Distal urethral reconstruction with AlloDerm: a case report and review of the literature

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Reconstruction of large urethral defects is a complex problem for which no standardized surgical guidelines exist due to the lack of clinical trials demonstrating definitively the superiority of one technique over another. AlloDerm has been used in other surgical specialties with success, however, its utility in urologic surgery and, more specifically, for urethral reconstruction has been limited. In this case report, we demonstrate its application in a single-staged closure of a significant anterior urethral defect following distal penile necrosis secondary to an extruded penile prosthesis in a diabetic patient.

Key Words: urethra, fistula, AlloDerm

Introduction

Anterior urethral defects occur most commonly secondary to trauma, but they can also be due to severe infection. Currently, there is no standardized algorithm for the management and repair of anterior urethral defects. Primary anastomosis has been proposed as the technique associated with the lowest rate of complications; however, it is best suited for defects smaller than 1 cm. When used for repair of larger areas, primary closure often places excess tension, resulting in high rates of stricture and stenosis.[1]

For defects greater than 1 cm, grafting has emerged as the primary reconstructive modality. A literature review demonstrates onlay, free grafts to be superior to both tubular and pedicled grafts.[1,2] Materials commonly accepted for grafting include buccal mucosa, lingual mucosa, and skin.[1,2] Of these, buccal mucosa grafts (BMGs) have been shown to have the lowest rates of secondary stricture development and graft shrinkage and the highest rates of long term patency.[3]

Unfortunately, regardless of the tissue type being harvested for reconstruction of an anterior urethral defect, all autografts introduce donor site morbidity. In particular, BMG is associated with significant site-specific morbidities, thus validating the search for an alternative method of reconstruction.

AlloDerm (LifeCell Corp., Branchburg, NJ, USA) is an acellular dermal matrix (ADM) that promotes neovascularization and cell repopulation while avoiding the dangers and side effects of immunogenicity. Human cadaveric skin is stripped of the keratin-containing epidermis and further processed to remove DNA from the remaining dermis.[4] This results in a collagen matrix scaffold of collagen types IV and VII, elastin, and laminin that has been shown in histologic studies to revascularize during the early postoperative period. Wong et al demonstrated that incorporation of ADM parallels normal wound healing: macrophage and histiocyte invasion by day 3 and increasing numbers of myofibroblasts and other cells characteristic of the proliferative phase after 7 to 14 days. They also demonstrated that host cells migrate into and

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proliferate within the ADM, thus facilitating the full integration of the ADM into the surrounding host tissue.[5] ADM has been used extensively in plastic and reconstructive surgery for abdominal and breast reconstruction/augmentation, and in otolaryngology for tympanoplasty and dural repair.[6-8]

This case report demonstrates the utility of ADM in the reconstruction of an anterior urethral defect following distal penile necrosis after a failed penile prosthesis. After review of the literature, this case represents, to our knowledge, the first reported use of ADM for a single stage urethral reconstruction.

Case report

A 68-year-old diabetic male developed extensive distal penile tissue necrosis and anterior urethral loss after AMS Spectra penile prosthesis implantation performed at another institution. Past medical history was significant for poorly controlled insulin-dependent diabetes mellitus diagnosed 18 years ago and an episode of necrotizing fasciitis of the right lower extremity 11 years ago. The patient underwent device removal and multiple debridements of the necrotic penile tissue, but was ultimately referred to our institution 8 weeks status-post implantation for further care for continued necrosis and infection of the glans and distal penile shaft.

Physical examination revealed erosive ulceration with fibrinous exudate on the dorsal surface of the penis, an open wound with fibrinous exudate on the ventral aspect, erosion of the corpus spongiosum with urethral fistula at the mid-distal shaft, eschar at the glans, and induration of the proximal ventral shaft, Figure 1a. A foley catheter was present. The patient underwent operative exploration, debridement, and washout. During initial exploration of the wound, penile morphology was difficult to discern secondary to infectious destruction of the tissue planes. The tip of the glans penis was completely necrotic within a 2 cm diameter surrounding the meatus, Figure 1a, and no clear corpora cavernosa nor corpus spongiosum could be identified. The foley catheter was found to be within the true urethral lumen proximally and distally, but a 2 cm mid-shaft ventral urethral defect was clearly evident. Intraoperative plastic surgery consultation was obtained, and Versajet debridement of the surrounding tissue was accomplished. After debridement of all devitalized tissue, fistualization extending from the ventral aspect of the filleted shaft to a 1 cm opening on the dorsal aspect was discovered, Figure 1b. A suprapubic tube was placed for urinary diversion, and a silastic foley catheter was left in

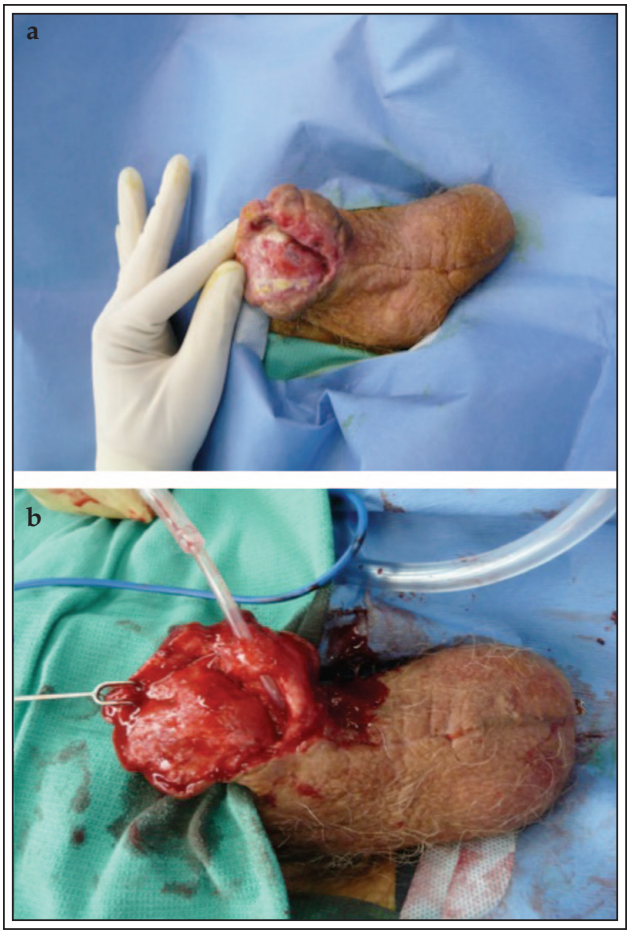

Figure 1. a) The necrotic glans penis prior to debridement. **b)** Urethral defect after intraoperative debridement prior to closure.

place to maintain the urethral lumen while the patient received intravenous antibiotics and local wound care with Acticoat Flex silver dressings as an inpatient.

Five days later, the patient was brought back to the operating room for attempted primary urethroplasty and reconstruction. At this time, the urethra was noted to be intact only for its distal 0.3 cm and at the base of the penile shaft, with an intervening 50% circumferential ventral 2.5 cm defect at the mid-shaft. The size of the urethral defect was felt to be too large for primary closure without tension. Therefore, to reconstruct the ventral defect, a square of ADM was cut to appropriate size and positioned over the defect, sutured along the lateral aspect of the defect to the remaining urethral tissue with 5-0 PDS suture in an interrupted fashion, further trimmed to size, and sutured over a silastic foley catheter medially and superiorly; thus covering the entire urethral defect, Figure 2a. We constructed a neomeatus from the distal urethra and spatulated it

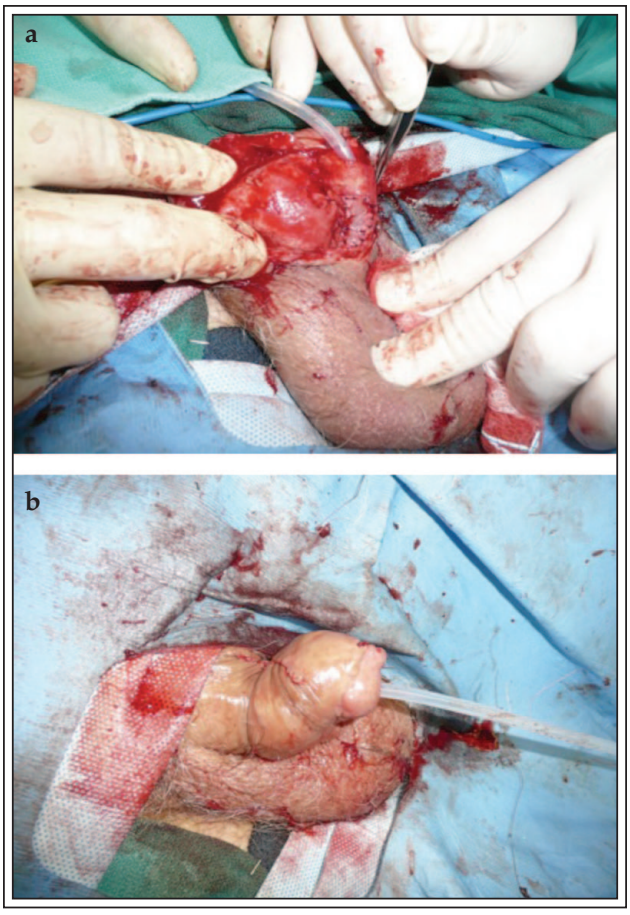

Figure 2 **a)** Urethral defect after AlloDerm onlay. **b)** Glans soft tissue closure over AlloDerm onlay.

circumferentially so that the catheter exited at the tip of the reconstructed glans. The fistulous tract was closed primarily with 2-0 Vicryl suture, and the plastic surgery service primarily closed the filleted shaft soft tissue flaps over the urethral defect to produce a slightly foreshortened but otherwise cosmetically acceptable and penis of sufficient functional length for voiding, Figure 2b. The silastic catheter was left in place post-operatively to stent open the urethra and provide a mold around which the ADM could revascularize and reepithelialize.

Over the ensuing 6 months of follow up the patient's postoperative course has been uneventful. One month after surgery, the silastic foley catheter was removed and the suprapubic tube clamped. Two weeks later, the suprapubic tube was removed, and he has been voiding normally with a cosmetically acceptable and functional penis. At 17 months follow up, retrograde urethrography continues to show a normal patent urethra with no evidence of stricture or fistula, Figure 3.

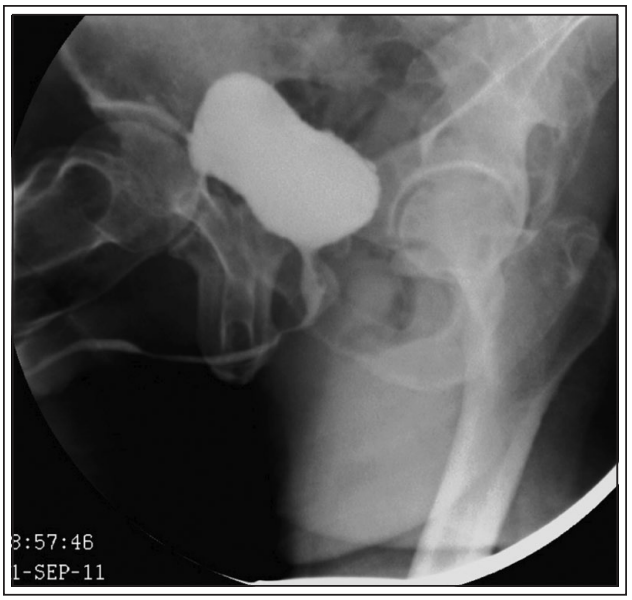

Figure 3. Normal retrograde urethrogram performed 17 months postoperatively showing patent urethra with no evidence of stricture or fistula.

Discussion

The anterior urethra comprises the bulbar and penile urethral segments. Primary anastomosis has been demonstrated to be the most successful method for closure, however, it is best suited to lesions less than 1 cm.[1] For larger defects or when the surrounding tissue is inadequate for use in the repair, whether secondary to trauma or, as in this case, extensive infection, a graft may be necessary for reconstruction. Overall success of the urethral reconstruction utilizing graft materials depends on the quality of the graft material used and subsequent neovascularization, effectiveness of the closure, long term patency, and donor site morbidity. Potential graft materials include penile skin and BMG. In this case, due to antecedent infection and tissue loss, penile skin was not available.

Buccal mucosa was first introduced as a material for reconstruction of ventral urethral defects in 1992.[2] BMGs are harvested by sharp dissection of mucosa from either side of the oral cavity superficial to the buccinator muscle. The tissue is defatted, and then used as an onlay or tubularized graft. While Kane et al report large variation in the literature of accounts of successful closure and subsequent patency with this technique, with rates ranging between 54% and 100%, their own experience with ventral onlay buccal mucosa grafts demonstrates a 94% success rate.[3] While this data supports the efficacy of BMGs for

urethral reconstruction, this technique is not without its own complications. In a study by Wood et al, more than half of the participants characterized the postoperative pain of the buccal procedure as extreme, and several patients experienced significant long term complications, including perioral numbness, changes in salivation, and difficulty with mouth opening.[9] While BMGs are an effective material for urethral reconstruction, their harvest causes patients potential donor site morbidity and the additional length and cost and potential morbidity of a second procedure. Both bladder and lingual mucosal grafts and skin flaps convey donor site morbidity when used for urethral reconstruction. Additionally, these techniques may fail due to graft shrinkage that may necessitate further reparative surgery.[1,9]

ADM was chosen for closure as an alternative to penile skin and BMG in this case because of a lack of adequate penile skin and to minimize operative time and morbidity in this brittle and high risk diabetic patient. ADM inherently lacks allogenicity, possesses structural integrity, and supports tissue ingrowth and angiogenesis by promoting cellular migration.[4,5] Additionally, its use avoids the potential morbidity of a graft harvest site and decreases the length of the procedure required if a BMG was to be harvested and the donor site closed.[9]

ADM has been used successfully in several other surgical subspecialties. Its use has been associated with decreased rates of contracture in breast reconstructive surgery and greater patient satisfaction.[6-8] It has also been associated with decreased incidence of hernia when used during abdominal wall reconstruction.[8] Girod et al argue that acellular dermal matrix is a better choice than the current gold standard of utilizing split thickness skin grafts (STSG) in oral cavity reconstruction. They found that its use decreased length of operation, reduced morbidity, and lowered overall cost.[6] Additionally, they demonstrated histologically that, in comparison to STSGs, ADM results in decreased inflammation and fibrosis, resulting in a superior surgical outcome.

Despite these examples of the successful integration and the expanding role of ADM in reconstructive surgery, the urological application of ADM has not been well studied. An extensive literature search revealed only one other report of ADM for urethroplasty.[10] In that study, primary anastomosis was not possible due to the size of the urethral defect and the extensive surrounding tissue destruction secondary to infection. Their reconstruction was performed in two stages. The first phase involved placement of ADM on either side of the soft tissue adjacent to the urethral defect. Four weeks later, buccal mucosa was grafted on top as a substitute for the urethral mucosal layer, and then the entire fabricated flap was rotated over the defect to form the tubular urethra. In contrast, we avoided a second surgery by foregoing buccal mucosal grafting. We hypothesize that the ADM provides a scaffold through which the adjacent urethral epithelium can migrate, thus reepithelializing the defect surface over time.

Further study and additional follow up will be necessary to compare reconstruction of ventral urethral defects with ADM to BMG. In particular, it will be important to establish the rate of stricture over long term follow up. Nevertheless, our experience, the experience of other surgical specialties, and review of the literature suggests that ADM is an elegant and novel reconstructive technique that may eliminate unnecessary patient donor site morbidity, multiple surgeries, and cost. □

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