Central European Journal of Urology

ORIGINAL PAPER

TRAUMA AND RECONSTRUCTIVE UROLOGY

Management of urethral complications after total phallic reconstruction: a single center experience

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Citation: Abdel-Rassoul M, El Shorbagy G, Kotb S, Alagha A, Zamel S, Rammah AM. Management of urethral complications after total phallic reconstruction: a single center experience. Cent European J Urol. 2024; 77: 310-319.

Article history
Submitted: July 28, 2023
Accepted: Feb. 9, 2024
Published online: March 15, 2024

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Introduction The aim of this study was to evaluate the outcomes of different urethroplasty procedures as well as two novel techniques, invented in our center, in management of urethral complications after total phallic reconstruction.

Material and methods Different urethroplasty procedures were conducted according to the urethral pathology for 36 cis-male patients with urethral complications after total phallic reconstruction including meatoplasty, visual internal urethrotomy, staged Johanson urethroplasty utilizing either buccal mucosal graft or skin graft (Tiersche-Duplay principle), non-transecting urethroplasty (Hieneke-Miiklulicz principle), excision and primary anastomosis, as well as two novel techniques: urethral closure under a suprapubic tunnel and abdominal pedicled skin flap urethroplasty. Each patient was routinely evaluated one month after surgery and every 3 months for 12 months, with clinical evaluation, uroflowmetry and post-void residual urine.

Results With a total of 41 procedures for the 36 patients, 32 patients (88.8 %) could eventually void while standing. The success rate was highest for staged Johanson urethroplasty using split thickness skin graft, staged abdominal pedicled skin flap and excision and primary anastomosis, respectively, while it was lowest for visual internal urethrotomy (0% success) and non-transecting anastomotic urethroplasty (50% success). For staged versus one-stage procedures prospective analysis, 17 out of 26 one-stage procedures (65.4%) succeeded while 13 out of 15 staged procedures (86.6%) succeeded.

Conclusions Urethral complications following phalloplasty require complex procedures demanding a high level of surgical expertise. Abdominal pedicled skin flap urethroplasty is a viable option for long and recalcitrant urethral strictures.

Key Words: phalloplasty ‹› urethral complications ‹› urethroplasty ‹› buccal mucosal graft

INTRODUCTION

Phalloplasty was first described in 1936 for war-injured patients by Nikolai Bogoraz and as a gender reassignment surgery by Gillies and Harrison in 1948 [1, 2].

This procedure was based on a random-pattern flap enclosing a tube-within-tube flap over the suprapubic area enabling voiding through a proximal urethrostomy. The goal of the created phallus had been limited to satisfy the body image expectations and to achieve penetrative sexual intercourse. This technique had remained the "state of the art" over the following 40 years until Orticochea described the first total phallic reconstruction (TPR) in 1972. With the newer technique, a urethral tube extending from the native urethra to a distal urethral meatus was created enabling the patient to void while standing.

Regrettably, due to high urethral complications rates, particularly strictures and fistulas, some

surgeons abandoned urethroplasty after TPR; which renders the procedure once again merely an external genitalia construction or reconstruction [3].
Although the incidence of urethral complications following phalloplasty has been decreasing over the last decades [4], there is still a lack of information in the literature about the ideal management of these complications. In this study, we attempted to assess the surgical outcome of different urethroplasty procedures and the outcome of two novel techniques, invented in our center, as a primary endpoint. The secondary endpoint was to compare between the one-stage and multi-stages urethroplasty procedures in management of urethral complications following phalloplasty regarding the success rate.

MATERIAL AND METHODS

This is a prospective observational study which was carried out at the Urology Department, Kasr Alainy Hospitals, Cairo University, Egypt between August 2020 and October 2022. The study included patients who had urethral complications after radial free forearm flap (RFFF) phalloplasty, using a tube within tube technique (Figure 1), performed in our center. Written consent was obtained from all participants. The study was approved by the local ethics committee "MD-85-2020".
An elaborate history taking, thorough clinical examination and preoperative routine labs were performed. Retrograde urethrography with voiding film ± urethro-cystoscopy were done before repair. The repair was conducted through different procedures regarding the urethral pathology. All intraoperative and postoperative complications were documented. Each patient was routinely evaluated one month after surgery and every 3 months for 12 months with clinical examination, uroflowmetry and post-voiding residual urine (PVR). The need for further instrumentation or reoperation and or the inability to void while standing were considered as a "failure of repair". These are the utilized surgical procedures:

Non transecting urethroplasty

This technique was used in anastomic urethral strictures (US) ≤1 cm in length.
The stricture segment is longitudinally incised then closed transversely in Heineke–Mikulicz principle (HMP).

Excision and Primary Anastomosis (EPA)

This technique was used in anastomotic US 1–2 cm in length.
After evaluation of the whole neo-urethra, the stricture segment is excised with prudent dissection of the dorsal part of both urethral ends to minimally disrupt the blood supply. Both urethral ends are then spatulated and a tension-free anastomosis is performed with 6 absorbable sutures over the catheter.

Repair of the urethro-cutaneous fistula (UC fistula)

Vigilant assessment of the neo-urethra should be performed as the fistula could be adjacent to a stricture segment and then both would be fixed together. After dissection of the fistula's tract, the fistula is excised leaving healthy surrounding urethral tissue. The urethral closure is then performed in non-overlapping layers of well vascularized local tissues.

Urethral closure under a suprapubic tunnel

This is a novel technique performed, in two stages one month apart, for complete urethral disruption. This type of urethral complication was managed with proper debridement of low-quality edges and necrotic tissues before using this novel technique.
The first stage: After the neo-urethra closure through Tiersch-Duplay (TD) technique, the whole phallus is buried inside a subcutaneous tunnel created in the suprapubic area. The glans is then fixed into the tunnel's exit with 2 non-absorbable sutures, one suture per side (Figure 2, 3).
The second stage: The phallus is released after the removal of stitches in the outpatient clinic.

Staged Johanson's urethroplasty (utilizing either buccal mucosal graft or skin graft)

This technique was used in cases of US >2 cm in length or recurrent UC fistulas.
The first stage: The urethral plate at the stricture segment is dissected then vertically incised throughout until a healthy and patent urethra is identified. In areas of dense scarring or unacceptable tissue quality, the plate is excised. After harvesting the buccal mucosal graft (BMG), the graft is sutured to both plate edges over a previously prepared and fixed tunica vaginalis flap. Graft meshing is always done to prevent formation of an underlying hematoma. Additionally, quilting sutures are always performed to properly fix the graft to its bed, thereby emphasizing its intake.
In case of skin grafting, a split thickness skin graft (STSG) harvested either from the inner side of the thigh or from the phallus is fixed in a similar way to BMG technique without the need for the tunica vagina flap bed. STSG was always the first option unless it would cause penile disfigurement if harvested

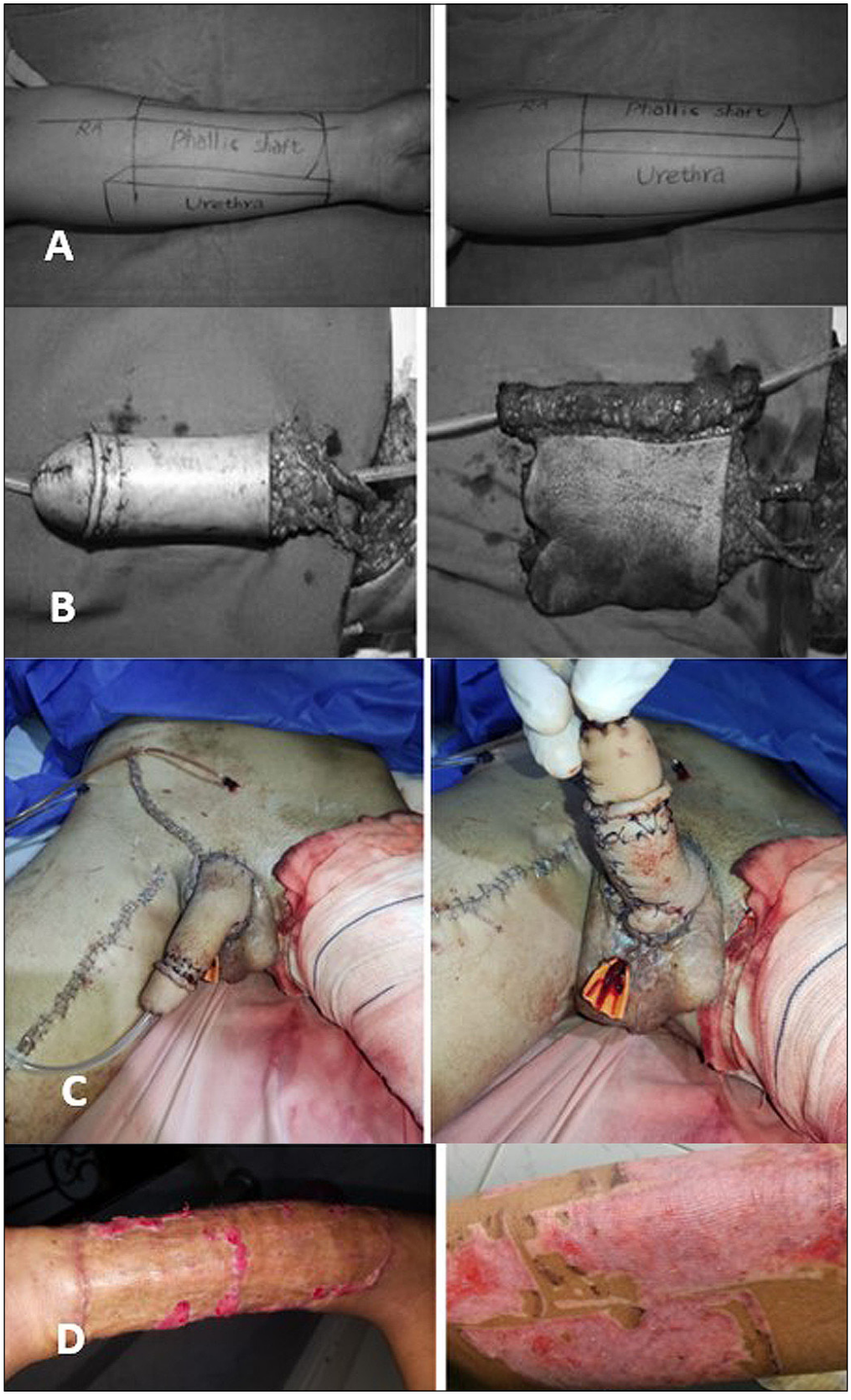

Figure 1. *Radial forearm free flap phalloplasty.* **(A)** *The radial forearm free flap design in two tubes.* **(B)** *Creation of neophallus and neourethra on urethral catheter.* **(C)** *The neophallus after microsurgical anastomosis in the recipient site.* **(D)** *Covering the donor site with split thickness skin graft.*

or upon shared patient decision; the BMG was the second option.
The second stage (after 6 months): Tubularization of the graft is carried out using TD technique.

Visual internal urethrotomy (VIU)

In case of anastomotic US ≤1 cm in length, a transurethral longitudinal incision at 12 o'clock is performed until identification of the peri-urethral fat. Additional incisions at 3 or 9 o'clock may be needed. Ventral urethral incisions are not recommended to preserve the urethral blood supply.

Abdominal Pedicled Skin Flap (APSF) urethroplasty

This is another novel technique that was invented for cases of long and recalcitrant US. It is performed in two stages, one month apart.
The first stage: A – Dissection of the neo-urethra then a vertical incision of the whole stricture segment is performed until a healthy urethra is identified thus creating a U-shaped urethral plate (recipient site).
By the end of this step, an inner urethral plate layer and an outer phallic skin layer are created.
B – A U-shaped incision in the either side of the lower part of the abdomen with comparable dimensions

Figure 2. *Urethral closure under a suprapubic tunnel* **(A)** *Creation of urethral plate.* **(B)** *Closure of the urethral plate in layers.* **(C)** *Complete skin closure.* **(D, E)** *Placing the phallus in a subcutaneous abdominal tunnel for subsequent release with completely healed urethra.*

to the urethral plate is made (creating a comparable donor site) (Figure 4, 5).
By the end of this step, two layers of the abdominal skin (inner and outer) are created.
C- Closure of both inner layers together is performed through water-tight continuous 4-0 PDS sutures followed by closure of the outer layers together through interrupted non-absorbable sutures, (Figure 4, 5).
Notably, traction of the phallus towards the donor site is usually needed to facilitate closure of the two layers. Furthermore, the base of the abdominal skin flap should be wide enough to decrease the incidence of UC fistula.
The second stage: The phallus is released through stitches removal of the outer layers, then the skin flap with the urethral plate all-together in one unit is liberated through careful dissection around the inner layers. The phallic skin is then closed through simple interrupted sutures (Figure 3). A primary closure of the abdominal skin is usually done and a STSG is seldom needed to assist the abdominal skin closure.

Meatoplasty

The standard technique was used as the first line management for non-recurrent meatal stenosis (MS). After introduction of a lubricated mosquito hemostat into the urethral meatus reaching to a wide normal lumen, the ventral tissue of the stricture segment with 3-5 mm depth is crushed by using the mosquito for 60 seconds and then sharply incised. After that, the inside urethral lumen and outer side phallic skin are re-approximated through interrupted absorbable sutures. In recurrent MS, staged Johanson's urethroplasty using STSG was considered. Finally, all these surgical techniques used for post phalloplasty urethral complications could be selected based on the urethral pathology, location and length as shown in the algorithm (Figure 6).

Statistical analysis

Statistical analysis was conducted using Package for Social Science (IBM SPSS) version 28.

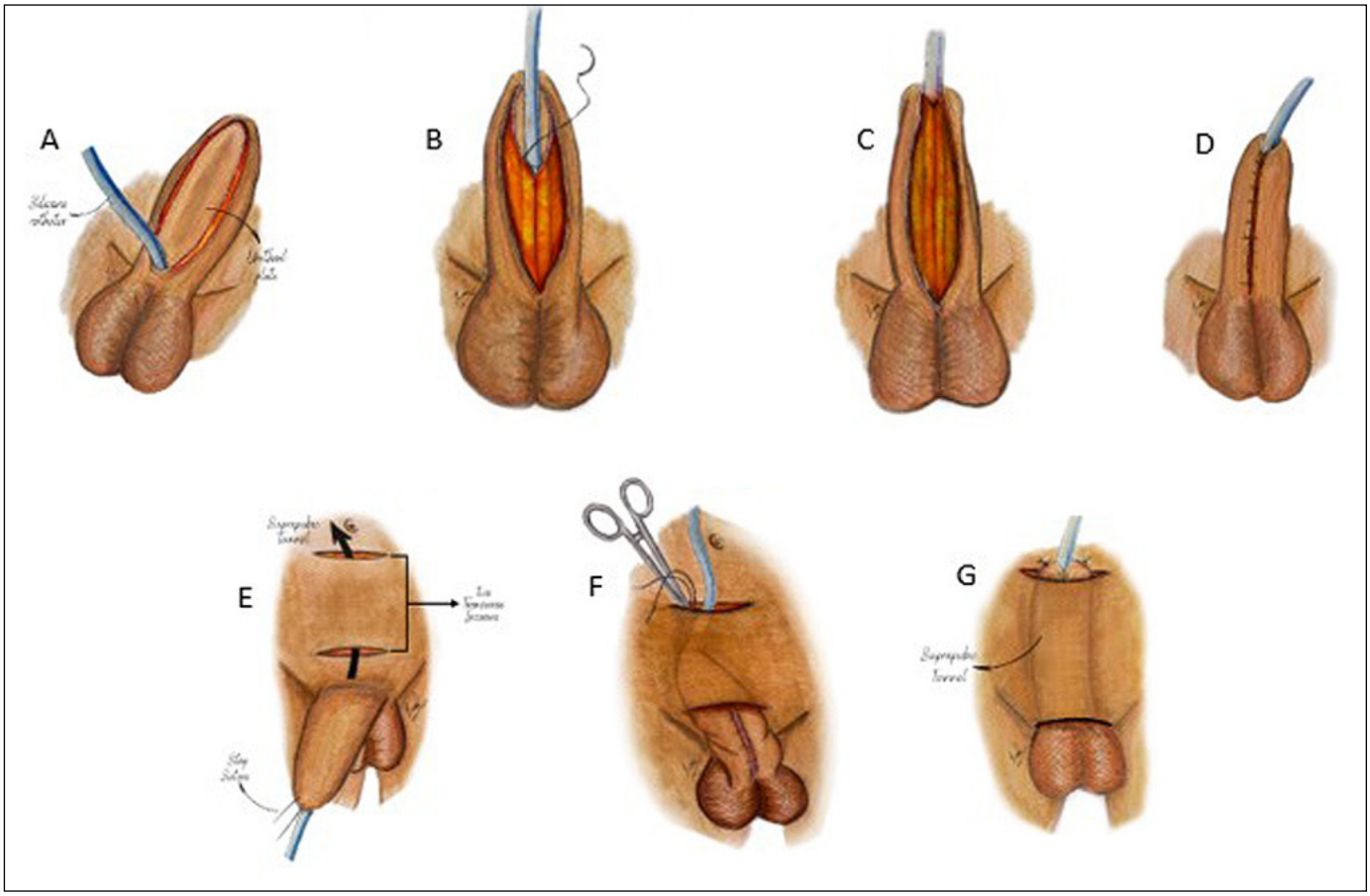

Figure 3. *The illustration shows the steps of urethral closure under suprapubic tunnel technique:* **(A)** *creation of urethral plate,* **(B, C)** *urethral closure,* **(D)** *skin closure,* **(E)** *creation of suprapubic tunnel,* **(F)** *putting the phallus in the tunnel,* **(G)** *fixation of phallus with two stitches.*

The quantitative data was presented as mean, standard deviations and ranges when their distribution found parametric and qualitative data was presented as numbers and percentages.

RESULTS

The study included 36 cis-male patients who had urethral complications after RFFF phalloplasty with a mean age of 27.95 years. The indication for phalloplasty was congenital micro penis in 20 patients (55.6%), crippled penis in 8 patients (22.2%), traumatic total penile loss in 5 patients (13.9%) and penile amputation due to Fournier's gangrene in 3 patients (8.3%).

Twelve patients (33.3%) presented with UC fistula. The main complaint was leakage of urine through an ectopic site rather than the distal meatus. The mean presentation was 10 weeks after phalloplasty. All fistulas were located at the anastomosis between the native urethra and the neo-urethra (anastomotic fistulae). One-third of these fistulas (4 fistulas) were small and deep while the other two-thirds were large and superficial. Half of the small fistulas closed spontaneously after suprapubic tube drainage within 4 weeks without recurrence during follow-up. The other 10 cases (83.3%) required surgical closure. The latter was successful in 8 cases out of 10 (80%) while the other 2 cases recurred in 10 days after closure. These two cases were managed successfully after 6 months through staged Johanson's urethroplasty using STSGs (Table 1).

Twenty patients (55.6%) presented with US. The main complaint was obstructive symptoms particularly weak urine stream and difficulty in micturition. The mean presentation time was 11 weeks after phalloplasty. Three patients had MS (15% of all strictures), 9 patients had anastomotic strictures (45% of all strictures) and the other 8 patients (40%) had long US involving the whole neo-urethra (4 patients

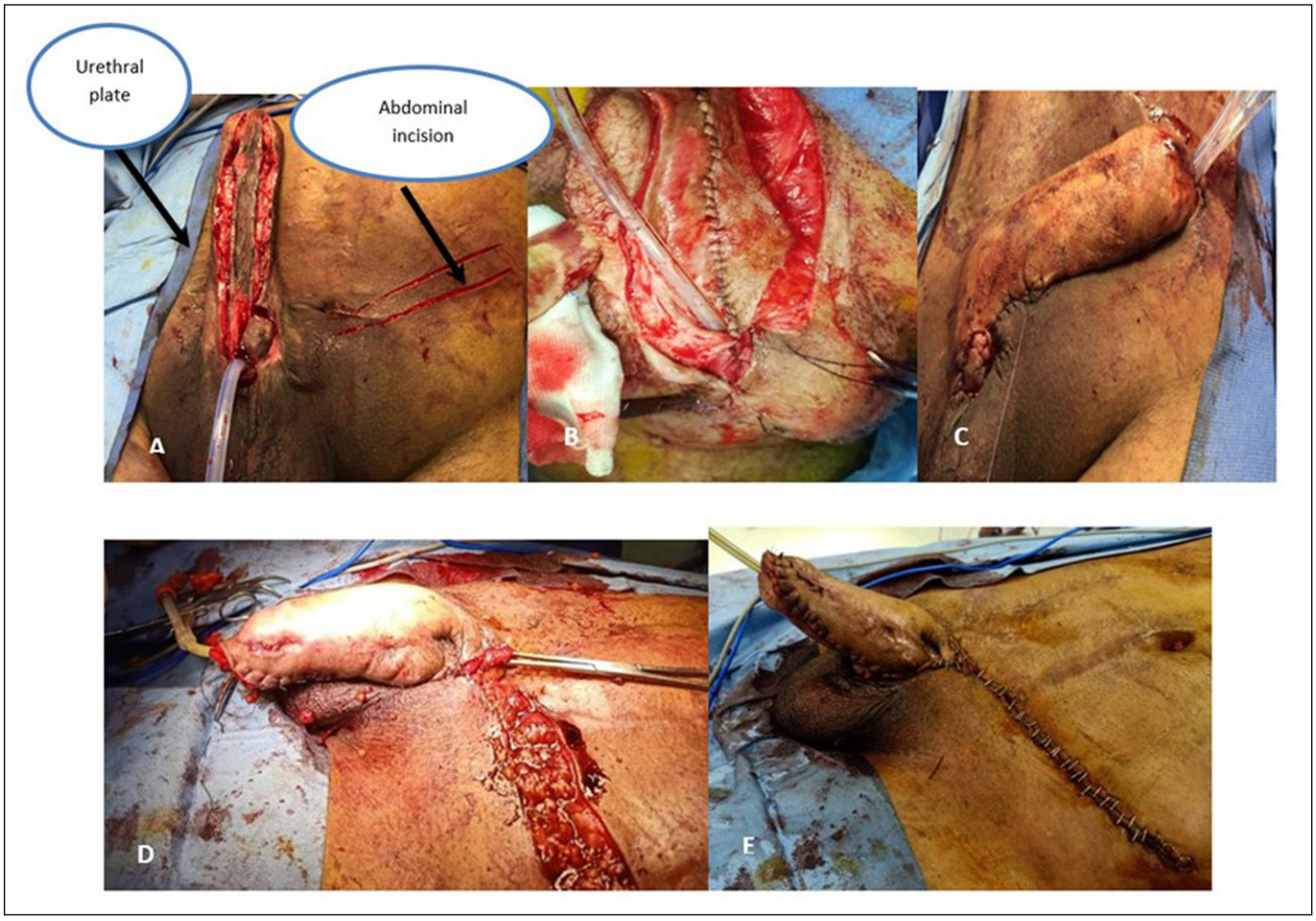

Figure 4. *Abdominal pedicled skin flap technique.* **(A)** *First stage: creation of urethral plate and abdominal incision to develop the raw area.* **(B, C)** *Suturing the urethral plate with abdominal flap.* **(D, E)** *Second stage: separation of phallus from abdominal wall and closure of raw area.*

were without previous repair trials and the other 4 patients had recalcitrant strictures).

Meatoplasty was successful for all patients with MS except for one patient who developed a stricture recurrence within 3 months for which successful staged Johanson's urethroplasty utilizing STSG harvested from the phallus was performed.

VIU was attempted for 3 patients with anastomotic stricture ≤1 cm in length but failed with a mean time of 6 weeks (100% failure rate). Therefore, open repair (HMP) was performed for the next 2 cases and VIU was not performed anymore. Moreover, all VIU cases were complicated with penile ± scrotal edema which subsided spontaneously within 10 days. After 6 months, these patients could void while standing with adequate urine flow (>15 ml/sec) and presented with insignificant PVR (<50 ml) after successful EPA procedure.

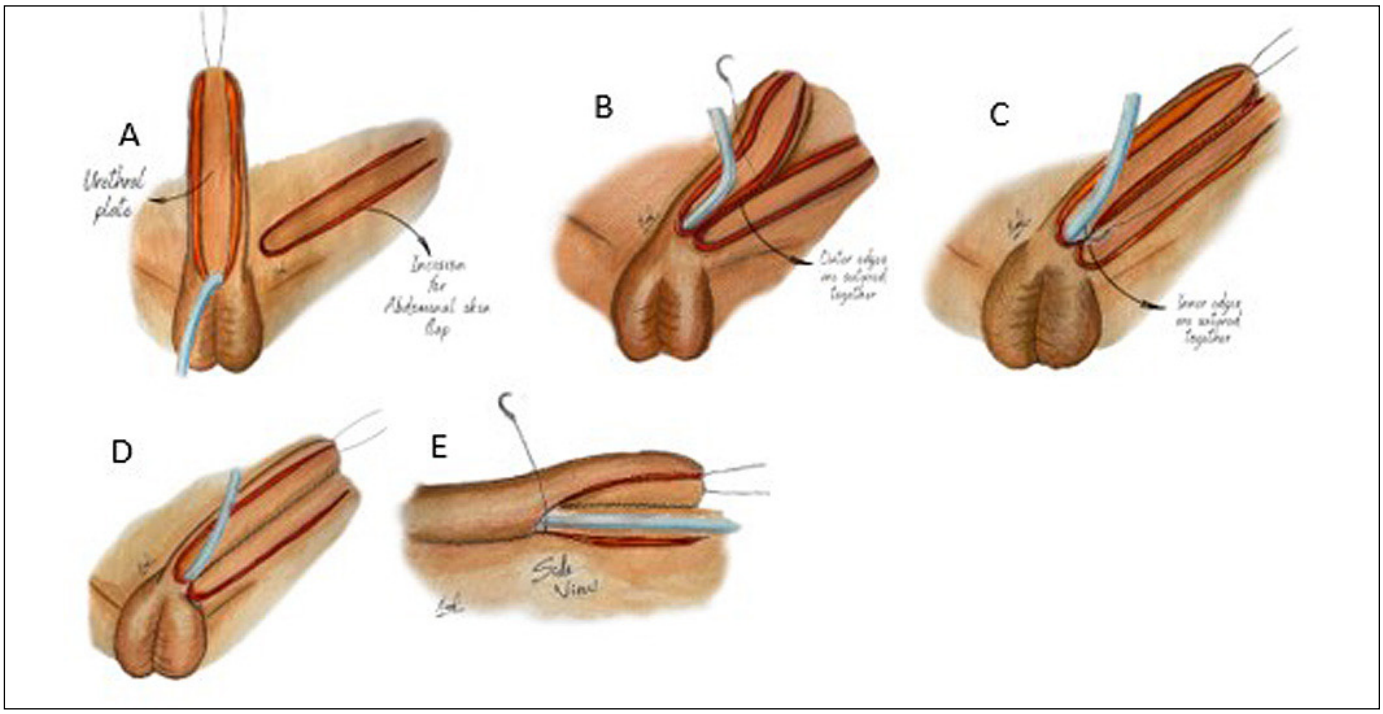

Figure 5. *The steps of abdominal pedicled skin flap technique:* **(A)** *creation of urethral plate and abdominal flap site,* **(B, C, D)** *suturing the inner layers,* **(E)** *suturing the outer layer.*

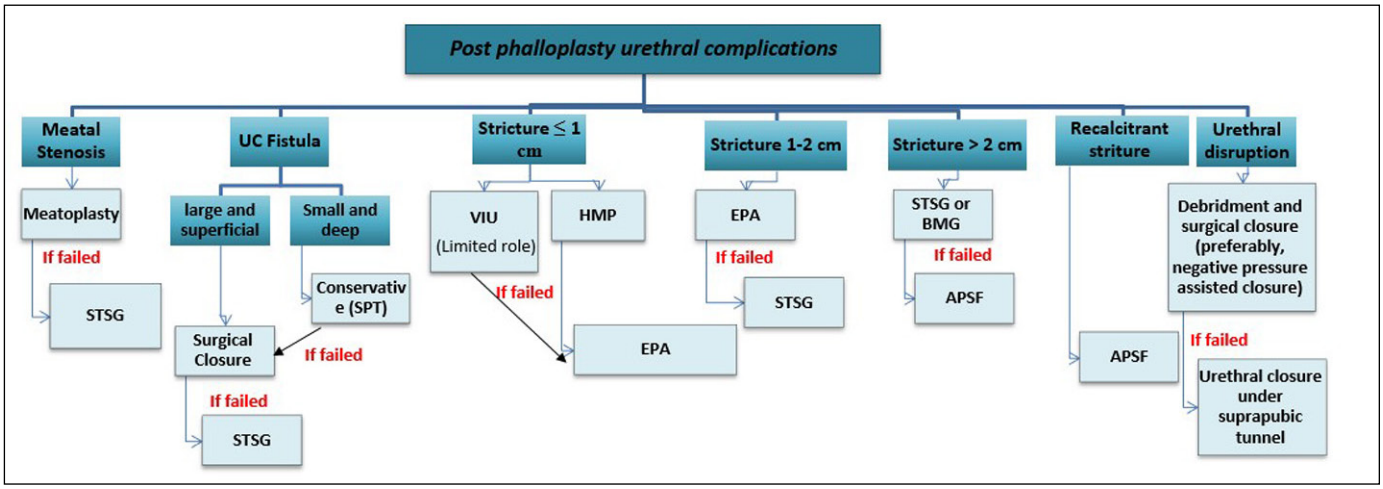

Figure 6. *Algorithm shows the surgical techniques used for different urethral pathologies.*

UC fistula – urethro-cutaneous fistula; STSG – split thickness skin graft; SPT – suprapubic tube; EPA – excision and primary anastomosis; APSF – abdominal pedicled skin flap; VIU – visual internal urethrotomy; HMP – Hieneke-Mikulicz principle; BMG – buccal mucosal graft

EPA was also conducted for another 4 cases of US with a length of 1-2 cm. One patient presented with stricture recurrence 4 weeks after surgery and the other 3 patients had no major complications during the follow-up. Although there is no urethral transection in HMP for preservation of urethral blood supply, non-transecting urethroplasty failed within 3 months for one of the two patients who underwent the procedure (only 50% success).

For the 4 patients with long US >2 cm without previous repair trials, 2 cases underwent staged Johanson's urethroplasty using STSGs and the others underwent BMG urethroplasty. Unfortunately, one of the two patients with BMG ended with a UC fistula for which a definitive perineal urethrostomy was conducted upon patient's decision. No donor site complications were documented.

Regarding the recalcitrant US, APSF urethroplasty was performed without major complications till the end of the follow up except for one case with a small UC fistula which was managed conservatively.

Four patients (11.1%) presented with complete urethral disruption while the rest of the phallus was viable. The mean presentation time was 2 weeks after phalloplasty. These patients had to wait for 6 months and the repair was then done through urethral closure under a suprapubic tunnel which resulted in 3 patients (75%) who could void while standing

Table 1. *Different Urethral complications presented after total phalloplasty and their treatment strategies*

Urethral pathology	Number of patients	Mean presentation time	First line management	Re-treatment method
Meatal stenosis	3	11 weeks	Meatoplasty	Staged Johanson's urethroplasty
UC fistula	12	10 weeks	Conservative management (SPT) & Surgical closure	Staged Johanson's urethroplasty with STSG
Anastomotic stricture ≤1 cm	5	11 weeks	VIU HMP	EPA
Anastomotic stricture 1–2cm	4	.....	EPA	Staged Johanson's urethroplasty
Long stricture >2 cm	4	.....	Staged Johanson's urethroplasty	APSF
Recalcitrant urethral stricture	4	.....	APSF	
Urethral disruption	4	2 weeks	Urethral closure under a suprapubic tunnel	

UC fistula – urethrocutaneous fistula; EPA – excision and primary anastomosis; VIU – visual internal urethrotomy; HMP – Hieneke-Mikulicz principle; SPT – suprapubic tube; STSG – split thickness skin graft; APSF – abdominal pedicled skin flap

Table 2. *The different urethral procedures used for management of urethral complications post-phalloplasty*

Procedures & Number of patients/ procedure	Urethral pathology	Mean operative time (min)	Mean hospitalization time (hours)	Mean catheter time (days)	Specific success rate (%)
Meatoplasty (3)	MS	14	6	7	75%
Staged BMG (2): 1st stage 2nd stage	stricture >2 cm	 136 85	 72 24	 10 21	 100% 50%
Staged STSG (5): 1st stage 2nd stage	– Recurrent MS – Recurrent UC fistula – Stricture >2 m	 126 90	 36 24	 14 21	 100% 100%
HMP (2)	Anastomotic stricture ≤1 cm	70	24	21	50%
EPA (7)	– Recurrent anastomotic stricture ≤1 cm – Anastomotic stricture 1–2 cm	80	24	21	85.7%
APSF (4) 1st stage 2nd stage	– Recurrent stricture >2 cm – Recalcitrant urethral stricture	 125 100	 24 24	 30 14	 100% 100%
Urethral closure under suprapubic tunnel (4)	Urethral disruption	110	24	30	75%
VIU (3)	Anastomotic stricture ≤1 cm	35	12	14	0%
UC fistula closure (10)	Non-recurrent anastomotic fistula	55	12	14	80%

MS – meatal stenosis; UC fistula – urethrocutaneous fistula; EPA – excision and primary anastomosis; VIU – visual internal urethrotomy; HMP – Hieneke-Mikulicz principle; BMG – buccal mucosal graft; STSG – split thickness skin graft; APSF – abdominal pedicled skin flap

and one patient with a UC fistula which is planned for repair through staged Johanson's urethroplasty (Table 1).

With a total of 41 procedures for the 36 patients (with a mean of 1.1 procedures per patient), 32 patients (88.8 %) could eventually void while standing. The success rate was highest for staged Johanson's urethroplasty using STSG, APSF and EPA respectively while, it was lowest for VIU (0% success) and HMP (50% success) (Table 2). For staged versus one-stage procedures prospective analysis, 17 out of 26 one-stage procedures (65.4%) succeeded while 13 out of 15 staged procedures (86.6%) succeeded.

The mean hospitalization time for BMG urethroplasty was the longest (72 hours) and the mean catheterization time was the longest for APSF (44 days) (Table 2). Blood transfusion was not required during the study.

DISCUSSION

Phalloplasty is a multi-stage procedure that entails a variety of steps, including the construction of the phallus with a functioning neo-urethra enabling the patient to void while standing [5]. RFFF phalloplasty has become the most performed surgical technique as its donor site is thin and pliable, allowing a tube within a tube design to create a competent neo-urethra. The dorsal penile/clitoral and ilioinguinal nerves can be joined to the sensory nerves of the flap, giving the phallus a tactile and erogenous sensibility. Additionally, the new phallus overlaps the glans penis/clitoris, allowing for stimulation during sexual activity and subsequent orgasm [6].

Although many authors [7, 8] described multiple techniques to minimize the urethral complications, the incidence is still high. This could be explained by the poor vasculature of the neo-urethra or venous congestion and/or the increased pressure inside the buried urethra. Moreover, standard urethroplasty techniques were described to treat the native male urethra and could be insufficient for the neo-urethra reconstruction [9].

In this study, some modifications in these known techniques have been made in concordance with the nature of the neo-urethra and pathogenesis of complications. In addition, two novel techniques are described for treatment of such onerous complications. The overall success rate of all procedures was 73.1% and 88.8% of the patients were eventually able to void while standing. For a total number of 41 procedures, the success rate for staged procedures was higher (86.6%) than that of one-stage procedures (65.4%).

For a total of 118 urethroplasty procedures, Lumen et al. [10] reported a success of 58.8% with highest success in two-stage urethroplasty (69.7%) and lowest in perineostomy (38.1%). These results match our study results regarding the superiority of staged procedures over the one-stage procedures, albeit, with lower success rates. Beamer et al. concluded that one-stage repair is feasible for patients with anastomotic strictures who have well-vascularized tissue and no prior augmented urethroplasty failures while staged repairs are feasible for patients with poor tissue quality [11].

Many difficulties could face the surgeon attempting to apply a BMG on a neo-phallus. Relative bed ischemia and high tendency for urethral grafts to kink due to gravitational forces on the neo-phallus are the main challenges. BMGs have higher metabolic requirements than STSGs [12] and the possibility for poor intake could be high in a neo-phallus. Therefore, transfer of additional well-vascularized tissue is imperative, such as tunica vaginalis flap in cis-male patients or labia minora flap in trans-male patients, to provide the graft with these requirements, consequently reducing the risk of urethroplasty failure. Wilson et al. reported a total of three patients who underwent revision urethroplasty after phalloplasty using ventral onlay BMGs, reinforced with fasciocutaneous flaps, for different urethral pathology (UC fistulas, US and MS). One stricture recurrence (requiring further repair with a BMG supported with gracilis musculocutaneous flap) occurred after 3 years. All patients, after that, were able to void while standing at a mean follow-up of 8.7 months [13].

Owing to the high failure rate, the authors could agree with Santucci et al. in limiting the role of VIU as a temporizing measure to achieve urine drainage till the definitive repair [14]. Furthermore, the main complication following all cases undergoing VIU, rather than failure, was the tissue edema due to loss of tissue support in the neo-urethra unlike that of the native urethra (only 10% post VIU in native urethra) [15].

For complete urethral disruption, we describe the "Urethral closure under a suprapubic tunnel" technique. Knowing that the distal and proximal edges of the neo-urethra are the most at risk for ischemia [14], simple closure of the disrupted neo-urethra would not be enough and the neo-urethra would be liable for re-disruption. The created tunnel provides a coverage support for the neo-urethra to optimally heal within. Despite being a staged procedure, the second stage only involves removal of stitches in the outpatient clinic. Patient discomfort remains the main drawback of this technique.

Long and recalcitrant urethral strictures require exceptional techniques. We experienced some techniques such as staged Johanson's urethroplasty but

the results were unfavorable. Hoping for fair outcomes, we have invented the "Abdominal Pedicled Skin Flap" technique. Sharing the same scientific basis of abdominal pedicled flap in hand reconstruction [16], this technique provides an abdominal skin flap covering the whole length of the neo-urethra without much concern about the flap perfusion. Following this technique, there was only one case that developed a UC fistula which was managed conservatively. All patients, then, could void while standing with a good urine flow during the follow-up period. Although our study included a diversity of cases, the small sample size is its main limitation. Further studies with larger sample size are warranted to investigate the outcome of different procedures used in this study, particularly the two novel techniques.

CONCLUSIONS

Urethral complications following phalloplasty require complex procedures demanding a high level of surgical expertise. Abdominal pedicled skin flap urethroplasty is a viable option for long and recalcitrant urethral strictures. Staged urethroplasty demonstrates a higher success rate compared to one-stage repair.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ACKNOWLEDGMENT

The authors would express special thanks to Mohammad Emad, MSc of Urology, for his sincere and valuable efforts in the new techniques' drawings.

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