 % success rate with ADSC, compared with 16 % in the control group (fibrin glue only). However, at 1 year this had decreased to 62.5 and to 33 % at 3 years.

An injectable form of Permacol (Tissue Science Laboratories, Covington, GA), a type of porcine acellular collagen matrix, was modified by centrifugation to form a paste and has been used to inject anal fistula in combination with an ERAF. Studies are limited but success rates in non-Crohn's patients have been reported as high as 82 % [167].

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