

Split-thickness skin grafting combined with a multi-anchor fixation technique for reconstruction of massive scrotal and penile skin avulsion: A case report

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Abstract. Isolated traumatic avulsion of the male external genitalia is a rare and surgically challenging. Reconstruction must restore both aesthetic and function, particularly given the substantial dimensional changes of penile skin during erection. To minimize long-term functional impairment and psychological morbidity, reconstruction should aim to restore normal anatomy and physiological compliance. The present study reported a case of massive left testicular, scrotal and penile skin avulsion, successfully managed using a split-thickness skin graft in combination with a novel multi-anchor fixation technique, resulting in optimal functional and cosmetic outcomes. A 39-year-old man sustained a severe perineal crush-avulsion injury after accidental entanglement in a conveyor belt. The injury resulted in complete avulsion of the penile skin, extensive scrotal skin loss, complete avulsion of the left testis and epididymis and exposure of the right testis, accompanied by active bleeding. The avulsed tissues were markedly fragmented and contaminated with machine oil. After thorough debridement of non-viable tissue, reconstruction was performed using a split-thickness skin graft harvested from the right anterolateral thigh. A novel multi-anchor fixation technique was used to secure the graft to key anatomical points on the tunica albuginea, thereby preventing graft redundancy, displacement and adhesion while preserving physiological compliance during erection. Follow-up at 6-12 months demonstrated complete

wound healing, preserved penile morphology, normal erectile function and satisfactory sexual performance. In conclusion, split-thickness skin grafting combined with multi-anchor fixation can provide reliable coverage and restore penile morphology and function after severe penoscrotal degloving injury. This technique may be a useful reconstructive option for selected patients with extensive penile skin avulsion.

Introduction

Avulsion injuries of the male external genitalia are rare and infrequently reported (1). If they are not treated promptly and appropriately, these injuries may result in lifelong functional impairment and psychological distress. Reconstructive surgeons must select strategies that minimize complications such as graft contracture, adhesion, redundant skin folds, restricted erectile expansion and sexual dysfunction (2,3).

The primary goal of penile reconstruction is to restore both functional and aesthetic outcomes, including the preservation of erectile function, urinary continence and an acceptable cosmetic appearance. This is particularly challenging given the dynamic dimensional changes that the penile skin must accommodate during erection, requiring any reconstructive material to possess sufficient compliance and elasticity (4,5).

Several reconstructive strategies have been described for penile and scrotal skin avulsion injuries. Split-thickness skin grafting (STSG) remains the most widely used technique due to its reliability, relative simplicity and low donor-site morbidity (6). However, STSG is associated with well-recognized complications, including graft contraction, reduced elasticity and impaired compliance during erection, which may ultimately compromise sexual function (7). Fang *et al* (8) combined STSG with a dermal regeneration template and vacuum-assisted closure (VAC) to repair circumferential penile shaft defects, demonstrating favorable graft survival; however, postoperative contracture remained a concern. Mesh skin grafts, as reported in a Japanese case series investigating the management of penile strangulation injuries, achieved satisfactory epithelialization but exhibited a more pronounced contraction rate compared with sheet grafts (9).

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Full-thickness skin grafts offer improved pliability and reduced contraction compared with STSG and have been advocated for by some authors for penile reconstruction; however, their application is limited by donor-site constraints, particularly in cases involving large defect areas (6). Local and regional flaps, including scrotal flaps, have been employed for partial penile defects. Wong *et al* (10) and Zhao *et al* (11) reported successful coverage of circumferential penile shaft defects using bipediced scrotal flaps, although this approach is inherently limited when scrotal skin is itself involved in the injury, as is frequently the case in penoscrotal degloving injuries. Fasciocutaneous and musculocutaneous free flaps, such as the anterolateral thigh flap and radial forearm free flap, represent alternative options for large or complex defects, but carry significant donor-site morbidity and technical demands that may not be justified in all clinical scenarios (6).

Secure graft fixation remains a critical determinant of reconstructive success, particularly on the penis where postoperative movement and physiological erection may displace or distort the graft. Conventional tie-over dressings and compressive wraps are commonly employed but may be insufficient to prevent graft mobility during the early healing phase (12). Anchor-based fixation strategies, well-established in hand and upper extremity surgery for tendon and ligament repair (13), offer a biomechanical advantage in securing soft tissue to underlying structures at defined anatomical points, thereby minimizing shear forces and promoting uniform graft adherence (14).

The present study reported a case of severe traumatic penoscrotal degloving injury involving complete penile skin avulsion, extensive scrotal skin loss, complete avulsion of the left testis and epididymis and exposure of the right testis, in which the resulting soft-tissue defect was successfully reconstructed using STSG combined with a multi-anchor fixation technique. The aim of the present study was to describe this novel reconstructive approach, evaluate its functional and cosmetic outcomes, and propose multi-anchor fixation as a viable technical adjunct to STSG in the management of extensive penoscrotal degloving injuries.

Case report

A 39-year-old male worker sustained a severe perineal crush-avulsion injury after accidental entanglement in a conveyor belt at work in September 2025. On admission, vital signs were stable, and physical examination revealed complete avulsion of the penile skin, extensive scrotal soft-tissue loss, complete avulsion of the left testis and epididymis, exposure of the right testis and active bleeding. The avulsed tissues were markedly contaminated with fabric fragments and machine oil. The clinical diagnosis was traumatic penoscrotal degloving injury with complete left testicular and epididymal avulsion, right testicular exposure and extensive perineal soft-tissue laceration (Fig. 1).

Emergency surgery was performed ~3 h after admission. Intraoperative exploration confirmed complete traumatic avulsion of the left testis and epididymis, with severe crushing and contamination of the detached tissues. Because the avulsed testis was non-viable and unsuitable for reimplantation, the detached left testis and epididymis were removed, and the

residual spermatic cord structures were carefully ligated for hemostasis. The exposed right testis was preserved and placed in a subcutaneous pouch in the right inguinal region. For penile reconstruction, the penis was induced intraoperatively to allow accurate estimation of the required graft area. A 12x12 cm split-thickness skin graft harvested from the right thigh was circumferentially applied to the penile defect. The graft was then anchored securely fixed to the tunica albuginea using a multi-anchor fixation technique, in which 5-0 absorbable sutures were placed at anchor points ~2 cm apart in a mesh-like configuration (Fig. 2). Telephone follow-up at 6 months revealed that the patient self-reported the ability to achieve erection and satisfactory sexual performance, with only occasional groin discomfort. No formal objective assessments were performed, as the patient had returned to their home region and was unavailable for in-person evaluation.

Discussion

Scrotal and penile skin avulsion injuries are rare, and data published on these injuries are lacking. The penile skin is thin, supported by loose subcutaneous tissue, making it vulnerable to avulsion and other open injuries. Severe trauma may injure the superficial dorsal vein, dorsal artery and dorsal nerve of the penis, and even deeper structures such as the corpus cavernosum and urethra. Timely and appropriate reconstruction is essential for minimizing physical morbidity and psychological distress and reducing long-term complications (15). Although penile reconstruction techniques are relatively well established, experience in penile wound repair remains limited (6). Skin grafting on the penis carries a high risk of complications, including infection, hematoma, graft loosening, adhesion, seroma and restricted mobility (16).

Several reconstructive approaches have been reported. Fang *et al* (8) used VAC with split-thickness skin graft to repair circumferential penile shaft defects. Although this method facilitates graft survival, postoperative graft contraction may compromise erectile expansion (9). Wong *et al* (10) and Zhao *et al* (11) used a scrotal flap to repair partial penile defects; however this technique is limited when scrotal tissue is insufficient. Japanese researchers (9) managed penile strangulation injuries with debridement, conservative therapy and mesh skin grafting, achieving good epithelialization, while compared with larger sheet grafts, mesh grafts showed a more pronounced contraction rate.

In the present case, graft contraction was not only considered but also dynamic changes in skin area and compliance during erection. Conventional skin graft fixation techniques, including tie-over bolster dressings and VAC, provide uniform compressive pressure but lack direct mechanical anchorage to underlying structures, rendering them susceptible to graft displacement during postoperative erection (17). Inspired by the anchor fixation principle used in hand surgery to secure soft tissue to bone at defined anatomical points (13), a multi-anchor suturing technique was applied in the present case to fix the skin graft directly to the tunica albuginea. This technique ensures reliable defect coverage while minimizing complications. Notably, the primary function of the scrotum is to regulate the local temperature of the testes. A relatively lower scrotal temperature is essential for spermatogenesis in

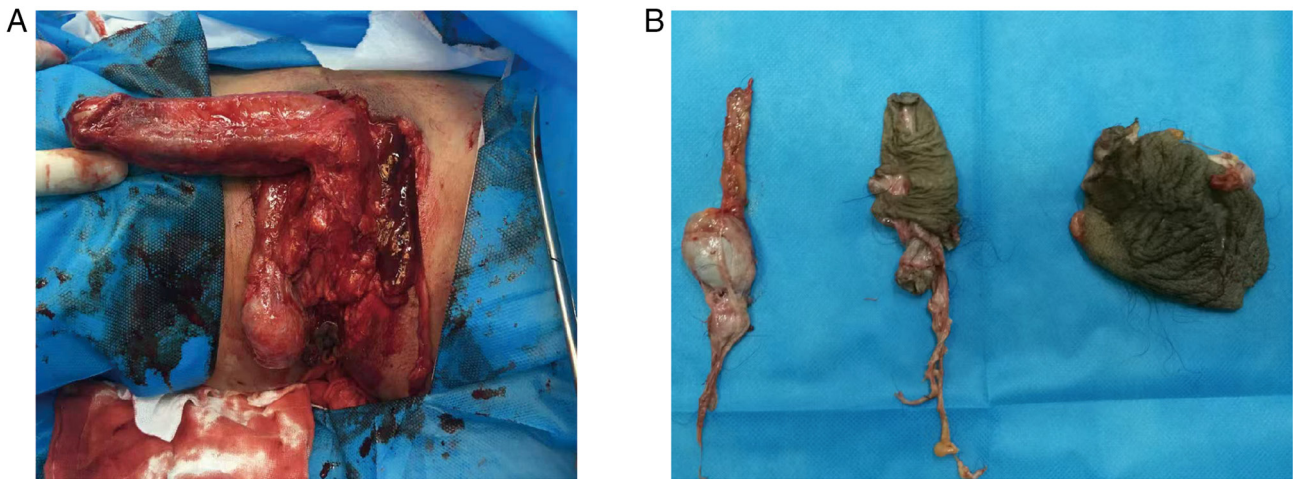


Figure 1. Clinical presentation of traumatic penoscrotal degloving injury. (A) Complete degloving injury of the penile and proximal scrotal skin. (B) Avulsed tissue including testicular, scrotal and penile skin.

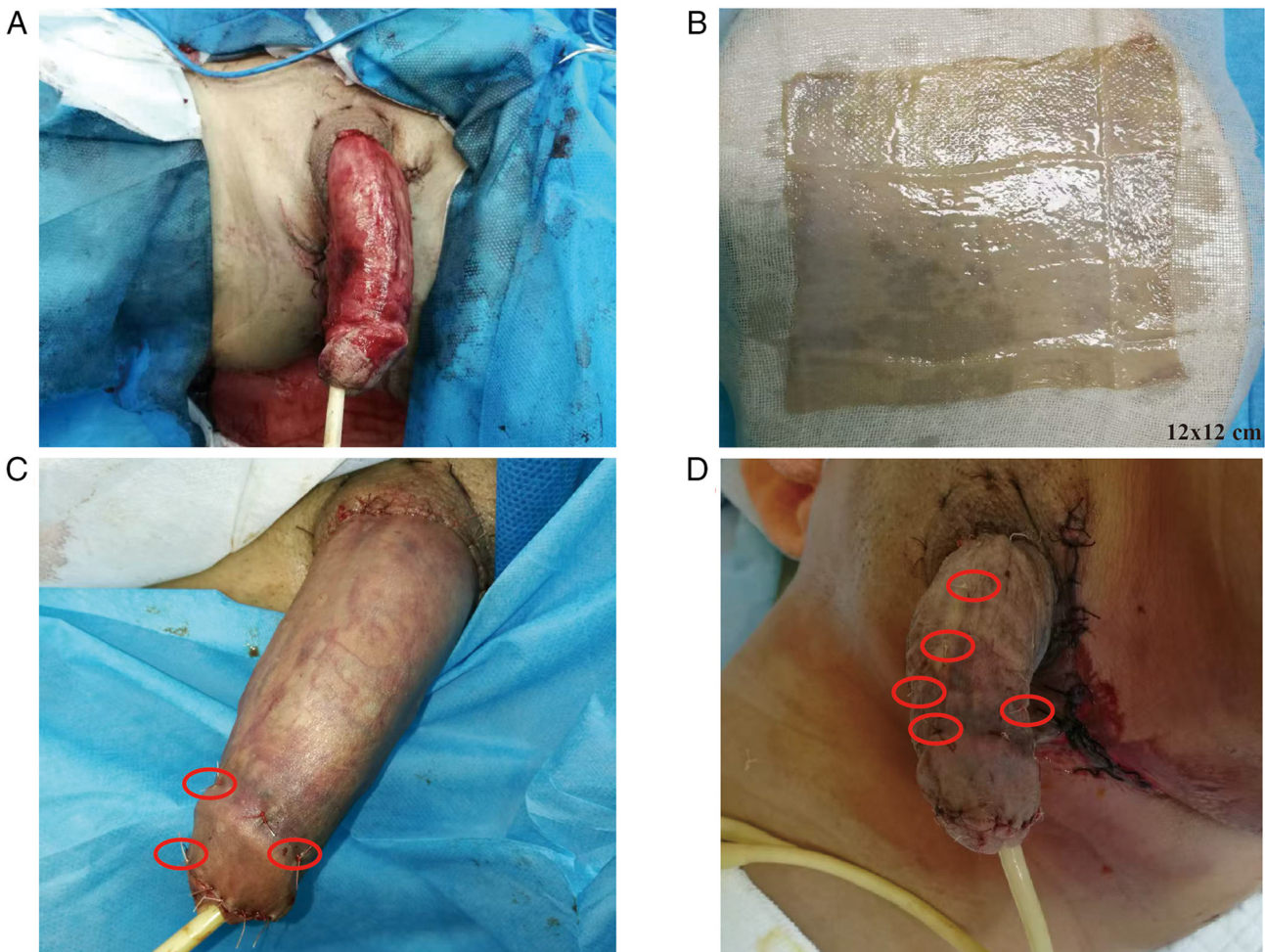


Figure 2. Intraoperative and postoperative findings of penile reconstruction using split-thickness skin grafting with multi-anchor fixation. (A) Massive penile skin defect of the penis before reconstruction. (B) 12x12 cm split-thickness skin graft harvested from right thigh. (C) Intraoperative multi-anchor fixation of the skin graft to the tunica albuginea. (D) Postoperative appearance of the reconstructed penis in the flaccid state.

mammals, which requires a temperature 4-5°C below core body temperature (18,19). In the present case, the right testis was temporarily relocated to a subcutaneous inguinal pouch due to extensive scrotal skin loss. The present case uniquely

employed skin grafting performed in the erect state combined with multi-point anchor fixation for penile degloving injuries, representing a promising solution for this rare and challenging condition.

The present case report has limitations. Follow-up data beyond 12 months and detailed photographic documentation of functional recovery were not available because of patient privacy concerns and psychological distress associated with the traumatic injury. Although the patient confirmed normal erectile function and satisfactory sexual performance at follow-up, the absence of standardized questionnaire-based assessments (such as the International Index of Erectile Function) and post-operative photographs represents a limitation that should be addressed in future studies. In conclusion, STSG combined with multi-anchor fixation represents a reliable reconstructive option for extensive penoscrotal degloving injuries. The multi-anchor technique addresses the unique biomechanical demands of penile reconstruction by securing the graft directly to the tunica albuginea, thereby preventing displacement and maintaining physiological compliance during erection.

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Availability of data and materials

The data generated in the present study are included in the figures and/or tables of this article.

Authors' contributions

ZO and PQ contributed equally to this work. ZO and SS were responsible for conceptualization. PQ and YX were responsible for collection of clinical data, including intraoperative records, postoperative follow-up and photographic documentation, and case analysis. ZO and PQ drafted the manuscript. SS supervised the study and revised the manuscript. ZO and PQ confirm the authenticity of all the raw data. All authors have read and approved the final version of the manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Written informed consent was obtained from the participant for the publication of personal and clinical details, as well as any identifying images, in the present study. The images are completely unidentified, and personal details are not mentioned in the text. The authors are accountable for all aspects of the work and for ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Competing interests

The authors declare that they have no competing interests.

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