

# Two laterally based scrotal pedicled flap grafts in the treatment of penile skin necrosis due to ring incarceration: a case series

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## Abstract

**Introduction:** The rise in the incidence of penile ring incarceration has led to additional cases of ischemic necrosis of the penile skin. Two laterally based scrotal pedicled flaps (LSPFs), noted for their rich blood flow and skin source, resemble penile skin and are the preferred donor sites for repairing such necrosis.

**Aims:** This study summarizes the outcomes of 2 LSPF grafts for the treatment of penile skin necrosis.

**Methods:** Data were collected from 5 patients with penile skin necrosis due to ring incarceration who sought treatment at Ankang Central Hospital between 2012 and 2023.

**Results:** All patients exhibited varying degrees of necrosis in the urethral corpus cavernosum and the penis's anterior tip. Two LSPFs were used for wound repair, with direct suturing of the donor site. None of the 5 patients experienced flap necrosis postsurgery, and they regained normal urination function. The patients reported satisfaction with both the aesthetic and functional results.

**Conclusion:** Two LSPF grafts are an effective approach for repairing penile skin defects. They reliably cover necrotic penile skin defects, prevent further wound progression, preserve penile structure, and improve patients' life quality.

**Keywords:** penile ring incarceration; penile skin defect; 2 laterally based scrotal pedicled flaps; wound repair; case series.

## Introduction

Penile ring incarceration, a rare urological emergency leading to ischemic necrosis of the penile skin and subsequent sexual dysfunction, has emerged in recent years.<sup>1,2</sup> Patients affected by this condition often delay seeking medical help due to privacy concerns, usually resulting in localized skin necrosis. The treatment approach is typically determined based on the extent and cause of the necrosis, as well as the patient's overall health.<sup>3</sup> Generally, treatment involves surgical debridement, antibiotic therapy, the use of healing-promoting medications, and in severe cases, skin full-thickness flap grafting with pedicle.<sup>4</sup> Managing extensive penile skin necrosis or defects while ensuring normal organ function is challenging. Importantly, because of the rarity of the relevant cases, there is a lack of standards or expert consensus on treatment.

Full-thickness flap grafting with pedicle, a surgical technique used for repairing tissue defects or wounds, relies on adequate blood supply, appropriate tension, and infection prevention for successful outcomes.<sup>5-8</sup> Notably, existing reports lack specific guidance on covering necrotic flaps of penile skin.<sup>9</sup> Generally, many physicians utilize axial flaps, such as the lower abdominal, inguinal, inner thigh, and scrotal flaps, to address penile skin necrosis or defects.<sup>9,10</sup> Additionally, skin grafting and superficial circumflex iliac artery perforator flap grafting have also been used to treat this condition.<sup>11-13</sup> However, the distinct skin characteristics of some donor sites

may lead to unsatisfactory graft results. Patients often seek both aesthetic and functional recovery, necessitating multiple surgeries and extended rehabilitation. Therefore, scrotal flap repair of penile skin defects has been proposed as a more suitable option for patients aligned with cosmetic needs.<sup>10</sup> Because the scrotal skin is closer to the skin of the receptor area, the two types of skin are more similar in appearance and function. Additionally, the advantages of using the scrotal skin as a donor site include high elasticity, ample availability, and ease of manipulation. Specifically, this donor site can be easily sutured due to low incisional tension, and scarring is minimal after healing. Moreover, separating the meatus tissue of the scrotum from the scrotal wall is relatively straightforward. Furthermore, the scrotal arteries are predominantly located within the musculus dartos layer, reducing the likelihood of injury during flap separation.<sup>14</sup> Consequently, scrotal flaps can be effectively utilized to repair large penile skin defects.

The primary scientific question to be addressed in this study pertain to the effectiveness and prognostication of grafting 2 laterally based scrotal pedicled flaps (LSPFs) in managing penile skin necrosis induced by ring incarceration. We hypothesized that the 2 LSPF grafts would effectively cover the wound and would not impede sexual function posthealing. This study aimed to summarize the outcomes of 2 LSPF grafts for treating penile skin necrosis. To achieve this goal, pertinent data pertaining to 5 patients with penile skin necrosis

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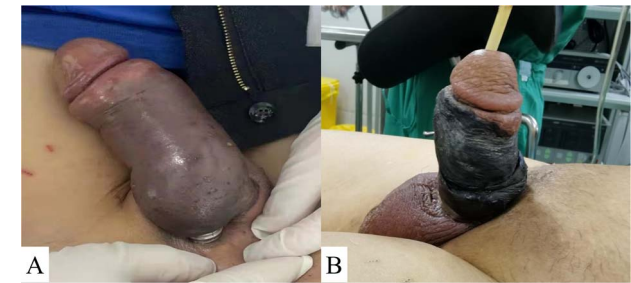
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**Table 1.** General information of 5 patients with penile skin necrosis.

Case	Age (y)	Body mass index (kg/m <sup>2</sup> )	Materials of rings	Necrosis time (d)	Skin defect area (cm <sup>2</sup> )	Penile cavernous body injury	Urethral cavernous injury	Staged surgery	Interval between stage 1 and 2 surgeries (d)
1	48	22.79	Metal	6	10.2	Yes	No	Yes	3
2	52	22.79	Metal	3	11.34	No	No	Yes	4
3	68	20.06	Plastic	7	9.68	No	Yes	Yes	3
4	61	25	Plastic	4	8.76	No	Yes	Yes	5
5	58	25.6	Metal	8	11.68	Yes	No	Yes	4



**Figure 1.** Representative photos of the injury in a patient. (A) Penile skin necrosis caused by ring incarceration. (B) Tissue necrosis after removal of the ring.

or defects who sought care at the Department of Urology at Ankang Central Hospital between 2012 and 2023 were collected. Given the limited case availability and the intricate nature of the treatment, this study sought to qualitatively delineate the treatment procedures and particulars. Furthermore, an evaluation of the patients' postoperative contentment regarding both the aesthetic outcome and functional recuperation was conducted.

The study was conducted after patients provided signed informed consent and was approved by the Clinical Research Ethics Committee of Ankang Central Hospital (2023, No. 042).

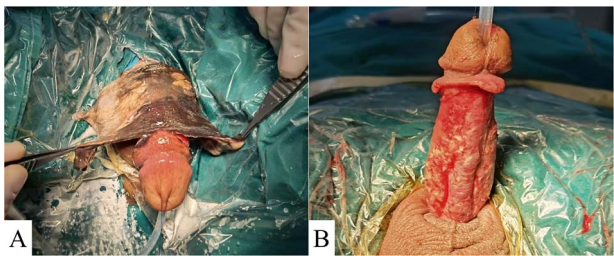
## Description of the cases

### Patients' characteristics and clinical diagnosis

From 2012 to 2023, the department treated 5 patients with confirmed penile skin necrosis (Table 1). These patients, 48 to 68 years of age, had no major mental disorders or genetic diseases, and routine blood tests showed no significant abnormalities. All patients had surgical indications, with penile ring incarceration as the underlying cause in each case (Figure 1A). When the skin defect size exceeded 70%, ischemic necrosis due to local blood circulation disorders was identified as the causative factor (Figure 1B). Among the patients, 3 had wounds affecting only the skin and tunica albuginea, while 2 had wounds extending to the skin, tunica albuginea, and a portion of the corpus cavernosum. Additionally, 2 patients exhibited involvement of the skin, tunica albuginea, a segment of the corpus cavernosum, and the urethra.

### Surgical approach and procedure

The treatment utilized a staged surgical approach. Upon admission, all patients underwent emergency debridement, involving necrotic tissue removal and skin trimming at the

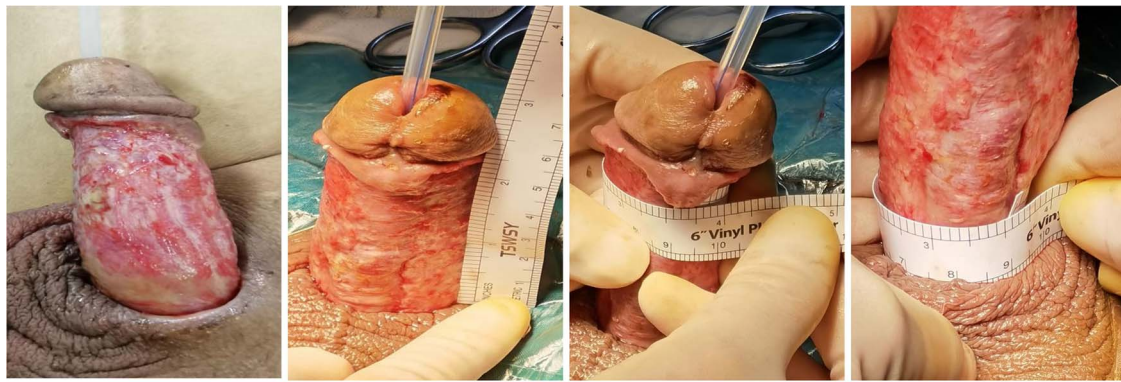


**Figure 2.** Representative photos of tissue debridement. (A) Clearance of necrotic tissue; (B) after debridement.

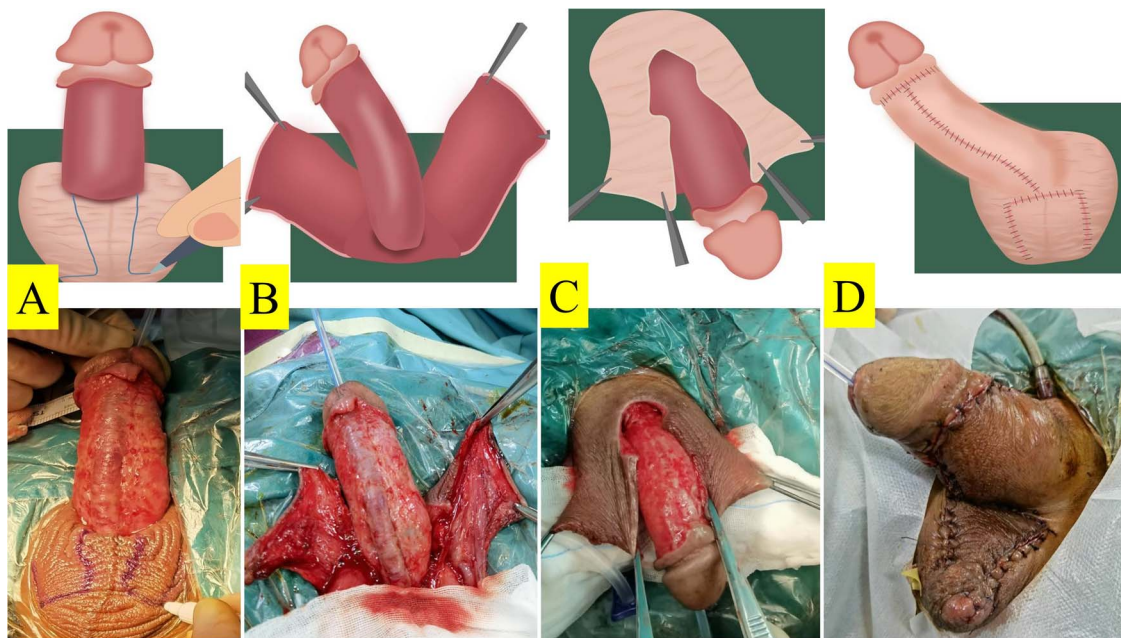
trauma margin (Figure 2A). Subsequently, a moisturizing dressing was applied to the exposed wounds (Figure 2B). The dressing was then changed as scheduled, and the wounds were observed for the recovery of granulation tissue growth. Apart from the first debridement and the second flap graft, the patient did not undergo any other surgical treatment.

The second-stage surgery was performed approximately 3 days after the debridement. Prior to surgery, a flap was designed to match the defect area, as assessed during penile erection (Figure 3). The length and width of the bilateral flaps were measured, setting the flap's transverse width at half of the penile skin defect's circumference and aligning its longitudinal length with the defect's length. Additionally, the bilateral flap tips were positioned on both sides of the scrotum, utilizing the medial branches of the bilateral anterior scrotal arteries as vascularized tips to supply blood to the flaps. In accordance with the principle of designing a flap with vascular tips, the flap was structured along the vascular pathway. The width of the flap tips typically ranged from 1.0 to 2.0 cm.

During the second-stage surgery, general anesthesia was administered, and the following specific steps were undertaken: (1) placement of a urinary catheter and thorough flushing of the wound in the penile scrotum with hydrogen peroxide and saline; (2) the skin at the margin of the wound was trimmed to expose the fresh wound (Figure 4A); (3) separation of the sarcoplasmic layer along the anterior side of the scrotum bilaterally; (4) free flaps were created on both sides based on the designed flap size (Figure 4B); (5) the flap was cut and transferred to both sides of the penis for penile flap reconstruction, ensuring that the dorsoventral penile skin could cover the penis without tension (Figure 4C); (6) placement of a drainage tube in the traumatized scrotum with external negative pressure equipment; (7) the wound surface was inspected for blood leakage, and the layers of tissue were intermittently sutured; (8) the penis was wrapped with sterile gauze and an elastic bandage and it was ensured



**Figure 3.** The designing of the flap based on the area of the traumatic defect during penile erection.



**Figure 4.** Schematic diagram of the surgery. (A) Design of the skin flap. (B, C) Lifting of the flap and its coverage of the penile body. (D) Overview of the wound suturing and negative pressure drainage.

that there was no tension on the penile flap with adequate blood flow, and a paracutaneous drainage strip was placed in the lowest position of the scrotal flap; and (9) the scrotal donor area was sutured (Figure 4D). Postoperatively, oral estradiol valerate tablets (1 mg/d for 14 days) are required to prevent painful erections, wound dehiscence, and other complications.

### Postoperative evaluation and complications

Following surgery, all patients exhibited favorable outcomes regarding the color, texture, sensation, and shape of the flaps. No edema was observed in the flap, and both the donor and recipient area incisions healed normally. Subsequently, a 6-month follow-up was conducted for all patients (Figure 5A-5D). The participants completed the sexual function score (5-item International Index of Erectile Function [IIEF-5]) measurement,<sup>15</sup> and the preoperative and postoperative controls revealed no statistically significant differences ( $22.8 \pm 1.6$ ;  $P > .05$ ). Furthermore, no patients developed severe urethral fistula, urethral stricture, scrotal deformation, or prominent scarring. All patients reported satisfaction with the appearance of the penis. In case 3, a severe urethral corpus

cavernosum defect was observed, along with urethral tube exposure. Despite a urinary fistula remaining in the penile coronal region after repair, the patient was able to urinate in an upright position. Case 5 presented with necrosis of the anterior two-thirds of the penile body and severe ischemia of the urethral corpus cavernosum. This patient developed a urethral stricture 4 weeks postsurgery. Normal urination was restored after urethral dilatation.

### Discussion

The treatment of large ischemic necrosis of penile skin typically involves wound debridement and free flap grafting. Some experts recommend that such complex wound repair should aim to restore the functionality and appearance of the recipient and donor areas as closely to the original state as possible.<sup>16</sup> However, this approach is often challenging due to significant variations in skin appearance and texture across different body regions. In this case series, all 5 patients were treated with 2 LSPF grafts to ensure normal organ appearance and function, providing evidence and insights for relevant surgical protocols.



**Figure 5.** Postoperative flap healing and penile appearance. (A) Three days postsurgery. (B) Six days postsurgery. (C) One month postsurgery. (D) Six months postsurgery.

The primary rationale for choosing 2 LSPFs for grafting is their ability to preserve organ function and appearance. While full-thickness skin flaps have been successfully used in many reports, scar contracture postgrafting may impede penile erection. Furthermore, skin flap grafts such as medial thigh, inguinal, and lower abdominal flaps are often utilized in repairing penile skin defects to better maintain skin elasticity, sensation, and color.<sup>9,10,17</sup> However, these flaps, when wrapped circumferentially around the penis, are large and can interfere with the patient's sexual life.<sup>18</sup> Xie et al<sup>19</sup> suggested that scrotal skin and penile skin share similar thicknesses; both lack a fat layer, and scrotal skin has less hair growth, suggesting that it is more akin to the original penile skin in appearance and color. Additionally, the scrotal skin has homologous innervation with penile skin, and patients report greater satisfaction with their penile appearance and sexual experience after surgery.<sup>4</sup> Therefore, the application of a scrotal skin flap can yield better functional and aesthetic results.

A significant factor in choosing a scrotal flap is its rich blood supply. The scrotum receives blood from 4 arteries on each side: the anterior scrotal artery, the lateral scrotal artery, the lateral branch of the posterior scrotal artery, and the septal scrotal artery. These arteries collectively form a robust, multisource blood supply system to the scrotal skin, resulting in a low incidence of ischemic necrosis in bilateral scrotal flaps with tips.<sup>20</sup> The medial branches of the anterior scrotal artery, originating from the penile root, traverse within the musculus dartos layer and anastomose near the scrotal median suture, providing the flap with abundant blood flow and high viability.

This study has several limitations. First, the small sample size and lack of controlled analytical data limit the scope of conclusions. Second, the short follow-up period leaves the long-term effects of this treatment uncertain. Third, it is uncertain whether there are better alternatives, such as biomaterials. Thus, more comprehensive follow-up data are necessary for future studies.

## Conclusion

The use of 2 LSPF grafts has several advantages in the treatment of penile skin defects, including reliable efficacy, an aesthetically pleasing postoperative appearance, minimal impact on sexual function, a high graft survival rate, and minimal significant complications. Moreover, the equipment required for the procedure is commonly available in primary hospitals. Therefore, this treatment approach can be regarded as a feasible and effective clinical option for penile skin defect surgery.

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## Author contributions

This study was done independently by J.X.

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None.

## Conflicts of interest

The author has no conflicts of interest to declare.

## Data availability

The data that support the findings of this study are available from the corresponding author.

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