

Skin Grafting Applications in Urology

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Skin grafting is a closure technique widely used in plastic surgery. Urologists may encounter patients with diseases that lead to severe tissue loss due to infection, trauma, burns, malignancy, skin maladies, or primary lymphedema. The development and study of skin harvesting techniques to manage tissue coverage of burns has allowed for great advances and the widening application of skin grafting. As such, there is a growing recognition and application of skin grafts within urology. The aim of surgical treatment and skin grafting within urology is to preserve genital function, improve quality of life, and restore cosmetic damage. In addition to basic technique, this article reviews specific surgical methods employed in reconstruction for patients with Fournier gangrene, buried penis, and hidradenitis suppurativa. Urologists must be aware of these techniques in order to provide adequate counseling for patients considering these operations and when encountering complications.

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KEY WORDS

Skin grafting, techniques • Fournier gangrene • Buried penis • Hidradenitis suppurativa

There are a variety of diseases that affect the male genitals that may lead to significant soft tissue loss. These pathologies often produce aesthetic and functional defects that negatively impact patient quality of life. A variety of techniques have been described in reconstructive urology, including primary closure with rotational and local advancement flaps and full-thickness and split-thickness skin grafts to cover a wide array of tissue deficits. Although urologists may work in a collaborative

fashion with plastic surgery in such cases, there are increasing numbers of urologists managing these conditions primarily. Surgical treatment aims to preserve genital function, improve quality of life, and restore cosmetic damage. This narrative review describes methods employed in various operations requiring skin grafting. Additionally, we review in detail specific applications for those suffering from Fournier gangrene, buried penis, and hidradenitis suppurativa.

Grafting Primer

There are two major types of skin grafts: split-thickness and full-thickness skin grafting. Split-thickness skin grafts (STSG) are partial thickness grafts that include the epidermis and varying amounts of dermis. The major advantage is the ability to cover large surface areas with less donor skin, whereas the major disadvantage is that these grafts can be fragile.

Skin grafts contract and shrink immediately after harvest from the donor; this process is separated into primary and secondary contraction. Primary contraction occurs due to dermal elastin fibers and begins immediately after a graft is removed from the donor site. Secondary contraction, a process mediated by myofibroblasts, occurs after the graft has healed at the recipient site.¹ Due to the lack of a full dermal layer, there is increased likelihood of secondary contracture in STSG due to its limited pliability and elasticity.

Full-thickness skin grafts (FTSG) include the entire layer of the skin as the graft (ie, both the epidermis and dermis). Compared with STSG, FTSG have better texture, elasticity, aesthetics, and pliability. They are also more resistant to secondary contracture and have greater overall patient satisfaction for both the recipient and donor sites. Primary contracture remains a concern. The primary disadvantage is that due to the donor site being unable to self-regenerate, there is limited availability of donor skin. Donor site closure must also be performed, which adds operating room time and provides an additional site for potential infection or wound breakdown. One large (n = 954) 25-year study found median autograft take to be 73% for adult patients.² A literature review found that even when patients have comorbidities

or severe preoperative pathology, STSG are associated with excellent rates of successful graft take.³

Surgical Pearls

The first step to skin grafting is the adequate selection of a donor site. Depending on the defect size, two large grafts can be taken from a single thigh or one from each thigh. In buried penis cases, it can be prudent to take grafts from the panniculectomy specimen.

There are a variety of techniques and tools available for harvesting STSG. Generally, the donor site is prepared by shaving hair and prepping the site with chlorhexidine or betadine. Once prepped and draped, liberal mineral oil is applied to lubricate and hydrate the skin. Penetrating towel clamps can be used to provide tension on the skin and flatten the graft surface, if needed.

The use of a surgical blade alone has generally been abandoned; dermatomes allow determination of the precise thickness and width of the skin to be harvested.⁴ The dermatome is applied firmly against the skin with downward and forward pressure (Figure 1). When a mesher is being used, an assistant can use forceps to gently grasp and apply traction on the graft to prevent folding once the graft starts to separate from the surrounding tissues.⁵



Figure 1. Using dermatome to harvest a split-thickness skin graft.

The thickness of the graft is determined by the surgeon and may be influenced by the location of the recipient bed. The thinner the skin graft, the easier the revascularization and incorporation of the graft. However, a thinner STSG can also produce less durable coverage when fully healed. We prefer the use of the Padgett dermatome at 0.015-in thickness.⁶ The width of the harvested skin graft is determined to match the recipient skin defect.⁴ Once harvested, the graft is applied, contoured to fit the defect, then anchored in place using absorbable sutures.

Meshing STSG increases the coverage of the tissue and can be performed at various ratios, most commonly 1.5:1 (Figure 2A).⁴ This provides expanded skin coverage when there is not enough skin available, such as in burn patients or for hidradenitis suppurativa. Graft take for meshed grafts is typically improved compared with unmeshed grafts because fluid collections can drain easily, therefore reducing the risk of graft loss. It is crucial for physicians to have a firm understanding of patient expectations surrounding sexual function in cases where the phallus requires grafting. Unmeshed STSG allows for more stretching, is more cosmetically appealing, and is less likely to lead to contracture. In patients who are not planning on sexual activity, meshing improves the take of the graft.⁶

Dressings

Graft. The graft is positioned over the defect and tacked in place using absorbable sutures. Typically, Xeroform® Occlusive Dressing (Medtronic Minimally Invasive Therapies, Minneapolis, MN) is applied and covered with mineral oil-soaked gauze. Fluffs and bolsters are used to secure the graft in place. It is important to ensure that

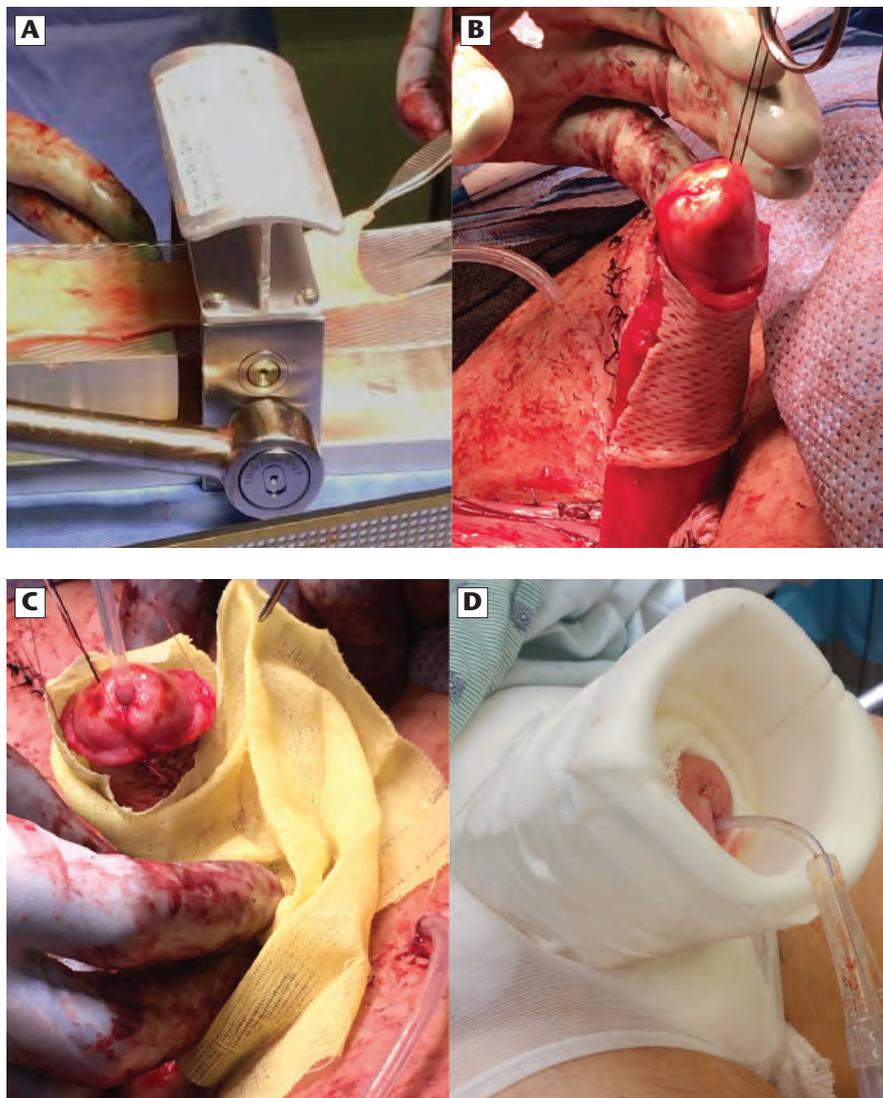


Figure 2. (A-D). Split thickness skin grafting (STSG). (A) Mesher used to increase tissue coverage for STSG. (B) STSG applied to phallus and secured with chromic sutures. (C) Circumferential non-adhering protective dressing applied to grafted penis. (D) "Penis palace" dressing.

the graft is at full stretch, as any wrinkling in the graft can prevent proper graft take and increase risks of contracture or poor aesthetics. In cases of skin grafts as a replacement for penile skin, a circumferential dressing can be applied (Figure 2B,C). Sutures should be left long in strategic locations along the side of the graft closure in anticipation for use in securing the dressing placement. Dressings on the penis can be a challenge. We recommend the so-called "penis palace": a simple, inexpensive, and effective dressing that provides circumferential compression along the shaft of a newly grafted penis (Figure 2D).

This method employs a normal saline bottle lined with foam.

The most challenging area to address in phallus grafting is at the dorsal base of the penis. In this area, it is very difficult to maintain pressure between the graft bed and graft. A small degree of graft loss and healing by secondary intention should be expected in this region and typically does not require additional intervention. Ultimately, genitourinary organs provide unique challenges to dressing placements, but by leaving stitches long on the periphery of a grafted area, force can be applied onto mineral oil-soaked cotton to ensure adherence



Figure 3. Bolster dressing applied to scrotal/perineal area.

to the bed (Figure 3). The objective is to press the graft into the wound bed with the dressing, not simply cover the area.

Negative-pressure wound therapy, also known as a wound VAC (vacuum-assisted closure), has been successfully described for this purpose, but may be costly.⁷ Wound VACs consist of a sterile, open-cell foam sponge that is placed in the wound and then covered with a transparent adhesive drape and non-collapsible tubing. Tubing is connected to a suction pump that provides continuous negative pressure, which increases perfusion, fibroblast migration, and cell proliferation in the wound.⁸ This facilitates wound closure and reduces wound surface area.⁸ In experimental models, application of a wound VAC has been shown to speed healing by increasing local blood flow, reducing bacterial contamination, and preventing accumulation of exudate.⁹ Wound VACs, when rendered portable, also do not interfere with patient ambulation. The formation of a secondary wound or blister at the periphery of the appliance is a concern. Despite widespread clinical use, high-quality studies on the impacts of negative pressure wound VACs are lacking.⁷

The graft area typically must remain immobile for 5 days; this ensures proper take of the graft. Use of fibrin glue has been demonstrated as effective as sutures in the adherence process of the graft.¹⁰ Dressings are removed on day 5 when the patient is encouraged to ambulate. In highly motivated patients, we have had success in early hospital discharge and return for dressing removal in an ambulatory setting. Removal of the dressing must be undertaken carefully in order to prevent tearing off the graft. To avoid graft destruction, a non-adhesive layer such as Xeroform or petroleum jelly-soaked gauze should always be applied directly to the graft. Any finely meshed non-adherent moist material would be ideal. Patients must shower twice daily and are encouraged to continue dressing the graft with such material for 1 month.⁶

Donor Site. The donor site can be covered with thrombin-soaked Telfa™ (Medtronic Minimally Invasive Therapies) dressings, which are removed at the end of the case and replaced with a clear adhesive dressing. The site can also be dressed with Xeroform and then wrapped. Alternatively, the donor site can be managed with a small closed-suction drain under a clear adhesive dressing. No matter the initial choice, after 2 to 3 days, this can be removed and replaced with Xeroform. Once the gauze falls off, no further dressing is required. Using a heat lamp on the area may aid in healing.¹¹

Complications

The greatest concern after complex reconstruction is graft loss. Graft loss may ultimately lead to a need for repeat surgery without the benefits of an ideal grafting site, as this was likely optimized during the initial surgery. An alternative

would be to allow the area to heal by secondary intention; however, this could lead to contracture or poor aesthetic results. It is therefore in the best interest of both the patient and physician to minimize any risk factors for graft loss.

The chances of graft loss are increased if the graft has poor contact with the wound bed. Any material that collects between the bed and graft could interrupt the delicate process of graft take. Hematomas or seromas are most often encountered. These can be avoided by “pie crusting” (ie, venting by fenestration) or using meshed grafts. Moreover, ensuring the graft bed is dry but not ischemic prior to suturing in the graft is important. Any open vessels should be closed via cautery or suture ligation to prevent hematoma formation. Grafts are particularly sensitive to shearing forces during the first few days postoperatively. The small neovasculature is easily damaged by lateral forces. Most of these issues can be mitigated by proper graft dressing and activity restriction.

Most importantly, any primary pathologies must be dealt with to prevent graft loss. For example, if a Fournier gangrene patient still has active infection, the graft is doomed to fail. In that and other infectious etiologies, a quantitative tissue culture or Gram stain can ensure that no bacteria remain prior to grafting. Using a pulsed lavage or a hydrosurgical debridement system that debrides the wound bed may also be of benefit.

Donor site complications are typically mild. Ample application of 1:100,000 epinephrine solution can stop any ongoing bleeding of the site during the case. The most common issue with the donor site is patient-reported pain, which can be mitigated by local anesthetic.¹² Less frequently, patients

can produce exudative drainage that requires prolonged dressing changes. For the elderly, frail, or malnourished, wounds may experience delayed healing. Patients may experience numbness or altered sensation in the area of grafting. Site selection should be discussed with patients preoperatively as the area will be left with a visible scar. For patients with a high suspicion of poor wound healing, applying a widely meshed graft back onto the donor site has been described.¹³

Case Studies

Fournier Gangrene

Fournier gangrene was first described in 1883 by Jean Alfred Fournier, and is a gas-forming, necrotizing soft-tissue infection of the scrotum and perineum.¹⁴ The most common origin of this infection is a perirectal abscess, but urethral cutaneous origins have also been described. Gangrenous infections can also develop after anal surgery, cancer, or trauma. The infection can spread quickly along tissue planes to the perineum, penis, thighs, and abdominal walls. Skin necrosis then ensues due to thrombosis of the microvasculature. This process progresses so rapidly that extensive areas of skin can be compromised in just a few hours. Infections are caused by polymicrobial combinations of aerobic and anaerobic organisms, and usually more than four different bacteria are present (eg, *Escherichia coli*, *Streptococcus*, *Enterococcus faecium*, *Acinetobacter baumannii*, and *Staphylococcus aureus*). Incidence is 1.6 cases per 100,000 males and increases to 3.3 per 100,000 in patients over age 50. The fatality rate is reported as 7.5% and worsens with delayed diagnosis. Predisposing risk factors include diabetes mellitus, obesity, alcohol, and illicit drug abuse.¹⁵ Common symptoms include perineal pain,

edema, necrosis, discharge, anal bleeding, suprapubic pain, difficulty in voiding and defecation, fever, and general weakness.

Management can be separated into three components: early detection, immediate and aggressive surgical debridement, and adequate administration of broad-spectrum antibiotics.¹⁶ Recommendations regarding the need for urinary and fecal diversion, use of hyperbaric oxygen, and early skin grafting vary in the literature.^{15,16} There is no association between urinary or fecal diversion with prognosis. Fecal diversion may help heal infections of anorectal origin or in cases of fecal spillage prevent spillage onto healing areas.⁸

Elevated white blood cell count and serum sodium abnormalities may be indicative of Fournier infection as opposed to complicated cellulitis.¹⁵ After initial management and stabilization of the patient, continued aggressive debridement should be pursued. Once there are no more signs of necrotic tissue, the area can be managed with a wound VAC or with skin grafting.

STSGs (0.016-0.018 in) are typically used for Fournier cases because they are hairless, take quickly, cause minimal contraction, and provide good functional and cosmetic results. A meshed STSG is often suitable coverage for the testicles. Careful hemostasis is recommended to avoid hematoma formation and subsequent skin damage. Testicles must be placed in the most dependent position so they can hang. This causes continuous tissue expansion, which helps to minimize graft contraction. Meshed skin is preferred because it mimics the rugated aspect of the scrotum. However, meshed skin may have more tendency for retraction.

Buried Penis

Buried penis occurs when the penis is either partially or completely hidden beneath the abdomen, thighs, or scrotum.¹⁷ Although the pathophysiology is not entirely elucidated, it is likely related to abnormal dartos fascia mobility and inadequate Bucks fascial attachments exacerbated by morbid obesity. Dysplastic dartos can hinder the normal stretch of the penis, and excessive suprapubic fat aggravates this anatomy.¹⁸ Morbidity occurs due to urinary dribbling and subsequent unhygienic voiding followed by inflammation, skin breakdown, and recurrent infections.¹⁹ Other sequelae include erectile dysfunction, painful sex, phimosis, low self-esteem, and depression.¹⁷

From 1999 to 2000, 30.5% of adults and 13.9% of youth were obese in the United States.²⁰ This has steadily increased to 39.8% of adults and 18.5% of youth in 2015 to 2016.⁶ As the prevalence of obesity increases globally each year, buried penis will likely become a more common pathology seen in urology clinics. However, not all patients with buried penis are obese; research is needed to further understand the pathophysiology of this condition.

Surgical management of buried penis usually involves panniculectomy or lipectomy of the suprapubic fat pad, scrotoplasty, and penile skin graft.¹⁹ Postoperative penile retraction rates may be decreased with a modified repair that involves a small longitudinal median incision at the dorsal prepuce and suturing of superficial and Bucks fascia.¹⁸ Local flaps may also be used instead of grafting.

Surgery initially involves scar release and mobilization of the penile skin (Figures 4A,B). Mobility is usually achieved by releasing the dartos band, and,

rarely, division of the suspensory ligament. Fat removal increases penile exposure. This can be done with either a panniculectomy (V-shaped incision above the mons pubis, and a Z-shaped incision at the lateral margins to prevent overlapping of abdominal flaps) or a suprapubic lipectomy (resection of the suprapubic fat pad and tethering of the dartos bands to elongate the penis).¹⁷ The latter is indicated in patients that have suprapubic fat remaining despite several attempts at weight loss. After fat is removed, tacking sutures are used from the tunica albuginea to the ventral subdermal dartos to prevent retraction of the penis back into the fat. Finally, reconstruction of skin defects is undertaken with a z-plasty or skin grafting. Grafts are taken from the abdomen (if panniculectomy was performed) or the lateral thigh. Either STSG or FTSG may be used depending on preoperative evaluation by the surgeon.¹⁷

The ventral slit scrotal flap is an outpatient procedure that does not involve complex skin grafting. An initial ventral slit is made in the phimotic ring, and local flaps are created by making a ventral midline scrotal incision with horizontal relaxing incisions.²¹

Several studies have found that surgical correction is very well tolerated by patients.²²⁻²⁴ Surgical correction seems to also significantly improve patients' postoperative sexual pleasure, ability to urinate, and genital hygiene. However, there are some reports of significant erectile dysfunction and increasing frequency of postoperative complications correlated with increasing BMI.²⁴⁻²⁶ Most patients from a University of Washington (n = 42) study between 2005 and 2016 reported they would undergo surgery again (85%), that the surgery led to positive change in their lives (74%), and that the

surgery had remained a long-term success (85%).²³

Hidradenitis Suppurativa

Hidradenitis suppurativa (HS) is a debilitating, painful, chronic inflammatory disease of the apocrine-bearing skin with an unpredictable course (Figures 4C,D). The disease process is quite uncommon but disproportionately affects young and African American or biracial patients.²⁷ Risk factors for disease severity include smoking, obesity, and possibly shaving. Although the pathophysiology is incompletely elucidated, the chronic obstruction of hair follicles and inflammation of the apocrine sweat glands are thought to contribute. HS is one of the most debilitating dermatologic conditions and universally decreases quality of life for those afflicted.²⁸ Patients present with exquisitely painful abscesses and nodules that often

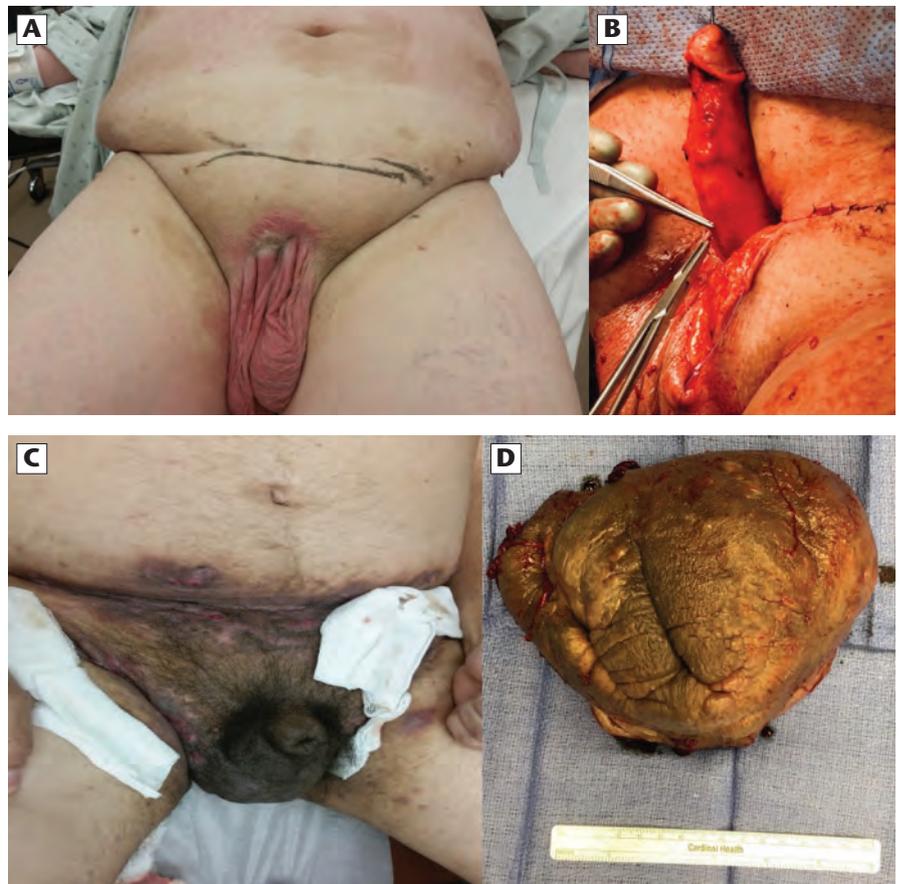


Figure 4. Case study examples. (A) Preoperative photograph before buried penis repair. (B) Intraoperative photograph after buried penis repair. (C) Hidradenitis suppurativa in groin area. (D) Scrotum specimen after removal for hidradenitis suppurativa.

MAIN POINTS

- Urologists may encounter patients with diseases that lead to severe tissue loss due to infection, trauma, burns, malignancy, or skin maladies who require skin grafting.
- The aim of surgical treatment via skin grafting is to preserve genital function, improve quality of life, and restore cosmetic damage.
- There are two major types of skin grafts: split-thickness and full-thickness skin grafting. Split-thickness skin grafts are partial thickness grafts with the ability to cover large surface areas with minimal donor skin. The major disadvantage is these grafts can be fragile. Full-thickness skin grafts have better texture, elasticity, aesthetics, and pliability. They are more resistant to secondary contracture but are used sparingly due to additional donor site morbidity.
- Graft loss may ultimately lead to a need for repeat surgery; it is therefore in the best interest of both the patient and physician to minimize risk factors for graft loss and ensure proper graft dressings.
- For cases of Fournier gangrene, repeated and aggressive debridement should be pursued. Once there are no more signs of necrotic tissue, the area can be managed with skin grafting.
- Surgical management of buried penis usually involves panniculectomy or lipectomy of the suprapubic fat pad, scrotoplasty, and penile skin graft. Local flaps may also be used instead of grafting.
- Recovery for patients with skin grafting for hidradenitis suppurativa is prolonged compared with other conditions, possibly due to inherent poor wound healing. More research is needed to optimize surgical and medical outcomes for these challenging patients.

form polymicrobial infections. Antibiotics for acute episodes and suppressive antibiotics to prevent recurrences have been effective.²⁸ Medical management can involve long-term steroids as well as anti-tumor necrosis factor (TNF) medications such as adalimumab and infliximab.²⁹ Retinoids have also been used with varied success.³⁰

Surgery is used as a last resort and almost always requires the techniques described herein due to the inability for local skin flap use due to risks of local disease recurrence. Some have described temporary porcine graft or 10 to 14 days of healing by secondary intention to allow active disease to acquiesce prior to formal skin grafting.²⁸ Despite aggressive surgical therapy, recurrence is still a possibility; biologic therapies may be a beneficial adjunct to surgery.³¹ Attempts to allow wounds to heal completely by secondary intention are not desirable given the length of time for full healing to occur and the large area typically affected.

Ultimately, the location and extent of disease will dictate patients' clinical responses to treatment. Extensive counseling should be undertaken to ensure patients' understanding of the chance of local recurrence. Anecdotally, these patients' recovery is prolonged compared with STSG in other conditions, possibly due to inherent poor wound healing in these patients. More research is needed to optimize surgical and medical outcomes; HS patients represent the pinnacle of challenging management in terms of preventing graft loss, recurrence, and lack of donor sites due to oftentimes extensive prior skin surgery.

Conclusions

Although skin grafting has traditionally been a technique primarily utilized by plastic surgeons, skin grafting has multiple applications within urology. Fournier gangrene, buried penis, and hidradenitis suppurativa are only three of many urological pathologies that may require complex closures. A common vocabulary and working knowledge of skin grafting techniques and applications is prudent for all clinical urologists. ■

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