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Research Article

Urethroplasty with Penile Skin Flaps A portrait from Sudan

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Abstract

Background: Urethral stricture, a common urological condition, involves the narrowing of the urethral lumen, often resulting from diverse aetiologies and impacting various segments of the urethra, broadly categorized as anterior or posterior. The surgical management of urethral strictures has advanced significantly, with numerous augmentation techniques and tissue sources available. Among these, skin flap urethroplasty is a well-established technique for managing long anterior urethral strictures, owing to the versatility and flexibility of skin, which allows for substantial length reconstruction in complex repairs. This study aimed to evaluate the functional outcomes, safety, and operative ease of using penile skin for augmented urethroplasty in patients with anterior urethral strictures.

Methods: This retrospective study included 30 patients who underwent augmented urethroplasty with a penile skin flap for anterior urethral strictures in Khartoum State in Sudan between 2019 and 2022. All procedures were performed by a single senior urology consultant. Patients underwent comprehensive preoperative assessment and subsequent postoperative follow-up, which included physical examination, urinalysis, and urethrograms. Treatment success was defined as the absence of any further intervention for stricture recurrence.

Results: The overall success rate of penile skin flap urethroplasty in this cohort was 90%. Patient satisfaction regarding urine flow was high, reaching 96.7%. Stricture recurrence occurred in two patients (6.7%), both successfully managed with direct visual internal urethrotomy (DVIU). One patient (3.3%) developed a urethrocutaneous fistula, which was subsequently repaired surgically.

Conclusion: Penile skin flap urethroplasty presents a favorable option for the reconstruction of anterior urethral strictures. Its advantages include ease of harvest, tissue versatility, and the potential to mitigate the additional morbidity associated with alternative graft sites (e.g., buccal mucosa harvest, which can necessitate general anesthesia and prolonged fasting). While our findings are encouraging, future randomized controlled studies are essential to minimize bias and further validate these results.

Keywords: Urethroplasty; penile skin flap; urethral stricture; anterior urethra; underserved setting

Introduction

Urethral stricture disease, characterized by the pathological narrowing of the urethral lumen, poses a significant challenge in urological practice, impacting patient quality of life and often necessitating surgical intervention [1]. The etiology of urethral strictures is diverse, encompassing trauma, iatrogenic injury (e.g., catheterization, endoscopic procedures), infection, and inflammatory conditions such as lichen sclerosus [2,3]. Anatomically, strictures are classified into anterior (penile and bulbar urethra) and posterior (membranous and prostatic urethra) segments, with anterior strictures being more common [4]. Historically, management strategies for urethral strictures have evolved from simple dilation and internal urethrotomy, which often yield suboptimal long-term success rates, particularly for longer or recurrent strictures [5]. The current gold standard for definitive management of urethral stricture disease is urethroplasty, a reconstructive surgical approach that aims to restore normal urethral caliber and function [6]. Urethroplasty techniques can be broadly categorized into excisional anastomotic repairs for short strictures and substitution urethroplasty using grafts or flaps for longer segments [7].

Among the various substitution techniques, skin flap urethroplasty has a long history and remains a viable option, particularly for extensive anterior urethral strictures [8]. Early pioneers such as Thiersch and Duplay in the 19th century laid the groundwork for using local skin to reconstruct the urethra, with later contributions by Browne and others refining these techniques [9]. Penile skin, especially the prepuce or distal shaft skin, is a preferred donor site due to its inherent characteristics: it is hairless (reducing the risk of hair-in-urethra complications like stone formation and infection), accustomed to a moist environment, highly adaptable, and offers good cosmetic outcomes [10]. The rich vascular supply of penile skin, typically derived from the external pudendal artery, allows for the creation of robust pedicled flaps that can be mobilized to reconstruct significant urethral defects [11]. The Orandi, McAninch, and transverse preputial flap techniques are notable examples of penile skin flap urethroplasties, each adapted to specific stricture characteristics and locations [12,13].

While buccal mucosa grafts (BMG) have gained considerable popularity in recent decades due to their ease of harvest, favorable tissue characteristics, and low donor site morbidity, penile skin flaps offer distinct advantages for certain cases, particularly for long or complex strictures where a well-vascularized, large-volume tissue is required [14,15]. Some studies have directly compared penile skin flaps with buccal mucosa grafts, showing comparable success rates but highlighting different sets of potential complications and operative considerations [16]. For instance, a prospective randomized study comparing local penile skin flap and buccal mucosal graft urethroplasties reported high success rates for both (93.7% for LPF and 94.4% for BMG) but noted longer operative times and slightly higher donor site morbidity with BMG, while LPF showed a higher incidence of penile curvature [17]. Another comparative study found a higher incidence of surgical site infection in the preputial skin flap group compared to the buccal mucosa graft group, along with longer average operative times for flaps [18].

The success rates for penile skin flap urethroplasty reported in the literature are generally encouraging, with many studies reporting outcomes ranging from 70% to over 90% [11,19]. For example, a study investigating the use of dorsal penile skin flap for anterior urethral strictures reported an overall success rate of 88% with a mean follow-up of 60 months [11]. Recurrence remains the most common complication, often managed by less invasive procedures like direct visual internal urethrotomy (DVIU) [20]. Other complications, though less frequent, can include urethrocutaneous fistula, wound infection, and changes in penile aesthetics [5,11]. The current study's findings of a 90% overall success rate and high patient satisfaction with urine flow (96.7%) align well with the published literature, reinforcing the efficacy of penile skin flap urethroplasty for anterior urethral strictures. The reported recurrence rate of 6.7% and fistula rate of 3.3% are also within the expected range for this type of reconstructive surgery [5,11]. The ease of harvest and versatility of penile skin, as highlighted by the authors, are well-recognized advantages that contribute to its continued use in urethroplasty [10].

Despite the promising outcomes, the treatment of urethral strictures, particularly long and complex ones, remains challenging [21]. While retrospective studies like the current one provide valuable insights into real-world outcomes, the need for high-level evidence from randomized controlled trials (RCTs) is crucial to minimize bias and further solidify the comparative efficacy and safety of different urethroplasty techniques, as acknowledged by the authors [22]. Future research should also focus on comprehensive patient-reported outcome measures (PROMs) to fully capture the impact of urethroplasty on quality of life, beyond purely anatomical success [23].

The Objectives of this study are:

a) To evaluate the functional outcomes of penile skin flap urethroplasty for anterior urethral strictures in an underserved setting.

b) To assess the safety profile of penile skin flap urethroplasty, including complication rates such as recurrence and fistula formation.

c) To determine the operative ease and practical advantages of utilizing penile skin flaps for anterior urethral reconstruction.

d) To ascertain patient satisfaction with urine flow following penile skin flap urethroplasty.

Patients and Methods

Study Design and Patient Selection

This retrospective cross-sectional study analyzed data from patients who underwent skin flap urethroplasty between May 2019 and September 2022. The study was conducted at a hospital in Khartoum State.

Inclusion Criteria

We included all patients who underwent skin flap augmentation for urethral stricture disease. This encompassed cases where sole augmentation was performed, as well as those involving adjuvant excision of an obliterative segment (Russell's technique).

Exclusion Criteria

Patients were excluded if they had inadequate data, were lost to follow-up, or refused to participate in the study.

Preoperative Assessment

All patients underwent a comprehensive preoperative evaluation, including a detailed medical history, physical examination, and routine laboratory investigations (complete blood count and renal function tests). A urethrogram was performed on all patients preoperatively to accurately assess the stricture length, location, degree of spongiofibrosis, and to identify the presence of multiple strictures.

Surgical Procedure

Patients undergoing urethroplasty for penile strictures were positioned supine, while those with bulbar or peno-bulbar strictures were placed in the lithotomy position. Spinal anesthesia was administered to all patients; for longer procedures, general anesthesia was supplemented following the spinal block. A suprapubic catheter was placed in patients who did not have one preoperatively.

Different surgical techniques were employed based on the stricture characteristics:

a) Orandi's Technique: This technique was primarily used for penile urethral strictures. After the stricture urethra was laid open, an additional 0.5-1 cm of apparently healthy urethra was opened proximally and distally. The length of the planned flap was measured. A longitudinal incision was made in the penile skin adjacent to the stricture (Figure 1A), and the flap was raised, flipped over the urethra, and sutured over a 14 Fr catheter using 4/0 Vicryl (Figure 1B). The wound was then closed (Figure 1C).

b) McAninch Technique: A circular flap was harvested from the distal penile skin, approximately 2 cm from the corona (Figure 2A). The flap was raised and mobilized to ensure adequate reach and flexibility (Figure 2B). The penis was then degloved, and the stricture was opened over a guide wire or ureteric catheter, preserving a margin of healthy urethra. For bulbar strictures, scrotal transposition of the flap was performed (Figure 2C). The flap was then sutured to one edge of the stricture, flipped over the catheter, and secured to the other edge.

c) Transverse Preputial Flap: A transverse patch of penile skin, along with its dartos fascia, was incised and raised. The flap was dissected to ensure free mobilization without compromising its blood supply. The stricture was opened, and the flap was sutured to one edge of the urethra, flipped over a 14 Fr catheter, and then sutured to the opposite edge. The wound was subsequently closed (Figures 3A-3C).

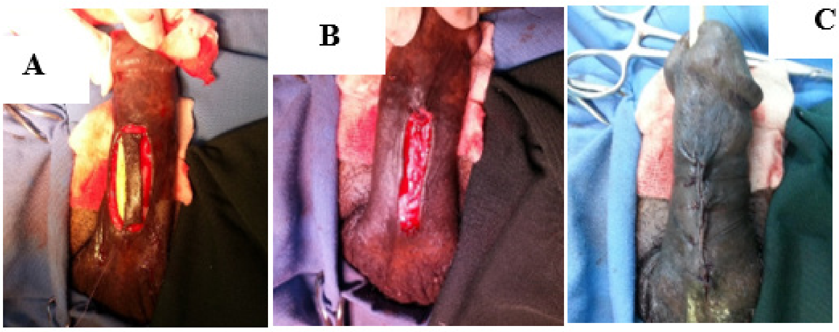

Figure 1: Orandi's flap harvesting, suturing and closure.

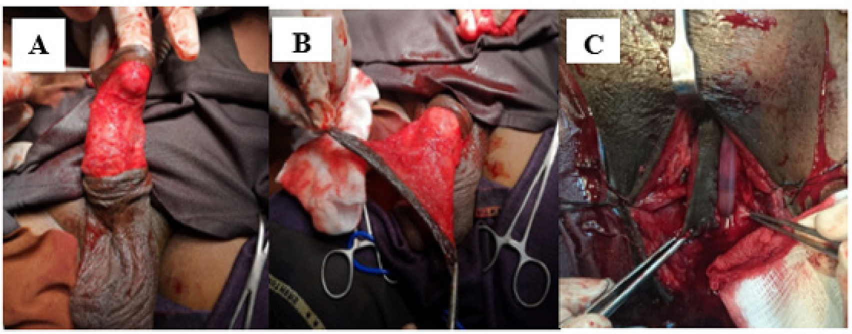

Figure 2: McAninch flap Harvesting, Mobilization and suturing.

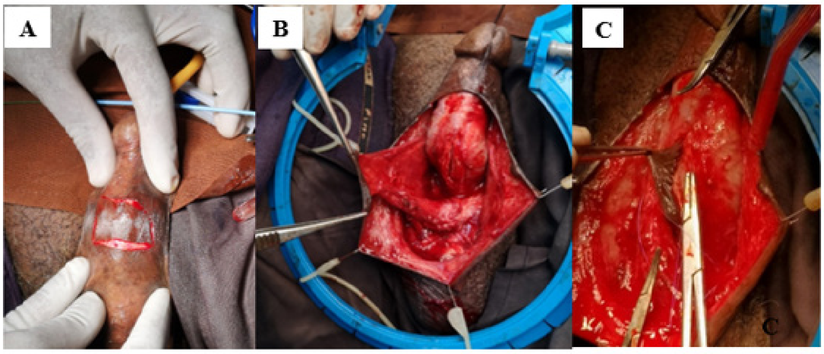

Figure 3: Transverse Prepucial Flap harvesting, mobilization and suturing.

Postoperative Care

Patients were typically discharged on the third postoperative day with injectable antibiotics and analgesia. Scrotal support was provided to patients who underwent a perineal approach for bulbar strictures. The urethral catheter was removed on the third postoperative week, provided that a peri-catheter urethrogram demonstrated complete healing and no extravasation.

Outcome Evaluation

Treatment success was defined as the absence of stricture recurrence at any point during follow-up, no further need for instrumentation (e.g., dilation), and patient satisfaction with urine flow. Patients were followed up through a combination of history taking and structured questionnaires. A urethrogram was performed for all patients at 3 weeks postoperatively. Subsequent urethrograms were requested only if clinically indicated. Follow-up appointments were scheduled at 3 months, 6 months, and 1 year after surgery, and annually thereafter.

Ethical Considerations

The study proposal received approval from the scientific committee of the local urology council. Permission was obtained from the hospitals where the patients received treatment. Verbal or written consent (when appropriate) was obtained from all participating patients. All collected data were handled with strict adherence to patient confidentiality.

Results

Demographics

This study included 30 male patients who were followed up to a complete one year for anterior urethral strictures. The mean age of the cohort was 30.0 years (SD ± 2.4), with an age range of 10 to 54 years. A significant majority of the patients, 40 (93%), were over 18 years of age. The surgeries were performed across four different hospitals in Sudan

a) Stricture Characteristics: The mean stricture length was 4.633 ± 3.261 cm Figure 4. The majority (16; 53.3%) of patients had a stricture involving the penile urethra, followed by those with stricture involving both the penile and peno-bulbar areas (7; 23.3%), as shown in Table 1. Most strictures (50%) were of iatrogenic origin, recurrent infection accounted for 5 (16.7%), 2 strictures (6.7%) were traumatic, while 8 (26.7%) were idiopathic (Table 2). Fifteen (50%) of patients had no previous treatment for their strictures, 6 (20%) underwent DVIU more than once, 4 (13.3%) had it once, 2 (6.7%) had dilatation once, while 3 (10%) had undergone a previous urethroplasty.

Table 1: Cause of stricture.

Iatrogenic	15 (50)
Traumatic	2 (6.7)
Recurrent infection	5 (16.7)
Idiopathic	8 (26.7)

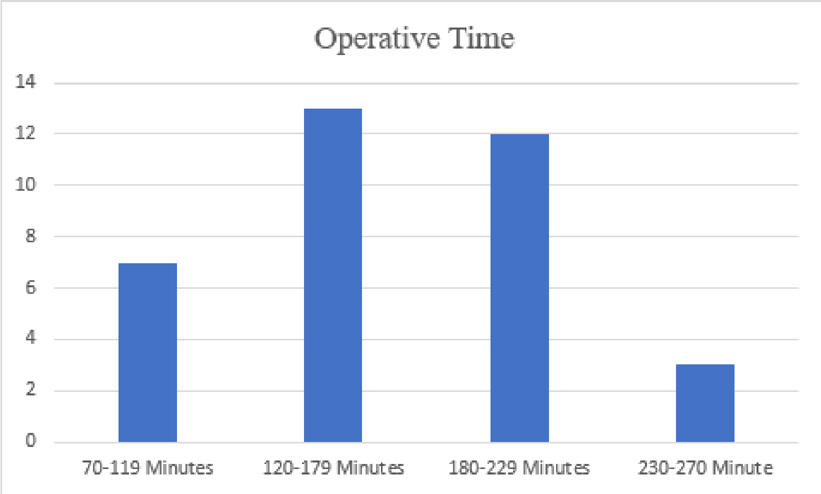

Figure 4: Operative time.

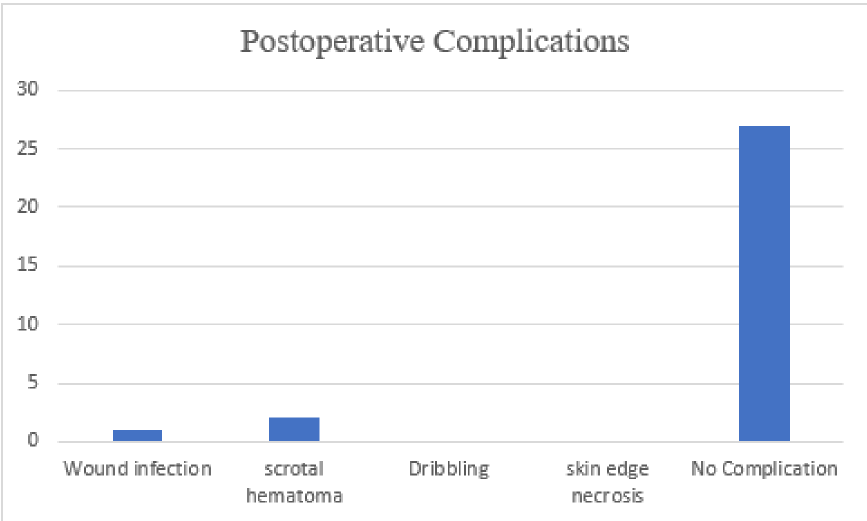

Figure 5: Postoperative Complications.

b) Operative information: The average operative time was 165.11 minutes (range, 70-270 Minutes) (Figure 5). The McAninch flap was used in 20 operations (66.7%), Orandi's flap in 3 (10%) patients, while the transverse preputial flap was used in 7 (23.3%) patients (Table 3). A very narrow or obliterated segment of urethral stricture was excised, and then the edges of the stricture urethra were anastomosed. The resultant plate was augmented with the skin flap as in "Russel's technique (Table 4). This was done in 20 patients (66.7%). Blood was transfused for only one patient. Scrotal hematoma developed in 2(6.7%) patients, while one patient (3.3%) suffered from wound infection. The average follow-up was 27.83 months (range 12-5 months).

c) Outcome-One-Year Follow-Up: The satisfaction with the urine stream was 86.7% delighted, 6.7% Satisfied. One patient (3.3%) suffered from a fistula, which was managed by urethroplasty, and another (3.3%) suffered from re-stricture, which DVIU managed. Only two patients (6.7%) required straining to initiate urination (Figures 6&7).

Overall complications after one year (Figure 6)

The overall success rate was 90%. Two patients (6.7%) suffered from recurrence of stricture and were managed by DVIU, and one (3.3%) suffered from fistula, which was treated by urethroplasty. Regarding immediate post-operative complications, three patients (10%) developed complications (Hematoma & wound infection). This is a short-to-medium-term study, and further follow-up is required to obtain more solid results.

Table 2: Etiology and location of strictures.

Stricture Characteristics	
Stricture location	Frequency (%), n=30
Penile	16 (53.3)
Bulbar	7 (23.3)
Peno-Bulbar	7 (23.3)

Table 3: Operative technique.

Type of Flap	Frequency (%), n=30
McAninch	20 (66.7)
Orandi	3 (10)
Transverse Prepucial	(23.3)

Table 4: Russel's technique.

Russel's Technique	Frequency (%), n=30
Used	20 (66.7)
Not Used	10 (33.3)

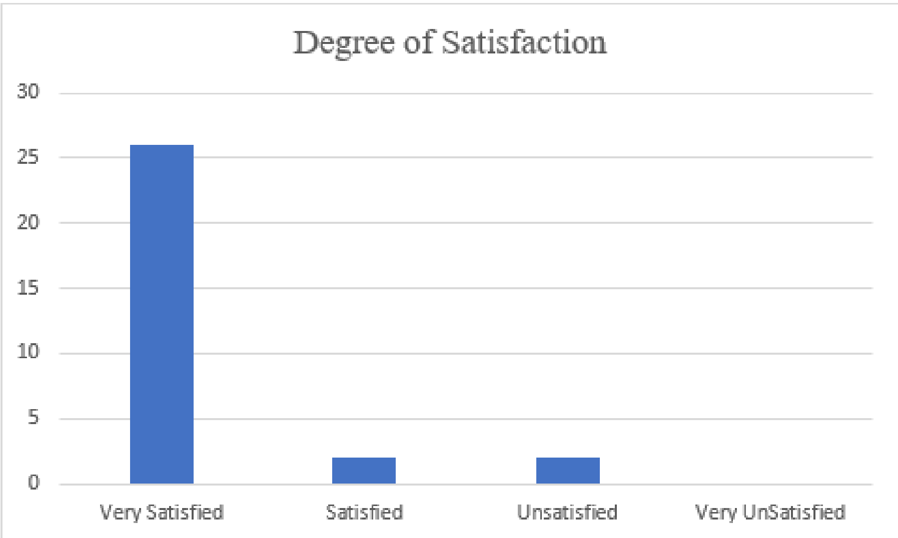

Figure 6: Urine flow after 1 Year.

Discussion

Preamble

Urethral stricture disease, a debilitating condition characterized by the narrowing of the urethra, significantly impacts urinary flow and quality of life. Surgical reconstruction, or urethroplasty, remains the gold standard for durable repair. Among the various reconstructive techniques, skin flap urethroplasty has historically played and continues to play a pivotal role, particularly for longer or more complex strictures where simple excision and primary anastomosis are not feasible. This approach involves transferring a segment of skin, along with its inherent vascular supply (pedicle), to reconstruct the narrowed urethral segment. The presented study investigated the functional outcomes, safety, and operative ease of using penile skin for augmented urethroplasty in 30 patients with anterior urethral strictures, reporting an encouraging 90% overall success rate at one-year follow-up. These findings contribute to the growing body of evidence supporting the use of penile skin flaps in urethral reconstruction. This discussion will interpret these results within the context of current literature, address the study's implications, and highlight areas for future research.

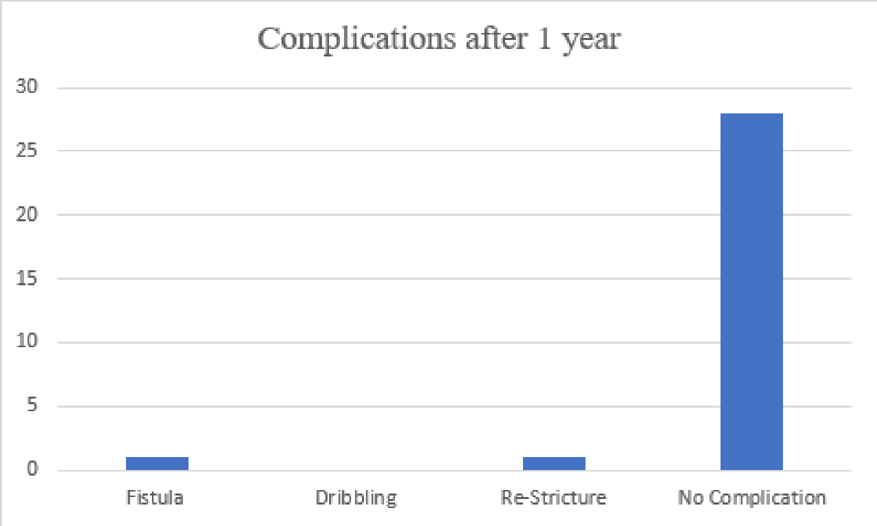

Figure 7: Complications after 1 year.

Flaps techniques

The reported 90% success rate at one year aligns favorably with contemporary outcomes for anterior urethroplasty using various skin flap and graft techniques, which generally range from 80% to 95% [24,25]. Penile skin, particularly preputial and penile shaft skin, has long been recognized as an excellent substitute material for urethral reconstruction due to its hairless nature, elasticity, and robust vascular supply, especially when fashioned as a pedicled flap [26,27]. The study's employment of established techniques such as Orandi's, McAninch's, and the transverse preputial flap reflects standard surgical approaches in reconstructive urology [28,29]. The predominance of the McAninch flap (66.7% of operations) and the application of augmentation over an excised stricture segment ("Russell's technique") suggest an adaptive approach to stricture characteristics, which is crucial for optimal outcomes in complex urethral pathologies [30]. The choice of skin flap depends on the stricture's location, length, and the availability of suitable tissue.

Complications and Outcomes

The low incidence of complications – two scrotal hematomas (6.7%) and one wound infection (3.3%) – is commendable and consistent with the relatively low morbidity associated with well-executed penile skin flap urethroplasties [31]. While the study observed a 6.7% recurrence rate and one fistula (3.3%), these figures are within the acceptable range for urethral reconstructive surgery. Fistula formation, though uncommon, is a recognized complication of urethroplasty, particularly in cases with compromised tissue or extensive dissection [32]. The management of recurrences with direct visual internal urethrotomy (DVIU) reflects a common initial strategy, although repeat urethroplasty is often required for durable results [33].

The average operative time of 165.11 minutes is within the expected range for complex reconstructive procedures, varying based on stricture length, location, and the specific flap technique employed [34]. The demographic data, with a mean age of 30 years and a significant proportion of strictures being iatrogenic (50%), is also typical of patient cohorts presenting with anterior urethral stricture disease, where instrumentation and previous interventions are common etiologies [35].

Implications of the Study

The findings raised the score of the viability and effectiveness of penile skin flaps as a primary reconstructive option for anterior urethral strictures, even in diverse poor surgical settings across Sudan. The consistent success rate across different centers, albeit within a limited sample, suggests that these techniques can be reliably implemented with appropriate surgical expertise. The low complication profile further reinforces the safety of using local penile tissues, minimizing the need for more complex or distant tissue transfers that might carry higher morbidity. For regions with limited access to advanced techniques or specialized materials, the reliance on readily available penile skin represents a practical and sustainable solution for managing a prevalent urological condition. The study implicitly supports the continued training and adoption of these established flap techniques in surgical residency programs.

The Enduring Value of Skin Flaps in Developing Regions

Skin flap surgery presents a compelling and often superior reconstructive solution in the developing world. Its advantages are particularly pronounced in settings where advanced medical infrastructure and resources may be limited. One significant benefit lies in the typical requirement for spinal anesthesia. This eliminates the need for complex nasal intubation services, which are often unavailable or underdeveloped in resource-constrained areas. Furthermore, the cost of anesthetics for spinal procedures is generally lower, directly addressing major financial concerns in these regions. Beyond the practicalities of anesthesia and cost, the efficacy of skin flaps holds its own against alternative graft materials. While buccal mucosal graft (BMG) is a common choice, high rates of snuff use in some populations can severely compromise its suitability and outcomes. In such situations, the reliability of skin as a reconstructive material becomes even more critical. Indeed, many reconstructive surgeons firmly maintain that skin is not inferior to BMG in its reconstructive capabilities, and in certain contexts, it may even be the preferred option. Despite its positive findings, the study possesses several limitations that warrant consideration and guide future research. The small sample size (n=30) significantly limits the statistical power and generalizability of the results to a broader population, or to specific stricture subtypes. Larger, multi-center studies are essential to validate these findings and provide more robust evidence.

Conclusion and Recommendations

The presented study provides encouraging short-to-medium-term outcomes for penile skin flap urethroplasty in the management of anterior urethral strictures, demonstrating a high success rate and low complication profile. These findings reinforce the value of established penile skin flap techniques in reconstructive urology, particularly in resource-diverse settings. However, to strengthen the evidence base, future research should focus on conducting larger-scale, prospective studies with extended follow-up periods, comparative designs, and the inclusion of comprehensive, objective, and patient-reported functional outcome measures. This will ensure a more robust understanding of the long-term efficacy and patient benefit of penile skin flap urethroplasty.

Ethical Clearance

The study protocol was reviewed and approved by the Scientific Committee of the Urology Council. Institutional permission was obtained from all hospitals where patient data were collected. All participants provided informed consent (verbal or written, as appropriate) prior to their inclusion in the study. All patient data were handled with strict confidentiality and in accordance with ethical guidelines for research involving human subjects. Nothing to be disclosed by the authors.

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