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ORIGINAL ARTICLE
Reconstructive

Two-stage Neoscrotum Reconstruction Using Porcine Bladder Extracellular Matrix after Fournier's Gangrene

Jacob Thayer, MD
Brian A. Mailey, MD

Background: Fournier's gangrene is a life-threatening infection. Survivors can be left with significant deformity of their external genitalia. We present our technique for restoring a more normal appearance to the scrotum.
Methods: A 2-stage orchiopexy and scrotoplasty are performed. At the first stage, the testicles are delivered to their anatomic place and sutured together. Xenograft powder and wound matrix are used to stimulate a granulation response. After 2–3 weeks, split-thickness skin grafting is performed to create a neoscrotum. This is protected for 1 week with negative pressure wound therapy. Postoperatively, the scrotum is protected with nonstick dressings to prevent synechiae to the perineum.
Results: Two to three weeks after product application, a robust granulation tissue bed can be seen, which is very receptive to a meshed skin graft scrotal pouch. Circumferential negative pressure wound therapy is safe and prevents synechiae of the scrotum to perineum. The scrotum healed without issue and demonstrated an acceptable aesthetic result.
Conclusions: This technique produces a near-normal appearing scrotum in the normal anatomic position for the testicles. The porcine xenograft material incites an intense granulation reaction, producing a wound bed amenable to accept a skin graft at 2–3 weeks. This 2-stage procedure to create a neoscrotum can be considered for the reconstruction of disfigured genitalia from Fournier's gangrene wounds.
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INTRODUCTION

Fournier's gangrene is a life-threatening variant of necrotizing fasciitis that affects genital and perineal tissues. It was first described in 1883 by a French venereologist, Jean-Alfred Fournier.[1] The infectious process spreads rapidly throughout the affected fascial planes, up to 1 inch per hour,[2] causing thrombosis of subcutaneous arterioles and subsequent tissue necrosis.[3] Mortality rates vary wildly in the literature, ranging from 20% to 80%.[4] These infections are commonly polymicrobial in nature and have a predilection for immunocompromised and debilitated patients.[5]

Treatment for these patients is multimodal, consisting of immediate surgical intervention for excision of infected tissue, broad antibiotic coverage, fluid resuscitation, and glycemic control. Resulting wounds can be extensive and are frequently disfiguring, with exposed testis and perineum. Traditional surgical management has included burying the testis in the medial thighs or individually skin grafting them. These treatments produce lifelong disfigurement, with a lack of anatomic normalcy. To date, little research exists that guides the reconstructive surgeon in the actual creation of a neoscrotum following Fournier's infections. We describe an orchiopexy technique along with using porcine bladder extracellular matrix (ECM) product (ACell Inc., Columbia, Md.) and negative pressure wound therapy to develop a wound bed suitable for scrotoplasty with split-thickness skin grafting.

SURGICAL TECHNIQUE

Life-threatening emergent surgical debridement is initially performed on the necrotizing soft-tissue infection (Fig. 1). Serial debridements are performed until the wound bed is cleared from gross infection. Wounds are generally maintained in Dakin's wet-to-dry gauze dressing changes during the debridement phase and

From the Department of Surgery, Institute for Plastic Surgery, Southern Illinois University, Springfield, Ill.

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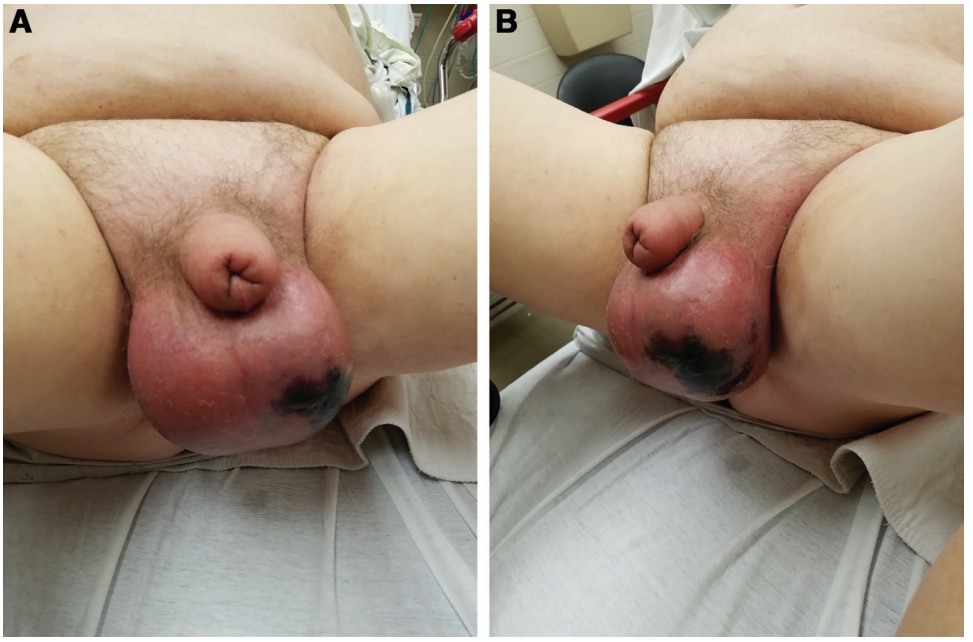

Fig 1. Wound appearance on the day of initial presentation with Fournier's gangrene infection. The patient was 75 years old with a history of hypertension and hyperlipidemia who presented with 3 days of scrotal pain and swelling. Workup demonstrated a leukocytosis of 12.9, elevated lactic acid at 4.2, hyponatremia to 131, hyperglycemia of 199 with periscrotal subcutaneous gas evident on CT (computed tomographic) pelvis imaging. The patient was taken for emergent surgical debridement after this picture was obtained.

switched over to negative pressure wound therapy once gross infection is eradicated. Commonly, the testicles are buried into the inner thigh tissue by the debriding surgeons.

Reconstruction is performed in 2 stages. The first procedure consists of retrieving the testicles from the inner thighs (Fig. 2A) if necessary and using the dartos muscle fascia to pexy the testicles to each other using an absorbable suture material in the normal anatomic position (Fig. 2B). The testicles are then covered with porcine bladder ECM powder (Fig. 3) and 2-layer regenerative matrix sheets (ACell Inc.). This is covered with a nonstick dressing and placed in a negative pressure wound dressing for 1 week. After the initial vac comes down, the negative

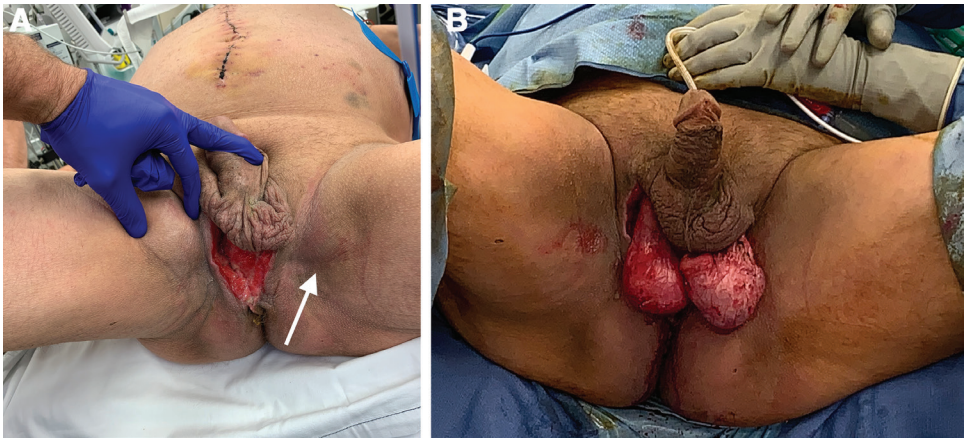

Fig. 2. Testicles within medial thigh subcutaneous pockets following debridement (A). This was a 56-year-old patient who had undergone multiple rounds of excisional debridement by the Urology service and was approximately 2 weeks out from initial presentation. The examiner's hand demonstrates the buried testicle between their fingers, which was placed in the patient's right thigh at the time of initial debridement. The white arrow demonstrates the location of the left buried testicle in the medial inner thigh. Testicles were removed from subcutaneous thigh pockets and returned to their (B) anatomic position in preparation for orchiopexy, porcine ECM matrix application, and neoscrotal reconstruction.

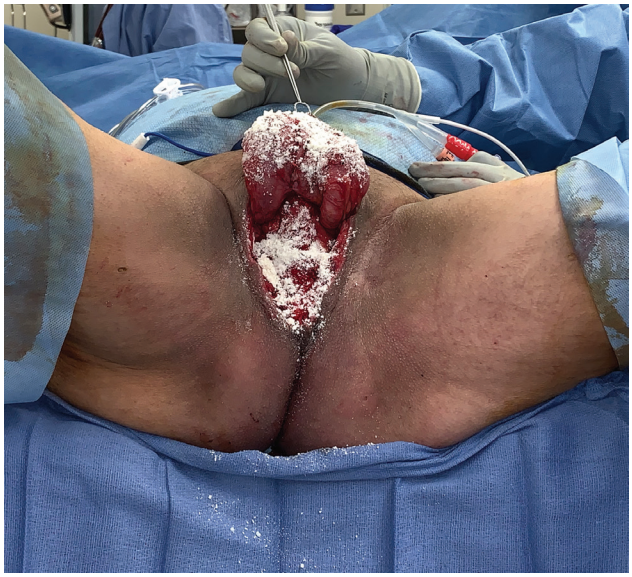

Fig. 3. Porcine bladder extracellular matrix powder is applied to the healthy wound bed. Once the majority of infectious tissue burden is debrided, the product is evenly distributed throughout the wound, with attention being paid to filling crevices and depressions. This product has bacteriostatic properties and can be used for treating slightly contaminated wounds without sacrificing product loss. The next step includes application of a 2-layer regenerative matrix sheet, which is then covered with nonstick dressings and placed in negative pressure wound therapy for 1 week.

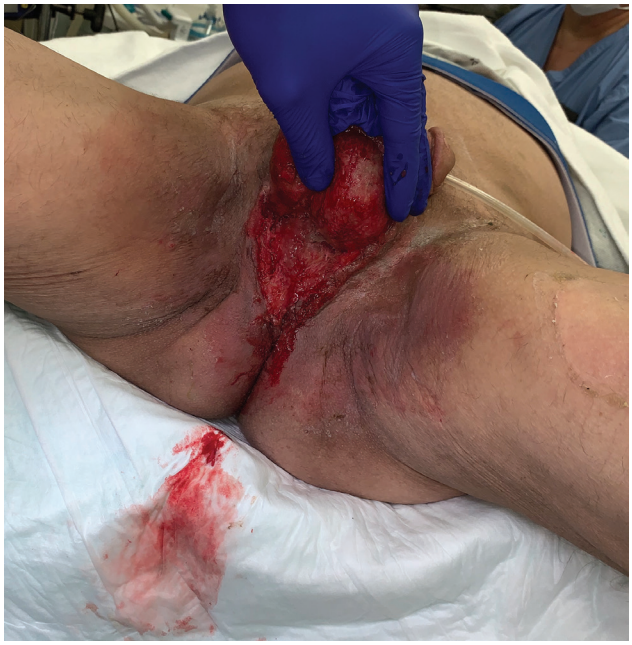

Fig. 4. A 56-year-old patient with robust granulating wound bed 2 weeks out following orchiopexy and application of porcine bladder ECM product with negative pressure dressing. Wound vacs are left in place for 1 week after product application and then changed biweekly on the floor until the wound bed is deemed appropriate for skin grafting.

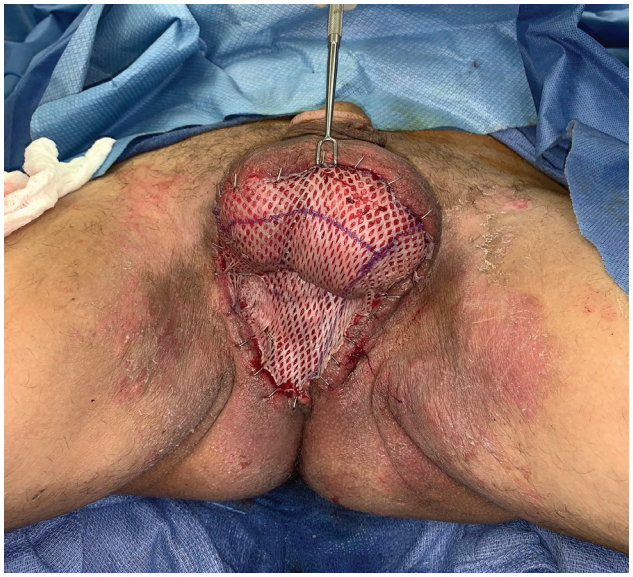

Fig. 5. Scrotal wound immediately following split-thickness skin graft application, which was harvested from the anterolateral thigh, meshed, and secured with staples. A negative pressure dressing is then applied over the skin graft to serve as a bolster and to optimize skin graft adherence. A nonstick dressing is used as a barrier layer between the skin graft and vac sponge. The wound vac bolster was kept in place for 5 days before takedown.

pressure dressing is changed 2 times per week for the next 2 weeks until a robust granulation bed is created that is suitable for skin grafting (Fig. 4).

Once the testicles are covered with a bed of granulation tissue, the second-stage procedure is performed with meshed split-thickness skin grafting to the anterior and posterior aspects of the scrotum and covered with a negative pressure wound dressing for 1 week (Fig. 5). After the dressing has come down, the neoscrotum is covered with a nonstick dressing for another 2 weeks to prevent synechiae of the scrotum to the perineum.

Patients generally demonstrate complete or near-complete take of the skin graft neoscrotum reconstruction (Figs. 6, 7). Secondary contracture of the skin graft is not usually a significant issue (Fig. 6E, F). Restoration of near-anatomic normalcy can be achieved (Fig. 7). Synechiae will occur between the neoscrotum and perineum if not protected until all skin grafts and wounds are completely healed and filled in. We have also had a patient develop very sensitive and painful testis, which did eventually spontaneously resolve after 3 months. We have also encountered a loss of skin graft between the anterior and posterior walls at the penile base, creating an unnatural but asymptomatic passageway (Fig. 6E). Patients can return to their prior level of activity and are generally pleased and appreciative of their overall outcome.

DISCUSSION

Numerous techniques exist for scrotal reconstruction following Fournier's gangrene infections. Akilov et al[6]

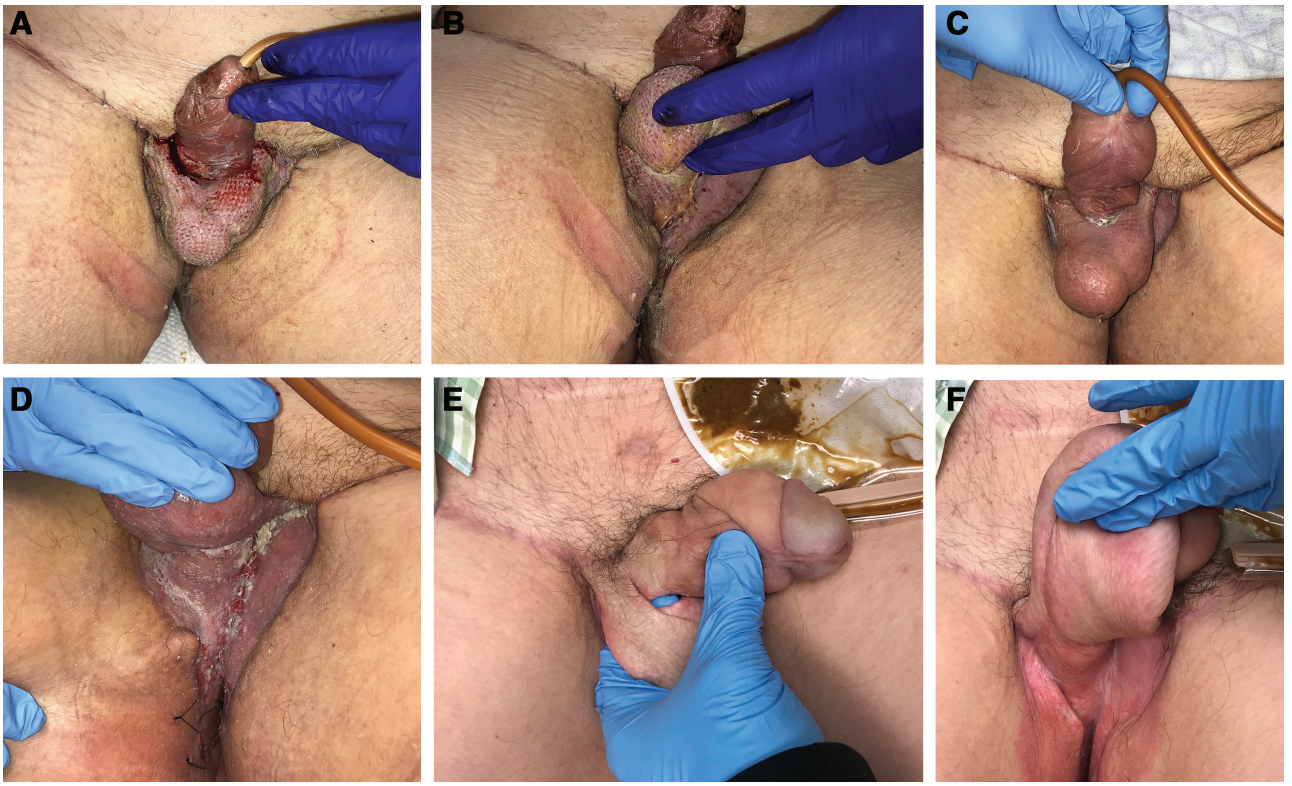

Fig. 6. Scrotal wound in a 75-year-old patient, at differing time points after split-thickness skin graft reconstruction. A, B, Scrotal wound 1 week after skin graft application, with no evidence of graft loss or nonadherence. C, D, Scrotal wound 3 weeks later, with complete skin graft take and fully healed skin graft. E, F, Scrotal wound 8 months out after neoscrotum reconstruction, with complete healing and Foley catheter removal. This patient did have a reconstructive loss at the penile base resulting in (E) an asymptomatic passageway at the superior aspect of the scrotum. This may be prevented by allowing more time for the wound bed to granulate and by securing the split-thickness skin graft to the penile base with dissolvable suture and staples. Protection and support is afforded thereafter with negative pressure bolster application.

Fig. 7. A healed neoscrotal reconstruction in a 44-year-old patient, 5 months out after split thickness skin grafting. Restored near-anatomic normalcy (A) without evidence of skin graft loss, contracture, or synechiae at the penile base (B, C). The patient was asymptomatic and was back to work at the time of this clinic visit. He denied any negative implication the reconstruction had on his quality of life.

have demonstrated favorable outcomes in wounds involving <50% of the entire scrotum with secondary intention healing alone, over an average course of 6–9 weeks. Others have favored scrotal advancement flaps for wound coverage of similar size.[7]

In larger wounds consisting of over 50% scrotal involvement, fascioctuaneous and muscle flaps have shown promise.[5,8–10] Pedicled anterolateral thigh and pudendal thigh fasciocutaneous flaps have also been reported, as well as pedicled gracilis muscle flap reconstructions.[7] These flaps bring the benefit of increased durability and bulk but come at the expense of donor-site morbidity and increased reconstructive complexity. These large flaps also do not create a normal appearance to the scrotum and are often bulky. Split-thickness skin grafting has been used by many, but criticisms include secondary contracture and graft loss, due

to the contaminated nature of the field and location of the body, resulting in wounds and need for revision surgery.[5,7,11]

Naturally derived ECM products have been isolated from a variety of organ systems. Porcine bladder is one such system in which products (ACell Inc.) have been described for use in recalcitrant wounds.[12] This product consists of basement membrane and lamina propria of the porcine urinary bladder and contains an assortment of proteins and glycosaminoglycans, which stimulate granulation tissue creation. This ECM scaffold contains the same structure of native tissue and, as such, allows for host epithelial cell ingrowth. The morphology of ECM varies according to the organ system in which it was harvested and the methods used for processing in medical applications. When compared with porcine small intestine and liver tissue, only the urinary bladder retained its characteristic morphology and composition of native intact ECM capable of affording successful in vivo cell growth.[13]

We favor using porcine bladder products for the overall purpose of stimulation of granulation tissue to prepare a wound bed for skin grafting. This process seems to accelerate healthier, thicker beds of granulation tissue than are created with simple dressing changes alone. The creation of robust granulation tissue using porcine products has also been documented using an acellular dermal matrix. In the study performed by Zhang et al,[14] the authors similarly felt that porcine xenograft promoted accelerated growth of granulation tissue in wound healing. Our experience compliments their finding and is the second documented report of this occurrence. Porcine xenograft material warrants further investigation in problematic, infected, and seroma-prone wounds. We believe the bacteriostatic and xenographic properties of this product incite an inflammatory reaction that quickly cleans and builds the wound bed. In our experience, this technique has prepared a wound bed quicker than using negative pressure alone; however, certainly, a comparative study between the 2 is warranted to demonstrate the differences; our hope is to perform this in our future endeavors.

This granulation response becomes beneficial in terms of filling in contour deficits and in creating suitable beds for subsequent skin grafting in the setting of contaminated Fournier's wounds. Scrotal pouch creation from meshed split-thickness graft pairs well with this technique. We have observed increased skin graft adherence and long-term survival in our patients to date. All patients demonstrated acceptable functional and aesthetic outcomes at the time of their final follow-up appointments. Some surgeons may feel that these wounds would granulate as effectively with negative pressure therapy alone, negating the need for such a product. We feel this product expedites the reconstructive process and, in doing so, reduces the number of painful dressing changes, time away from work, and assistance required with wound care. Additionally, this product is cheaper at our institution than other alternatives (Integra Bilaminar Wound Matrix; Integra LifeSciences, Princeton, N.J.) used for similar indications.

CONCLUSIONS

Scrotal reconstruction after Fournier's gangrene can be challenging. We describe a technique that details the use of a biologic product with split-thickness skin graft reconstruction. In our experience, this technique generates expeditious, robust beds of granulation tissue and helps restore more anatomic normalcy in Fournier's wounds. This 2-stage technique has been reliable for creating a neoscrotum with near-anatomic normalcy.

Brian Mailey, MD
Department of Surgery
Institute for Plastic Surgery
Southern Illinois University
747 N. Rutledge St
Springfield, IL 62704
E-mail: bmailey48@siumed.edu

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