



Mystery and realities of phalloplasty: a systematic review

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ABSTRACT

The neophallus creation is still a mystery and it remains challenging even today. In this article, we performed a comprehensive review of the literature regarding phalloplasty and penile reconstructive surgery between January 2008 and May 2016. In this review, we have included 15 research articles and the results of 276 patients were examined. Studies revealed several indications and when indications were reviewed, 191 patients were female-to-male transgender, 9 patients had disorder of sex development/micropenis, 16 had penile amputation/trauma, 9 had ambiguous genitalia, 40 had exstrophy and/or epispadias, 11 had other problems. As a result of this review, phalloplasty is a reliable and useful operation with good functional and aesthetical results.

Keywords: Gender reassignment surgery; phalloplasty; penile reconstructive surgery; surgical flaps.

Introduction

The neophallus creation is still a mystery and it remains challenging even today.^[1] Bogoras et al.^[2] reported the first penile reconstruction with successful micturition and coitus in 1936 by using a rib cartilage and an abdominal flap. Female to male gender reassignment surgery was firstly performed by Sir Harold Gillies.^[3] Despite the technologic developments and the new equipments, phalloplasty operation is still a dream-like operation. There are several indications for phalloplasty operation such as congenital anomalies (ambiguous genitalia, aphallia, epispadias, bladder exstrophy, micropenis, etc.), surgical amputation of penis (penile cancer), traumatic penile amputation, female to male gender reassignment.^[1,4] (Figure 1, 2). The bladder exstrophy ranges from 1/10000 to 1/50000 and males with bladder exstrophy may have ambiguous genitalia that requires surgical reconstruction.^[4] Gender identity disorder prevalence varies depending on populations and according to DSM-IV it is 1/30000 for men and 1/100000 for women.^[5,6] Penile fractures and traumas are one of the other reasons and it is highly underreported an uncommon in America and Europe.^[7,8]

There are several surgical techniques and different types of flaps used for phalloplasty. Random pattern flaps, pedicled flaps (groin flap, anterolateral thigh flap, island tensor fascia lata flap), free flaps (radial forearm free flap, osteocutaneous radial forearm free flap, lateral arm free flap, osteocutaneous free fibula, anterolateral thigh free flap, latissimus dorsi free flap, free scapular flap) would be used for phalloplasty operations (Figure 3).^[9] Neophallus should provide a satisfying and aesthetic appearance and also neourethra should allow comfortable voiding while standing.^[1,9,10] In addition, tactile and erogeneous sensibility, enough bulk for a stiffener insertion are also important features.^[1,9,10]

This study was designed for reviewing the literature for phalloplasty articles and comparing the results and complications of this surgery.

Material and methods

In this article, we performed a comprehensive review of the literature regarding phalloplasty and penile reconstructive surgery between January 2008 and May 2016. 15 research ar-

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Figure 1. Bladder extrophy (Mr. Ralph's photo archive)



Figure 2. Traumatic penile amputation and phalloplasty result (Mr. Ralph's photo archive)

ticles and the results of 276 patients were included. Our research was restricted to English-language studies. This article mainly reviews the outcomes of recent studies about phalloplasty reported in the literature. We searched the Medline and Cochrane Library with the following MeSH terms; 'phalloplasty', 'transsexualism', 'radial forearm', 'free flap', 'sex reassignment surgery', 'surgical flaps'. Original research articles were included in the study. Patient numbers, indications, operative techniques, postoperative results and complications were reported in detail. Also the results and the complications of the similar techniques were compared.

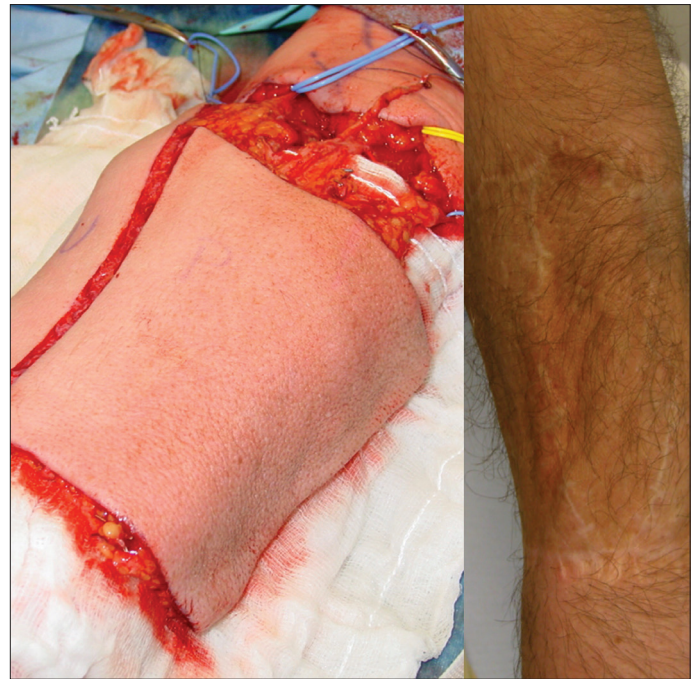


Figure 3. Radial forearm flap-donor site and postoperative period (Mr. Ralph's photo archive)

Results

In this review, we have included 15 research articles and the results of 276 patients were examined.

Studies revealed several indications and when these indications were reviewed (Table 1):

- Female-to-male transgender-191,
- Extraphy-40,
- Penile amputation/trauma-16,
- DSD and micropenis-9,
- Ambiguous genitalia-9,
- Other-11.

Due to these conditions, several phalloplasty techniques were performed (Table 1):

- Radial forearm flap-197,
- Anterolateral thigh flap-9,
- Bird-wing phalloplasty-4,
- Suprapubic phalloplasty-34,
- Fibular flap-32.

Rieger et al.^[11] reported 27 radial forearm free-flap operations for female-to-male transgender patients. In this study, 7 free groin flaps and 20 full-thickness skin grafts were used for donor site coverage. Mean functional rating was 3.6/4 for free groin flap group and 3.1/4 for full-thickness skin graft group (1=poor, 2=satisfactory, 3=good, 4=excellent), mean aesthetic rating was 3.7/4 for free groin flap group and 2.9/4 for full-

Table 1. Indications and operative techniques

Author	No of patients	Indications	Type of phalloplasty
Rieger et al. ^[11]	27	Female-to-male transgender	Radial forearm free-flap
Kim et al. ^[12]	58	Female-to-male transgender	Radial forearm osteocutaneous flap
Callens et al. ^[13]	18	4 (46 XY DSD and micropenis), 8 (bladder or cloacal exstrophy), 5 (trauma), 1 (idiopathic)	14 Radial forearm free-flap, 4 Anterolateral thigh flap
Garcia et al. ^[14]	25	Female-to-male transgender	15 Radial artery forearm-flap, 10 pedicle-flap suprapubic phalloplasty
Massanyi et al. ^[15]	10	8 classic bladder exstrophy, 2 cloacal exstrophy	Radial forearm free-flap
Garaffa et al. ^[16]	16	Bladder/cloacal exstrophy and micropenis-epispadias complex	Total phallic reconstruction with radial artery based forearm free flap phalloplasty
Bajpai et al. ^[17]	4	Disorder of sex development with 46 XY and severe penile deficiency	Bird-Wing' abdominal phalloplasty
Elhaggagy et al. ^[18]	9	Intersex patients with ambiguous genitalia as a result of female circumcision	Radial forearm free-flap
Lumen et al. ^[19]	7	Female-to-male transgender	6 Radial forearm free-flap, 1 Anterolateral thigh flap
Timsit et al. ^[21]	6	Bladder exstrophy and unsatisfactory penile appearance	Radial forearm free-flap
Lumen et al. ^[20]	11	6 shrivelled penis, 2 penile necrosis, 1 micropenis, 1 crippled penis, 1 penile amputation	7 Radial forearm free-flap, 4 Anterolateral thigh flap
Terrier et al. ^[1]	24	23 Female-to-male transgender 1 Penil amputation	Suprapubic phalloplasty (3 stages)
Song et al. ^[22]	19	Female-to-male transgender	Radial forearm free-flap
Falcone et al. ^[23]	10	2 self-amputation (schizophrenic episode 3 traffic accident, 3 blast injury, 1 donkey bite, 1 fournier gangrene	Radial forearm free-flap
Papadopulos et al. ^[24]	32	Female-to-male transgender	Osteofasciocutaneous fibular flap

thickness skin graft group. In another study by Kim et al.^[12] 58 radial forearm osteocutaneous flap operations were reported as gender reassignment. Satisfaction score of rigidity and volume were assessed using a scale from 1 to 5 (1=very poor, 2=poor, 3=not good, 4=good, 5=very good). Most of the patients had softened neophallus after the surgery and 12 patients, who wanted corrective operation, were reviewed. Two of these cases were due to shallow bony component and 10 of them were due to fat absorption.^[12] Shallow bony components were treated with rib bone graft, 6 of fat absorptions were treated with using implant, 3 of them with fat injection and 1 with artificial dermis.^[12]

After the surgery:

- 4 patients were very good satisfied,
- 7 of them were good satisfied,
- 1 of them was dissatisfied.^[12]

Callens et al.^[13] reported 18 patients:

- 4 had disorder of sex development,
- 8 had exstrophy,

- 5 had trauma,
- 1 was idiopathic.

Fourteen radial forearm free-flaps and 4 anterolateral thigh flaps used for these patients.^[13] Ten of these patients were assessed for sexual satisfaction. Sexual quality of life outcomes were compared to the patients with hypospadias repair. All patients were sexually active (80% intercourse and 100% masturbation). 75% of the patients were inhibited in seeking sexual contacts while it was 40% for hypospadias. Garcia et al.^[14] used radial forearm free-flap for 15 patients and 10 pedicle-flap suprapubic phalloplasty operations were included for femal-to-male transgender patients. Mean satisfaction score was 9.1/10 for suprapubic phalloplasty and 9/10 for radial artery forearm-flap phalloplasty Massanyi et al.^[15] reported 8 patients with bladder, 2 patients with cloacal exstrophy and radial forearm free-flap operations were performed. Transferred flap survived in all 10 patients. Garaffa et al.^[16] reported 16 patients with bladder/cloacal exstrophy and radial artery forearm free-flaps were used. 15 patients (93%) were fully satisfied with phallic cosmesis and size. 1 patient had distal part loss due to acute thrombosis. Bajpai et al.^[17] reported

Bird-Wing abdominal phalloplasty technique for 4 patients who had disorder of sex development and severe penile deficiency. The neophallus remained viable and survived in all patients and also there was no problem about the donor site. Elhaggagy et al.^[18] operated 9 intersex patients with using radial artery forearm free-flap. All patients were fully satisfied. Lumen et al.^[19,20] reported two studies about phalloplasty. In the first study, 11 patients were included and indications were different.^[19] 6 patients with shrivelled penis, 2 patients with penile necrosis, 1 patient had micropenis, 1 patient had crippled penis and 1 had penile amputation.^[19] For 7 patients, radial forearm free-flaps were used and for 4 patients, anterolateral thigh flaps were used.^[19] All flaps survived and there were no complications about the donor site. In the second study, 7 female-to-male transgender surgeries were included. 6 of the surgeries were radial forearm free-flap phalloplasty operations and 1 of them was anterolateral thigh flap phalloplasty.^[20] Graft survival was noticed for all patients, patient satisfaction was high for 6/7 patients and was moderate for 1 patient. Timsit et al.^[21] reported 6 radial forearm free-flap phalloplasty operations due to bladder exstrophy and unsatisfactory penile appearance and there were 3 complications in the postoperative period. Terrier et al.^[1] reported the results of 24 patients and 23 of them were due to female-to-male gender reassignment, 1 of them was due to penile amputation. Neophallus survived in all patients and overall satisfaction was 95%. Song et al.^[22] reported 19 radial forearm free-flap phalloplasties due to female-to-male gender reassignment. There were good aesthetic results but unfortunately there were 2 complete flap loss. Falcone et al.^[23] reported 10 patients with several indications. Two patients had self-amputation due to schizophrenic episode, 3 had traffic accident, 3 had blast injury, 1 had donkey bite and 1 had Fournier gangrene. All patients were fully satisfied and urinary functions were normal. Radial forearm free-flaps were used for these patients. Papadopulos et al.^[24] reported 32 osteo-cutaneous fibular flap phalloplasty operations. All patients were sexually active and reported good results during the intercourse. When considering the overall results of these studies, successful outcomes were reported. Most of the patients were fully satisfied with both appearance and the function. Also very good quality of life results were obtained.

When all the complications in the studies were reviewed (Table 2):

- Softened phallus-12,
- Infection-19,
- Thrombosis/necrosis-16,
- Urethral complications-60,
- Flap loss-3,
- Other-36.

There were some rare systemic problems like pulmonary embolism. There were urethral complications and most of them were urethral stricture and fistula that required reconstruction. Most of the complications related with neophallus were arterial thrombosis and necrosis that caused total or partial flap loss.

Reconstructive additional procedures were performed for that complications.

Discussion

Phalloplasty is a challenging and a mysterious operation that has several indications. This reconstructive operation is usually performed for gender reassignment and penile amputation (usually postoncologic).^[25] Micropenis, epispadias, hypospadias are the less frequent indications.^[25] Different surgical techniques would be used and for each technique there are several benefits and limitations.^[26] Metoidioplasty is one of these techniques and easier when comparing to other techniques but there are some important limitations like short phallus that does not allow for sexual penetration.^[26] Radial forearm-flap, first described by Song et al.^[22], Chang and Hwang^[26-28], has probably the best cosmetic and functional results (Figure 3). Radial forearm free-flap provides superior cosmetic results with a cylindrical phallus and it is better than the wedge-shaped neophallus as in infraumbilical and groin flap phalloplasties (Figure 2, 4).^[27,29-33] Salgado et al.^[34] used uterine mucosa for prelamination of neourethra for a patient who underwent hysterectomy and vaginectomy before the stage of radial forearm phalloplasty and reported good result.

With fibula flap and latissimus dorsi flap, there is no need for an erection device.^[26] For thigh flap, it is easier to hide the donor site and the suprapubic flap phalloplasty is an easier technique.^[26] When compared to radial forearm flap, there are some advantages of using anterolateral thigh flaps.^[33] With anterolateral thigh flap, there is no need for a microsurgical procedure, no scars are seen at the noticeable sites, no major vessel damage and small functional loss at donor site.^[35]

Types of procedures would be classified as microsurgical and non-microsurgical.^[35] Microsurgical procedures are myocutaneous latissimus dorsi flap, radial forearm free-flap and osteo-cutaneous fibular flap phalloplasties.^[36] Non-microsurgical operations are extended pedicle island groin flap, De Castro neophalloplasty and scrotal phalloplasty operations.^[36] Penile reconstructive surgery has also psychological effects beside its functional and aesthetic effects.^[37] Several techniques are commonly used for penile lengthening and penile girth enhancement.^[37] Penile girth enhancement is mainly performed by two different techniques.^[37] Cavernosal and albugineal surgeries are used for this purpose.^[37] Autologous dermal or dermis-fat grafts are used for enhancement during pericavernosal surgery and alloplastic or saphenous-patch grafts are used for enlargement of the cavernous body in albugineal surgery.^[37-40] Also there are some techniques used for penile lengthening such as suspensory ligament release, augmentation corporoplasty, ventral phalloplasty, and suprapubic lipectomy, monsoplasty.^[41] Ventral phalloplasty would be used for penile lengthening with or after partial penectomy as Wallen et al.^[42] reported good results. Aphallia is a rare congenital defect with the ratio of 1/30 million births.^[43]

Table 2. Operative results and complications

Author	Results	Complications
Rieger et al. ^[11]	7 free groin flaps (Group A), 20 FTSGs from the groin (Group B) used for the donor site coverage	1 patient required revision due to haematoma (Group A), 2 patients (Group B) required revision at the forearm 1 patient (Group B) had wound dehiscence at donor site
Kim et al. ^[12]	12 patients had softened phalli (2 due to shallow, bony component and 10 due to fat absorption)	6 patients were treated with implant, 3 with fat injection, 2 with rib bone graft and 1 with artificial dermis
Callens et al. ^[13]	10 patients were assessed with Sexual quality of life (QoL). All men were sexually active	No complications with donor area, 8 urethral complications, 3 infections, 1 pilonidal sinus
Garcia et al. ^[14]	Overall satisfaction was 9.1/10 for SP, 9.4/10 for RAP without nerve anastomosis, 8.7/10 for RAP with nerve anastomosis. Mean flaccid phallus length during follow-up was 13.3cm for SP, 11.95 cm for RAP	No complications indicated
Massanyi et al. ^[15]	10/10 flap survival.	1 patient required operative debridement for small area of partial necrosis, 1 required revision of arterial anastomosis due to arterial thrombosis
Garaffa et al. ^[16]	3 stages were completed in 12 patients, 4 had undergone phallus construction only.	2 had acute arterial thrombosis, 1 had phallic partial necrosis, 3 had incomplete arm graft take, 6 had fistula, 2 had stricture, 2 had prosthesis infection, 1 cylinder was too short
Bajpai et al. ^[17]	The phalloplasty remained viable during follow-up for all cases and wound healing was excellent.	No complications indicated
Elhaggagy et al. ^[18]	The length of the new phallus was 11-15 cm and all patients were fully satisfied with the size and cosmetic appearance.	No complications were seen.
Lumen et al. ^[19]	In all patients the graf survived.	1 pulmonary embolism, 1 severe haematuria with clotting and obstruction of the urinary catheters. 5 had urethral reconstruction due to fistula/stricture. No complications with donor area.
Timsit et al. ^[21]	Flap survival was 100% the mean penile length was 12.6 cm in traction.	1 late prosthesis extorsion and infection of artificial sphincter, 2 urethral stricture
Lumen et al. ^[20]	Total flap survival was noticed in all patients. In 9 patients aesthetic appearance was excellent and in 2 appearance was moderate.	No complications for the donor area, 8 patients underwent urethral reconstruction, 4 urethral complications, persistent fistula at anastomosis developed in 3 patients
Terrier et al. ^[11]	Overall satisfaction was 95%, Appearance 95%, Penile length 81%, Circumference 71%	Stage 1 (Tissue expanders)- 17% minor complications (2 migration, 1 perforation, 1 abscess) / Stage 2 (Tubing)- 54% minor complications(10 infections, 18 shearing sutures) / Stage 3 (Liberation)- 4% (1 distal necrosis)
Song et al. ^[22]	Total flap survival was noticed in all patients. In 9 patients aesthetic appearance was excellent and in 2 appearance was moderate.	2 tip necrosis, 1 distal flap loss, 3 forearm cellulitis surrounding the tube-shaped skin graft, 2 complete flap loss, 2 neoscrotal abscess, 1 fistula, 5 stricture, 9 fistula+stricture, 1 chronic moderate left hydronephrosis.
Falcone et al. ^[23]	All patients were fully satisfied and urinary functions were normal	2 patients had acute arterial thrombosis of the microsurgical anastomosis, 3 patients had urethral fistula, 1 patient developed stricture, no complications about the donor site.
Papadopoulos et al. ^[24]	All patients were sexually active and reported good to very good sexual intercourse	2 total, 4 partial necrosis, 10 urethral stricture, 7 fistula, donor site morbidity was moderate

Phallic reconstruction is challenging and there are several microsurgical techniques are used but also several limitations for these techniques are known. Lack of further growth is one of the limitations and also the large size of neophallus would a problem for a child at younger age.^[43] There are several suggestions

about the timing of surgery and according to most of them phalloplasty should be performed before or at around the time of puberty.^[4,33,44] Most of the techniques use somatic tissues that are not responsive to hormones and for pediatric patients, adult-size phallus should be planned.^[4,33,45] Scrotal phalloplasty described

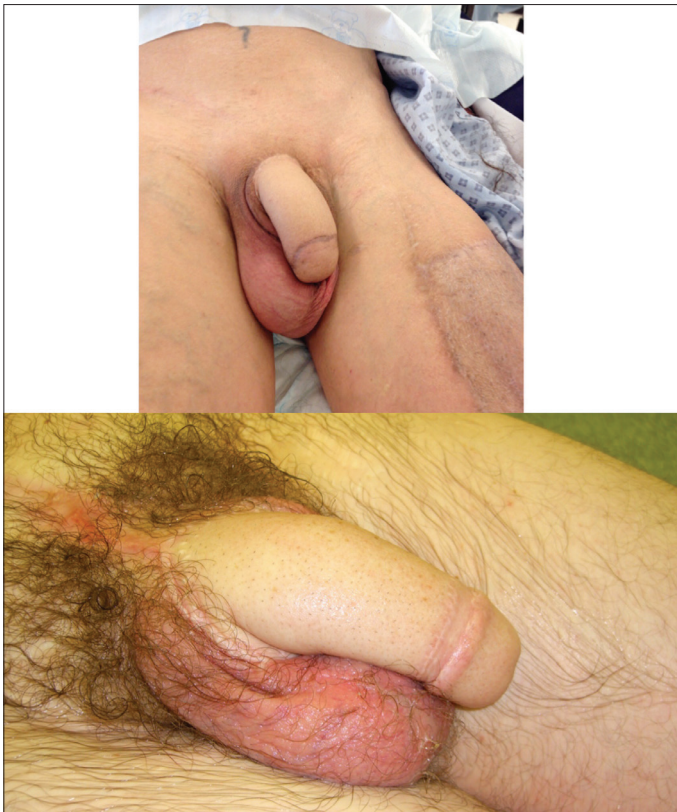


Figure 4. Postoperative appearance and aesthetic neophallus (Mr. Ralph's photo archive)



Figure 5. Direct closure of donor site and outcomes (Mr. Ralph's photo archive)

by Bajpai et al.^[43] would be considered for the children at early school ages. Parascrotal flap phalloplasty is a similar technique that provides a physiological and psychological satisfaction with a realistic penis with urethra.^[46] 'Bird-wing' abdominal phalloplasty is a different technique by Bajpai et al.^[17] that would be

used at around the time of puberty for minimising the psychological trauma. Gender reassignment surgeries have become more common in different population worldwide and a significant decrease in age for the recent years, is clearly obtained in a study by Aydin et al.^[47] in Denmark. In this study, the sex ratio was 1.9/1 (female-to-male/male-to-female) that is similar with Belgium and Netherlands.^[47-49]

Awareness of gender dysphoria and its treatment are increasing.^[50] Female-to-male transgender surgery includes some components such as hysterectomy, ovariectomy, flap preparation for urethral elongation, formation of distal urethra, metoidioplasty and phalloplasty (if the patient wants a neophallus).^[5] Penile cancer is a rare malignancy and the most common form is squamous cell carcinoma.^[51] Penile cancers are generally treated with subtotal or total penectomy but if the patient refuses amputation different techniques would be used.^[51] Penile amputations are also uncommon conditions that would occur with self mutilation, accident or felonious assault.^[52] The treatment of amputation includes basic forms such as surgical replantation, tailoring the penile stamp and total phallic reconstruction.^[52]

Penile fracture is one the indications of penile reconstructive surgery as a cause of rupture of tunica albuginea of the corpora cavernosa after blunt trauma to erected penis and it is an uncommon condition in Europe and America.^[7] There are conservative and surgical managements of penile fracture.^[7] Electrical burn is one of the other rare causes of penile loss and Sridhar et al.^[53] reported a challenging case that was treated with phalloplasty using a right-side groin flap. In recent years, augmentation phalloplasty of normal penis is gaining popularity among men but there would be some complications.^[54] Spyriounis et al.^[54] reported a case with dorsal penile skin necrosis and a pedicled anterolateral thigh flap was used for reconstruction. The donor-site morbidity is another problem during the postoperative period of phalloplasty operations. Van Caenegem et al.^[55] reported the donor-site morbidity results and there were no functional limitations for daily activities, pain-free aesthetically acceptable appearance with a favorable bone health (Figure 5).

In conclusion, phalloplasty is a mysterious operation that would be performed due to several indications. There are different types of surgical techniques and lots of benefits and limitations for these techniques. Several studies were reported in order to present the results and complications for this operation. In this review, different techniques, results and complications of these techniques are evaluated and compared.

As a result of this review, phalloplasty is a reliable and useful operation with good functional and aesthetical results. There are some major and minor complications but most of these complications are treated with different reconstructive techniques.

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