

Complications of free-flap procedures for phalloplasty in female-to-male transgender surgery: 25-year experience a single medical center

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Abstract

Background: To present the complications of free-flap phalloplasty in three-staged female-to-male transgender surgery.

Methods: This retrospective study included patients who underwent a three-staged free-flap phalloplasty for female-to-male transgender surgery between January 1988 and December 2013. Data regarding demographics, operative techniques, and complications were collected and analyzed.

Results: A total of 101 patients with a mean age of 30.2 years were included. Phalloplasty with traditional free forearm tube-in-tube fasciocutaneous flap was performed in 25 (24.8%) patients, free forearm fasciocutaneous flap with vaginal mucosa for a prefabricated urethra in 30 (29.7%) patients, free radial forearm osteocutaneous flap with vaginal mucosa for a prefabricated urethra in 22 (21.8%) patients, and free fibula osteocutaneous flap with vaginal mucosa for a prefabricated urethra in 24 (23.8%) patients. Complication rates of partial flap loss, urethrocutaneous fistula, urethral stricture, and hair or stone formation were 12.9%, 49.5%, 24.8%, and 5.0%, respectively. Patients receiving fibula osteocutaneous flap phalloplasty had the lowest overall complication rate (33.3%), followed by those with radial forearm osteocutaneous flap (40.9%), forearm fasciocutaneous flap (43.3%), and forearm tube-in-tube fasciocutaneous flap (80.0%). Forearm tube-in-tube fasciocutaneous flap procedure was associated with significantly higher rates of overall complications ($p = 0.05$), urethrocutaneous fistula ($p = 0.005$), and hair or stone formation ($p = 0.002$) compared with the other three types of procedures. Rates of all complications did not significantly differ among fibula osteocutaneous flap, radial forearm osteocutaneous flap, and forearm fasciocutaneous flap procedures.

Conclusion: In free-flap phalloplasty for female-to-male transgender surgery, utilization of free fibula osteocutaneous flap with vaginal mucosa for a prefabricated urethra resulted in the lowest complication rate. Further comparisons among different procedures of phalloplasty are warranted.

Keywords: Demography; Fibula; Forearm; Sex reassignment surgery; Urinary Fistula

1. INTRODUCTION

Since the first case of total penile reconstruction was reported by Bogoras in 1936, surgical techniques of phalloplasty have advanced greatly.¹ However, a standardized procedure of female-to-male transgender surgery has not been established.^{2,3} Phalloplasty is a challenging and complex procedure, and a successful one entails demanding requirements. A neophallus

should allow for voiding while standing, be with tactile and erogenous sensation, be sufficiently rigid for sexual penetration, and be aesthetically acceptable.^{4,5} Numerous types of phalloplasty have been reported, including metoidioplasty, abdominal flap, groin flap, anterolateral thigh flap, fibula flap, and forearm flap, with each having distinct advantages and disadvantages.^{2,6} For example, although metoidioplasty creates a relatively short neophallus, its advantages over flap-based procedures include shorter hospitalization, lower cost, and greater erogenous sensitivity.^{5,7} Prior to the era of microsurgery, abdominal flap and groin flap procedures were mainstays in phalloplasty, but have drawbacks of diminished sensation, atrophy over time, and limited ability to sexually penetrate and to void in the standing position.^{5,8} Currently, the most commonly used procedure in phalloplasty utilizes a free flap, such as anterolateral thigh flap, radial forearm flap, and fibula flap. However, donor site morbidity remains an issue for free-flap procedures.^{9,10}

Attempts have been made to increase the neophallus rigidity. Various prostheses have been used as rigid penile supporting tissue, including iliac crest bone, costal cartilage, rib bone, radial bone, fibula bone, and acrylic resins.¹¹⁻¹⁴ Among these, radial

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forearm or fibula osteocutaneous free flaps are the most frequently used, and fibula bone has been suggested as an optimal solution for its weight-bearing properties, allowing for sexual penetration.¹⁵ However, donor site morbidity, urologic complications, and the sustained erected phallus are serious concerns.^{3,16}

To construct a neourethra is another difficulty in phalloplasty. Several techniques for replacement of urethral tissue have been reported, such as skin graft, buccal mucosal graft, and vaginal mucosal graft.^{17,18} Vaginal mucosal graft has advantages over the others, including avoidance of morbidity from an additional donor site by reusing waste tissue and absence of hair growth.¹⁹

As reconstruction of a fully functional phallus remains elusive, this study aimed to present our 25-year experience of three-staged free-flap female-to-male transgender surgery by describing complications associated with different phalloplasty procedures.

2. METHODS

2.1. Subjects

Ethical approval for this observational study was granted by the Institutional Review Board of Taipei Veterans General Hospital in Taiwan. Retrospective chart review was conducted to identify patients who underwent a three-staged free-flap female-to-male transgender surgery between January 1988 and December 2013. All surgeries were performed by a plastic surgeon with 10 to 15 years of board certification. Data regarding demographics, operative technique, and complications, including flap loss, urethrocutaneous fistula or urine leakage, urethral stricture, and hair or stone formation, were collected and analyzed.

2.2. Surgical procedures

During the 25-year period, four types of free-flap procedures were used in phalloplasty for female-to-male transgender surgery, and the evolution of phalloplasty procedure over time reflected advancements in technique. Phalloplasty using free forearm tube-in-tube fasciocutaneous flap was performed from 1993 to 1995, free forearm fasciocutaneous flap from 1995 to 1996, free radial osteocutaneous flap from 1997 to 2004, and free fibula osteocutaneous flap from 2004 to 2013.

All four free-flap procedures consisted of three main surgical stages. During the first stage, hysterectomy, salpingo-oophorectomy, vaginectomy, and subcutaneous mastectomy were performed (Fig. 1A). For patients who were planned for a prefabricated urethra using vaginal mucosa, the excised vaginal mucosa was tubed as an inlay graft stented with a urinary catheter (Fig. 1B) and implanted in the subcutaneous tunnel of the radial side of the nondominant forearm or the lateral aspect of the lower leg (Fig. 1C). In the second stage at approximately three months after the first stage, a tubed free-flap phalloplasty was performed. For patients who were planned for an

osteocutaneous flap, a piece of the radial bone or the fibula bone was harvested with the flap (Fig. 2). In the third stage at approximately two to three weeks after the second stage, glansplasty was performed (Fig. 3).

2.3. Management of complications

Most occurrences of urethrocutaneous fistula resolved after conservative treatment with urinary catheterization for one to three months. For nonhealed fistula, repair was done by local flap surgery. Urethral stricture was treated with direct vision internal urethrotomy under urethroscopic guidance. Urethral or cystic stones were treated using urethroscopy or extracorporeal shock wave lithotripsy. For urethral hair formation, hair follicles were removed with laser therapy. Partial flap loss was repaired with skin graft, local flap, or resurfacing procedure (ie, debridement followed by secondary healing).

2.4. Statistical analysis

Continuous variables are presented as mean (SD) and categorical variables are presented as count (percentage). Pearson's chi-squared test or Fisher's exact test was conducted for comparisons. Post hoc test was performed with Bonferroni adjustment. Statistical significance was set at two-tailed $p < 0.05$, and all statistical analyses were performed using IBM SPSS, version 24.0 (IBM Inc., Armonk, NY, USA).

3. RESULTS

This study included 101 patients who underwent three-staged free-flap female-to-male transgender surgery for gender dysphoria between January 1988 and December 2013. Mean age was 30.2 years (SD, 6.2). Among the 101 patients, four different operative procedures were utilized: 25 (24.8%) patients received traditional forearm tube-in-tube fasciocutaneous flap, 30 (29.7%) patients received free forearm fasciocutaneous flap, 22 (21.8%) patients received free radial forearm osteocutaneous flap, and 24 (23.8%) patients received free fibula osteocutaneous flap. Vaginal mucosa was utilized for a prefabricated urethra in 77 (76.2%) patients (Table 1). Mean duration of follow-up was 12.1 months.

As presented in Table 2, 50 (49.5%) patients experienced postoperative complications, among whom 20 underwent free forearm tube-in-tube fasciocutaneous flap procedure. The overall complication rate was significantly higher in patients receiving free forearm tube-in-tube fasciocutaneous flap (80.0%) than in those receiving free forearm fasciocutaneous flap (43.3%), free radial forearm osteocutaneous flap (40.9%), and free fibula osteocutaneous flap (33.3%). Results of post hoc analysis revealed statistically nonsignificant differences in overall complication rate among free forearm fasciocutaneous flap, free radial forearm osteocutaneous flap, and free fibula osteocutaneous flap procedures.

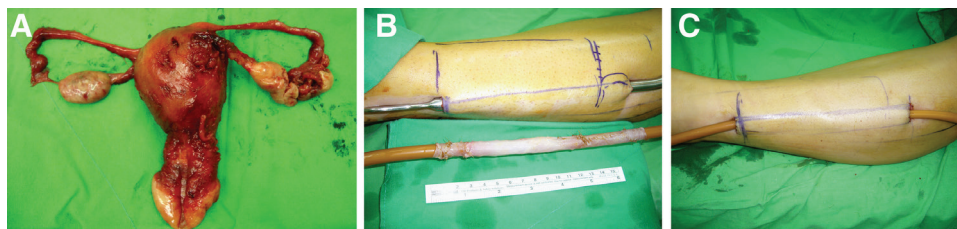


Fig. 1 Surgical procedures of female-to-male transgender surgery using fibula osteocutaneous flap. A, In the first stage of female-to-male transgender surgery, hysterectomy, salpingo-oophorectomy, and vaginectomy were performed. B, The excised vaginal mucosa (approximately 15–20 cm) was tubed as an inlay graft stented with a urinary catheter and (C) was implanted into the subcutaneous tunnel of the radial side of the nondominant forearm or the lateral aspect of the lower leg.

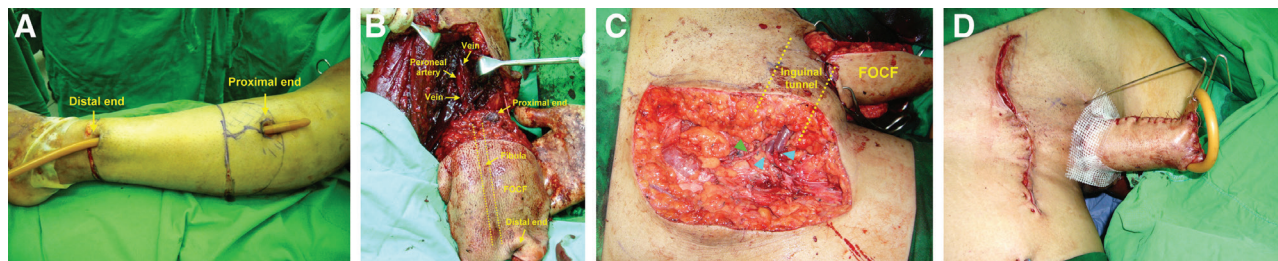


Fig. 2 A, In the second stage, phalloplasty was performed using a free fibula osteocutaneous flap (FOCF). The opening of tubed vaginal mucosa in the proximal end of flap was sutured with the original female urethral meatus as the proximal end of neourethra. The opening of tubed vaginal mucosa in the distal end of flap formed the neourethral meatus on the glans. B, The peroneal artery and two concomitant veins of the peroneal artery were exposed after resecting the fibula and overlying skin paddle. C, Through an inguinal tunnel, the peroneal perforator artery of the FOCF was anastomosed with deep inferior epigastric artery (green arrowhead) and the two concomitant veins of peroneal perforator artery with the two branches of great saphenous vein (blue arrowheads). The arrowheads indicate the anastomoses. D, The immediate postoperative appearance of phalloplasty.

In this series, the complication rates of urethrocutaneous fistula, urethral stricture, partial flap loss, and hair or stone formation were 49.5%, 24.8%, 12.9%, and 5.0%, respectively. Total flap loss was not observed in any patient. Patients who received free forearm tube-in-tube fasciocutaneous flap had significantly higher rate of urethrocutaneous fistula than those who underwent the other three types of procedures ($p = 0.005$). Post hoc analysis revealed that the complication rates of urethrocutaneous fistula did not significantly differ among patients receiving free forearm fasciocutaneous flap, radial forearm osteocutaneous flap, and fibula osteocutaneous flap procedures. Five patients who underwent free forearm tube-in-tube fasciocutaneous flap phalloplasty experienced complications of stone or hair formation, whereas patients who underwent the other three types of procedures did not experience such complications. Occurrence of partial flap loss ($p = 0.185$) and urethral stricture ($p = 0.563$) did not significantly differ among the four operative techniques (Table 2).

Complication rates following the different surgical procedures are presented in Table 3. There was no significant difference in complication rates between patients receiving forearm flap and fibula flap. Patients in whom vaginal mucosa was used for a prefabricated urethra had significantly fewer urethrocutaneous fistula (39.5% vs 80.0%; $p < 0.001$) and fewer stone or hair formation (0% vs 20.0%; $p = 0.001$) than patients in whom vaginal mucosa was not used for a prefabricated urethra. Urethrocutaneous fistula was significantly less frequent following osteocutaneous flap procedure than fasciocutaneous flap

procedure (37.0% vs 60.0%; $p = 0.021$). After excluding free forearm tube-in-tube fasciocutaneous flap procedures, rates of complications did not significantly differ between forearm flap and fibula flap procedures nor between osteocutaneous flap and fasciocutaneous flap procedures. As the plastic surgeons were of similar seniority at the time of the procedures, results were not further stratified by duration after board certification of the surgeon.

4. DISCUSSION

In Taiwan, the first legal female-to-male sex reassignment surgery was performed in 1988 by Dr. Rong-Hwang Fang at Taipei Veterans General Hospital. Since then, social attitudes and legal regulations have evolved, and availability of medical services for transsexual patients in Taiwan have improved profoundly.¹⁹ This series comprising 101 patients demonstrated our 25-year experience of three-staged free-flap phalloplasty for female-to-male transgender surgery. The highest complication rate was observed in patients receiving free forearm tube-in-tube fasciocutaneous flap phalloplasty and the lowest was observed in those receiving free fibula osteocutaneous flap phalloplasty.

The most common complication associated with female-to-male transgender surgery was related to the neourethra, including urethrocutaneous fistula, urethral stricture, and stenosis. The complication rate of fistula formation and urethral stricture varied greatly among different operative approaches. In a systematic review, 54 studies including 1124 patients receiving free

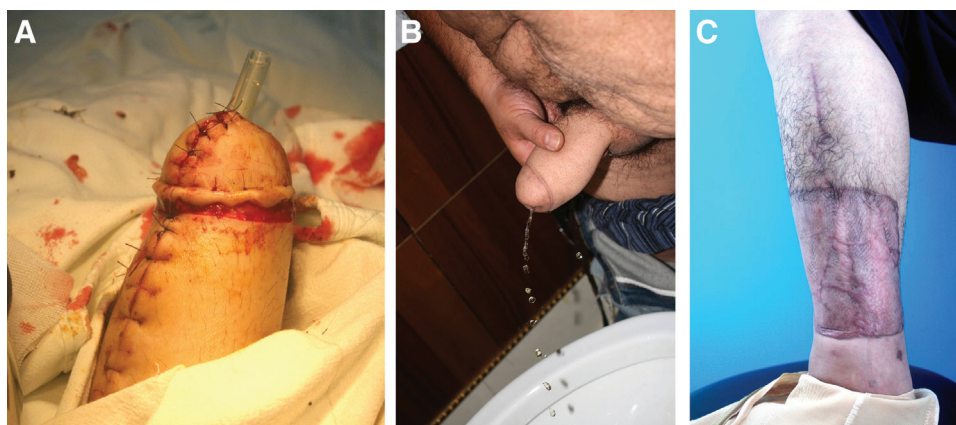


Fig. 3 A Glansplasty was performed in the third stage. Three months after the female-to-male transgender surgery, (B) the patient was able to void while standing and (C) the donor site of fibula osteocutaneous flap had healed well.

Table 1
Surgical procedures in patients who completed three-staged female-to-male transgender surgery

Operative procedures	n = 101
Free forearm tube-in-tube fasciocutaneous flap	25 (24.8)
Free forearm fasciocutaneous flap with vaginal mucosa for a prefabricated urethra	30 (29.7)
Free radial osteocutaneous flap with vaginal mucosa for a prefabricated urethra	22 (21.8)
Free fibula osteocutaneous flap with vaginal mucosa for a prefabricated urethra	24 (23.8)
Forearm flap	77 (76.2)
Fibula flap	24 (23.8)
With vaginal mucosa for a prefabricated urethra	76 (75.2)
Without vaginal mucosa for a prefabricated urethra	25 (24.8)
With radius or fibula bone graft	46 (45.5)
Without radius or fibula bone graft	55 (54.5)

Data were presented as count (percentage).

radial forearm flap and 6 studies including 61 patients receiving osteocutaneous free fibula flap were identified. The pooled complication rates of fistula formation and urethral stricture/stenosis associated with free radial forearm flap were 26.6% and 12.3%, respectively. Following osteocutaneous free fibula flap, the pooled complication rates of fistula formation and urethral stricture/stenosis were 5.4% and 24.6%, respectively.² In our study, the complication rates of urethrocutaneous fistula and urethral stricture were 54.5% and 24.7% following free radial forearm flap and were 33.3% and 25.0% following free osteocutaneous fibula flap. The higher complication rate might reflect the early phase of the 25-year learning curve.

It is generally accepted that using vaginal mucosa to prefabricate a neourethra is an economical method (from waste to wealth).^{3,20} In addition to its low cost, vaginal mucosa is not hair bearing and provides abundant vasculature to the anastomotic site of the native urethra and neourethra.^{21,22} In a study by Zhang et al, histological comparisons of normal forearm skin, vaginal, buccal, and urethral mucosa showed that vaginal mucosa was distinctly similar to buccal mucosa and morphologically resembled urethral epithelium more closely than forearm skin. Vaginal mucosa graft also showed a good “take” after 3-month prefabrication.²² The author commented that using vaginal mucosa for a prefabricated urethra could reduce the incidence of urethral stricture because of the homology between vaginal and urethral mucosa, sufficient blood supply by vaginal mucosa, and sufficient amount of graft materials.²² In our series, patients who underwent vaginal mucosa graft for a prefabricated urethra had lower complication rates of urethral stricture (23.7% vs 28.0%)

and fistula formation (39.5% and 80.0%) than those who did not. Our results provide clinical evidence that supports the histological findings by Zhang et al.²²

At our institution, the free forearm tube-in-tube fasciocutaneous flap procedure has not been performed for decades due to its high complication rate. Complication rates did not differ among the free forearm fasciocutaneous flap, free radial forearm osteocutaneous flap, and free fibula osteocutaneous flap procedures; however, free fibula osteocutaneous flap with vaginal mucosa for a prefabricated urethra is the mainstay of phalloplasty at our institution. There are several reasons for this preference. First, fasciocutaneous flap is not sufficiently rigid for sexual intercourse.²³ Although both radial forearm osteocutaneous flap and fibula osteocutaneous flap could effectively enhance the rigidity of the neophallus for sexual penetration,^{12,24} there are several advantages of fibula osteocutaneous flap over radial forearm flap. The fibula is cortical bone with weight-bearing properties that has lower risk of fracture and greater resistance to bony resorption than radius. Additionally, free fibula flap clearly provides a longer vascular pedicle that facilitates vessel anastomosis without the need for additional vascular graft. The longer length of the fibula flap not only allows for anastomosing neourethra as proximally as possible but also allows for possible flap shrinkage.²⁵ Aesthetically, compared to radial forearm flap, the skin texture of the fibula flap is characterized by thicker dermis, thinner subcutaneous tissue, and tougher fascia, making it more similar to that of penial shaft. Although these two types of flaps seem to have comparable donor site morbidity, a scar on the lower leg is much more easily hidden than one on the forearm.^{15,26,27}

There are several limitations of this study. The first is the retrospective study design in which potential selection bias could not be avoided. Second, the results only reflect the experience of a single medical center, limiting the external validity of this study. Third, several clinical parameters and outcomes were not collected, for example, personal history, medical history, patient satisfaction, voiding function, and sexual function. Potential risk factors for complications and further comparisons could not be evaluated. Fourth, this study showed higher complication rates of urethrocutaneous fistula and stone or hair formation in the patients without vaginal mucosa graft for urethra reconstruction than in those with vaginal mucosa for urethra reconstruction. Because only patients who underwent free forearm tube-in-tube fasciocutaneous flap did not receive vaginal mucosal graft for urethra reconstruction, we could not draw the conclusion that the observed higher complication rates resulted from skin graft or from the procedure itself. Finally, this study lacked data from long-term follow-ups. For patients, in addition to privacy issues, cost is a barrier to long-term follow-up because all services related to transgender surgery are not covered by the National Health Insurance.

Table 2
Distribution of complications in patients who completed three-staged female-to-male transgender surgeries

Complications	All (n = 101)	Operative procedures ^a				p
		A (n = 25)	B (n = 30)	C (n = 22)	D (n = 24)	
Overall	50 (49.5)	20 (80.0)	13 (43.3) ^b	9 (40.9) ^b	8 (33.3) ^b	0.005
Urethrocutaneous fistula	50 (49.5)	20 (80.0)	13 (43.3) ^b	9 (40.9) ^b	8 (33.3) ^b	0.005
Urethral stricture	25 (24.8)	7 (28.0)	9 (30.0)	3 (13.6)	6 (25.0)	0.563
Partial flap loss	13 (12.9)	5 (20.0)	2 (6.7)	1 (4.5)	5 (20.8)	0.185
Stone or hair formation	5 (5.0)	5 (20.0)	0 (0) ^b	0 (0) ^b	0 (0) ^b	0.002

Data were presented as count (percentage).

^aGroup A received free forearm tube-in-tube fasciocutaneous flap; group B received free forearm fasciocutaneous flap with vaginal mucosa for a prefabricated urethra; group C received free radial forearm osteocutaneous flap with vaginal mucosa for a prefabricated urethra; and group D received free fibula osteocutaneous flap with vaginal mucosa for a prefabricated urethra.

^bStatistically different from that in group A by post hoc analysis using Bonferroni adjustment.

Table 3**Comparison of complications between different operative procedures of three-staged female-to-male transgender surgery**

Complications	Operative procedures		p
	Forearm flap (n = 77)	Fibula flap (n = 24)	
Urethrocutaneous fistula	42 (54.5)	8 (33.3)	0.070
Urethral stricture	19 (24.7)	6 (25.0)	0.974
Partial flap loss	8 (10.4)	5 (20.8)	0.292
Stone or hair formation	5 (6.5)	0 (0)	0.335
	With vaginal mucosa for a prefabricated urethra (n = 76)	Without vaginal mucosa for a prefabricated urethra (n = 25)	
Urethrocutaneous fistula	30 (39.5)	20 (80.0)	<0.001
Urethral stricture	18 (23.7)	7 (28.0)	0.664
Partial flap loss	8 (10.5)	5 (20.0)	0.300
Stone or hair formation	0 (0)	5 (20.0)	0.001
	Osteocutaneous flap (n = 46)	Fasciocutaneous flap (n = 55)	
Urethrocutaneous fistula	17 (37.0)	33 (60.0)	0.021
Urethral stricture	9 (19.6)	16 (29.1)	0.269
Partial flap loss	6 (13.0)	7 (12.7)	0.962
Stone or hair formation	0 (0)	5 (9.1)	0.061

Data were presented as count (percentage).

In conclusion, in this series of patients undergoing female-to-male transgender surgery, we observed that free fibula osteocutaneous flap procedure combined with prefabricated urethra constructed from vaginal mucosa for free-flap phalloplasty was associated with a low complication rate. Further comparisons of different phalloplasty procedures are warranted.

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