Penile Reconstruction
Evaluation of the Most Accepted Techniques

Alireza Babaei,[1] Mohammad Reza Safarinejad,[2] Farhat Farrokhi,[2] Elham Iran-Pour[2]

Purpose: Loss of the penis can have a devastating effect on the lives of sufferers with significant psychogenic implications. Penile reconstruction or phallus construction poses a difficult challenge and a demanding problem to the urologists and plastic surgeons. Different techniques have been used for construction of a total penis and reconstruction of severely injured penis. The objective of this review was to determine the efficacy, advantages and disadvantages of the most popular penile reconstruction (PR) and phallus construction techniques.

Materials and Methods: We searched without language restriction MEDLINE, Pre-MEDLINE EMBASE, and the Cochrane Central Register of Controlled Trials (CENTRAL) from January 1960 to January 2009. In addition, we searched the citation lists of relevant articles and book chapters. Studies evaluating the functional and cosmetic results of different techniques of total phallus construction (TPC) and penile reconstruction (PR) were identified. Two authors independently evaluated studies for selection, study quality, and extracted data. The primary outcome was creation of a sensate and cosmetically acceptable phallus. The secondary outcomes were competent neourethra that allows voiding in comfortable position, sexual intercourse, and the rate of complications.

Results: One hundred and forty-six studies with a total of 1622 patients were included in this review.

Conclusion: Data from the available studies are insufficient to recommend any technique for TPC or PR. In the absence of evidence to support any method, the review authors recommend the one-stage TPC or PR. Further studies are warranted, preferably multi-centered studies.

Keywords: penis, reconstructive surgical procedures, gender assignment

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[1]Department of Plastic Surgery, Aja University of Medical Sciences, Tehran, Iran
[2]Urology and Nephrology Research Center, Shahid Beheshti University, MC, Tehran, Iran

Corresponding Author:
Mohammad Reza Safarinejad, MD
Urology and Nephrology Research Center, No.103, 9th Boustan St., Pasdaran Ave., Tehran, Iran
Tel: +98 21 2256 7222
Fax: +98 21 2277 0954
E-mail: safarinejad@unrc.ir

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INTRODUCTION

Background

Total phallus construction (TPC) or penile reconstruction (PR) is indicated for loss of the penis due to various causes such as trauma, burns, animal bites, congenital anomalies, self-amputation, malignancy, gender dysphoria, and etc.[1,2] Penile loss negatively affects different aspects of life, psychological status, and social relationships as well as the relationship with the partner. The type and extent of the penile loss varies from minimal partial to total. The value of the various microsurgical techniques for replantation of the penis remains uncertain.[3] A variety of operative techniques have been developed in order to restore the functional and esthetical male genitalia. The main

goals of the surgery are creation of a cosmetically acceptable sensate penis, incorporation of the urethra that extends up to the distal tip which permits voiding in a comfortable position, and providing enough bulk to allow the insertion and retain a permanent penile prosthesis for sexual intercourse. In addition, the donor-site should cause minimal secondary morbidity and should be easy to conceal. However, penile reconstructive operations have generally been challenging not only for the limited availability of the donor materials, but also for requirements (mainly sexual intercourse, normal appearance, and voiding) that must be addressed.[4,5] Phallus construction requires a holistic multidisciplinary team approach, involving both the urological reconstructive and plastic surgeon. Total phallus construction may be considered in patients with severe congenital penile defect and gender reassignment, and in those who have suffered from penile loss resulting from various causes. Historically, several techniques have been described for TPC. The first TPC was done in 1936 by Bogoras,[6] who used a traditional tubed pedicle flap without including a competent neourethra. Penile rigidity was obtained by inclusion of a rib cartilage inside the flap. This method required multiple staged surgeries without cosmetically acceptable phallus. Afterward, Bogoras technique was improved by creating a penis which incorporated a neourethra using the 'tube within a tube' design.[7,8] During the past two decades, the advent of microsurgical techniques and well-designed composite flaps have made great advances in PR. Various surgical techniques have been used for PR, among them are pedicled flaps,[9,10] pedicled myocutaneous flaps,[11] free skin flaps,[2,12,13] and combined osteocutaneous flaps.[4,12] As pedicled flaps, gracilis,[14,15] iliac,[16,17] fibula,[16,18,19] scrotal,[20,21] groin,[22,23] and abdominal tube flaps[10,11] have been used with various success rates.

Despite great advances in microsurgical techniques, and penile revascularizations,[24] management of any type of penile loss remains a challenging task for urologists and plastic surgeons. Choosing an appropriate donor/graft material and technique is a crucial aspect of successful PR and ideal functional outcome of surgery. In this study, using comprehensive in depth review, we assessed the functional outcomes and patients' satisfaction with the use of the most accepted procedures for TPC and PR techniques.

Objectives

We determined the overall efficacy and complications of the most popular TPC and PR techniques in patients who have had a partial or total penile reconstruction. We also characterized the anatomical, physiological, and cosmetic features and feasibility of the procedures as well as the short-term and long-term clinical results.

The main outcome was creation of sensate and cosmetically acceptable penis. Secondary outcomes included competent neourethra that allows voiding and sexual intercourse, and the rate of complications. Complexity of techniques, configuration, good function, and deformity of the donor-site were also assessed.

MATERIALS AND METHODS

Criteria for considering studies for this review:

Types of studies

All published studies evaluating surgical techniques for TPC and PR were included. Controlled clinical trials and case reports were to be considered in the absence of randomized controlled trials.

Types of participants

Participants were from all ages that have undergone TPC or PR.

Search methods for identification of studies

We searched MEDLINE from January 1960 to January 2009 with the following search terms:

phalloplasty, penile reconstruction, penile cancer, penis, trauma, reconstructive surgical procedures, surgical flaps, amputation of penis, penile reconstruction and penile cancer, penile reconstruction and amputation of penis

Data collection and analysis

Eligibility

In this review, one reviewer evaluated the titles

and abstracts obtained from our literature search and assessed all possibly relevant articles to determine eligibility.

Extraction

Two authors independently collected the study characteristics and data, and disagreements were resolved by discussion.

RESULTS

Types of surgery

Radial free forearm flap[18,25-39]

Radial free forearm flap (RFFF) was originally described by Song and colleagues in 1982.[40] Later, Chang and Hwang used this technique successfully for TPC in 7 patients following penile amputation.[41] Radial free forearm flap technique has proven to be superior to all other techniques.[25]

Fifteen patients, who had a subtotal penectomy for penile or urethral cancer, had undergone total phallic reconstruction using RFFF.[25] All patients had cosmetically acceptable phallus and 14 were able to void while standing. In this study, only 7 patients had insertion of a penile prosthesis, of whom 5 could engage in sexual intercourse. The most common complications were urethral strictures (3, 20%) and fistula formation (4, 26.7%).

Hu and associates[10] identified success rates of 3 penile reconstruction techniques (lower abdominal pedicled fascia flaps, para-umbilical island flaps, and free forearm flaps) in 44 patients. Half of the flaps survived in patients receiving lower abdominal pedicled fascia flaps, but neopenis survived in 100% of patients with para-umbilical island flaps and free forearm flaps. The authors concluded that the best methods for PR are the para-umbilical island flaps and free forearm flaps. In other study, 22 cases of primary female-to-male trans-sexuals had undergone phalloplasty using free radial forearm osteocutaneous flaps. Twenty-one subjects (95.5%) had complete flap survival. The most common complications were urethrocutaneous fistula (40.9%) and urethral stricture (13.7%). No complete flap loss occurred and 1 patient developed partial loss (10% reduction). Significant donor-site morbidity was noted in 9.1% of the subjects. The entire reconstructed penis gained protective sensation within 9 months. Of 22 subjects, 9 engaged in sexual intercourse and all of them rated their sexual performance "satisfactory". Leriche and coworkers analyzed the long-term results of RFFF in 56 trans-sexuals, retrospectively.[36] The subjects were followed up for 11 to 204 months (mean, 110 months). The flap survived in 53 (95%) of the cases and 51 (93%) of the patients reported normal-appearing external genitalia. Flap and prosthesis complications were noted in 25% and 29% of the subjects, respectively. In addition, 7 of 19 patients (37%) who had undergone urethroplasty, developed complex urethral strictures and fistula that led to perineal urethrostomy. The authors concluded that phalloplasty using RFFF leads to good results in term of flap survival and patient satisfaction; however, there are noticeable complications. In other study, during a 5-year period, 56 phallus constructions using sensate free forearm flaps were done for 56 primary female trans-sexuals by Fang and colleagues.[39] The urethrocutaneous fistula rate was high (67.9%), therefore, Fang and associates proposed a tubed graft of vaginal mucosa which had less complications and a lower fistula rate.

Mutaf described the first nonmicrosurgical use of the radial forearm flap for PR in 4 patients.[28] With this technique, an osteocutaneous radial forearm flap is elevated as a reverse-flow island flap and used to create a neophallus in the classic "tube within a tube" design. All of the patients had good results. The author concluded that although radial forearm flap is a multistage technique, it is easy to be carried out and does not necessitate the sophisticated equipment and skill of microsurgery.

Free sensate osteocutaneous fibula flap[4,18,19,42-48]

Free sensate osteocutaneous fibula flap was first described for total penile construction by Sadove and colleagues in 1993.[44] Schaff and Papadopulos reported neophallus creation with free sensate osteofasciocutaneous fibula in 31 and radial forearm flap in 6 female-to male trans-sexuals.[18]

Partial flap necrosis occurred in 16.1% and 16.6% of patients with fibula and forearm flaps, respectively. The most common complications were urethral stricture (32.4%) and fistula (16.2%). Subjects with fibula flap reported a better sexual intercourse compared to the forearm group. The donor-site morbidity was comparable in both groups.

In other study, free prelaminated and sensate osteofasciocutaneous fibula flap was done in 32 female-to-male trans-sexuals.[19] Total and partial necrosis of fibula flap occurred in 2 and 4 patients, respectively. Urethral strictures (10) and fistula (7) were the most common complications. Significant variation in size, length, shape, and stiffness of the constructed phallus were not seen. Patients had acceptable tactile as well as the erogenous sensation in the neophallus. All subjects had good sexual intercourse and the donor-site morbidity was moderate. In other study by Sengezer and associates, 18 biological male patients with penile loss resulting from various causes had undergone total penile reconstructions with sensate osteocutaneous free fibula flap.[4] Of a total of 18 subjects, 1 patient developed flap failure. Interestingly, no urethral fistula was observed, and only 1 patient developed urethral stricture. Sexual intercourse and orgasm were satisfactory in most of the patients. The results of the bone viability investigations are consistent with viability of the bone grafts.

Free Scapular Flap[2,12,49]

Free scapular flap technique was first described by Rohrich and colleagues.[50] They used a combined latissimus dorsi-scapular free flap for simultaneous penis and perineum reconstruction. This simple technique is a practical method, which yields appropriate configuration, satisfactory penile function, and less donor-site morbidity.[12]

Yang and coworkers reconstructed 20 patients with penile loss using this technique.[2] The rate of postoperative viable flap was 100%. In these subjects, complications such as urethral fistula, prosthesis infection, or extrusion were not reported. The authors concluded that the scapular free flap is an ideal flap that yields satisfactory penile function and cosmetic appearance. In another study, 15 men aged 20 to 48 years underwent the free scapular skin flap for penile reconstruction.[12] Of reconstructed penis, 14 (93.3%) patients were satisfied with good esthetic results as well as functionality. In this study, sensory nerves were not transferred, but the flap regained sensitivity within 6 months. The scapula may be used for obtaining penile rigidity; nonetheless, its configuration is difficult. Therefore, insertion of a penile prosthesis should be done.

Vertical rectus abdominis flap[11,51,52]

Vertical rectus abdominis flap was first described by Santi and associates.[52] It is suitable for immediate one-stage penile reconstruction; however, information about this technique is very scarce. Kayes and colleagues used vertical rectus abdominis flap for PR in 4 patients with advanced penile cancer.[11] All grafts were viable and patients' satisfaction was excellent. Davies and Matti used the deep inferior epigastric flap to construct a phallus in 3 trans-sexuals and 1 pseudohermaphrodite. All subjects were extremely satisfied with their surgery.[53]

Suprapubic abdominal wall flap

Bettocchi and coworkers reported the results of pedicled pubic phalloplasty in 85 female-to-male trans-sexual patients.[9] Three patients had complete loss of the reconstructed phallus due to a gangrenous infection. The cosmetic outcome was rated as good, by both patient and surgeon, in 58 (71%) of the subjects. The neourethra complications were high (75%). Of 85 patients, 64% and 55% developed urethral stricture and fistula, respectively. The authors believe that creation of the neourethra in 2 stages has less urethral complications. Perineal fistula occurred in 94% and 24% of the one-stage and two- stage operations, respectively. Sixteen patients were able to engage in sexual intercourse without prosthesis.

DISCUSSION

The ultimate goals in PR are as follows: the penis should have adequate size and bulk with enough rigidity, the constructed phallus should have enough protective, tactile, and erogenous

sensation and should provide adequate urethra up to the glans without any fistula.[54]

Recently, the use of a radial forearm flap has become the most popular technique to reconstruct a neophallus. However, it has its own limitations such as urethral fistula and penile fibrosis as a result of the tissue atrophy. In addition, the donor-site morbidity is a great concern with this technique. Forearm free flap phalloplasty also provides excellent long-term satisfaction in patients with bladder exstrophy.[33,55] In an earlier study, using radial forearm flap in 5 trans-sexual subjects, disappointing results and high incidence of complications have been reported.[56] The main complications, advantages, disadvantages, and limitation of forearm free flap are as bellow:

Complications: Overall complication rate and donor-site morbidity may occur in 45% of subjects.[38] The most common complications are related to neourethra. The reported urethral complications greatly vary in different studies (0 to 60%), which may be related to surgeons' experience and equipment used to construct neophallus.

Advantages: Good cosmetic result by forming a cylindrical phallus, creation of an acceptable sensate phallus,[25] providing good sensory nerves for its neurovascular pedicle,[12] excellent phallus sensation if the nerve is well-functioned,[54] and well-vascularized neourethra that allows voiding from a standing position.[29,47]

Disadvantages: Sacrificing a trunk artery of the forearm decreases muscle function of the forearm,[2] large donor-site depressive scar, urethral fistula, and need for microvascular anastomosis,[57] thin subcutaneous tissue, less tissue for transfer, thin reconstructed phallus,[12] erosion of the penile prostheses in significant number of subjects due to softening of the flaps,[4] and susceptibility of the radial bone to fracture as a result of being thin and unicortical.[4]

Limitations: Unsuitable to reconstruct the urethra in patients with thick hair.[2]

Once the new phallus has been reconstructed, providing adequate rigidity for sexual intercourse remains a major challenge. Various different solutions have been proposed, including the autologous bone, the autogenous cartilage rods,[58] silicone prostheses,[59,60] and the autologous engineered cartilage rods.[61] But, the best results have been reported by inserting an inflatable penile prosthesis.[62]

With radial free forearm flap technique, penile rigidity can be obtained by inclusion of the radius bone. One can harvest this forearm free flap with thin unicortical radius bone. The long-term survival of this bone has not been shown adequately.[54] Indeed, the resorption of the bone, fracture, and perforation are the potential complications that can lead to failure.[47,63]

Felici and Felici, after a 10-year experience with neophallus construction in female to male gender reassignment surgery and with more than 100 patients treated, introduced a new technique.[64] They performed 6 neophallus constructions with free anterolateral thigh flap. The esthetic results of the neophallus were suitable, the flap achieved sensation and an erectile prosthesis could be easily inserted. Use of the anterolateral thigh flap for penile construction eliminates various concerns about the forearm donor-site morbidity.[64] Satisfactory results with free anterolateral thigh flap have also been reported by other authors.[65,66]

The scapular free flap technique is a practical method, which yields appropriate configuration, satisfactory penile function, and less donor-site morbidity.[12] Due to adequate amount of tissue, the scapular free flap is an ideal donor-site for harvesting large amount of flap. In addition, owing to constant vascularity and sufficient blood supply, few donor-site morbidities are encountered.[2] The advantages of this technique are ideal donor-site for obtaining great amount of flap, and easier intra-operative vascular anastomosis due to inferior epigastric artery and vein long pedicle.

Disadvantages include difficulty of nerve transfer and being inappropriate to reconstruct the urethra in hirsute patients.[2] The advantages of the rectus abdominis flap over other flaps include a strong tissue paddle for filling tissue defects and a very good blood supply through segmental

perforators of the superior and inferior epigastric arteries. Thus, large defects on both donor and recipient sites can be easily covered with primary closure. However, this method is contraindicated in obese patients and subjects who have pre-existing midline and paramedian scars.[11] Phallus construction with free sensate fibula flap gives good cosmetic and functional results.[4] Sengezer and colleagues recommended the free sensate osteocutaneous fibula flap as the standard technique in penile reconstruction.[4]

CONCLUSION

The literature lacks enough data concerning the detailed erogenous and tactile sensibility, and erectile capability of the reconstructed neophalluses. Of penile reconstruction techniques, free radial forearm and sensate osteocutaneous free fibula flaps are the most accepted ones that provide phallic rigidity.

The scarcity of detailed data in the urologic and plastic surgery literature raises assumption about the true efficacy and morbidity of each technique. Reconstructing a neophallus with enough rigidity to permit sexual intercourse and penetration has remained a great challenge in the field of urology.

CONFLICT OF INTEREST

None declared.

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