Current Urology Reports (2018) 19: 36
https://doi.org/10.1007/s11934-018-0795-y

SURGERY (J SIMHAN, SECTION EDITOR)

Reconstructive Management Pearls for the Transgender Patient

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Published online: 11 April 2018

Abstract

Purpose of Review A growing number of transgender patients are seeking gender-affirming genital reconstructive surgery (GRS). These complex procedures have high complication rates. We describe common surgical pitfalls in GRS and approaches for minimizing complications.

Recent Findings Penile inversion vaginoplasty has been associated with excellent cosmetic and functional outcomes. A robotic-assisted dissection may minimize risk of rectal injury. As a younger transgender population chooses pubertal suppression, alternative sources for lining the vaginal canal, such as enteric vaginoplasties, may be more widely utilized. Since adoption of microvascular techniques in phalloplasty, transmasculine individuals have potential for a sensate neophallus and penetrative intercourse. Urethral complications are common and challenging to manage; techniques using flap coverage may minimize ischemia-related strictures. Innovations in prosthesis placement require adaptations to neophallus anatomy.

Summary A growing number of transgender individuals are seeking genital reconstruction. Ongoing innovation in surgical technique is needed to improve patient outcomes.

Keywords Transgender · Vaginoplasty · Phalloplasty · Urethral stricture · Penile prosthesis

Introduction

Transgender and gender nonconforming individuals, or individuals who do not identify with their sex assigned at birth, are estimated to comprise up to 0.6% of the US population [1••]. As societal recognition and acceptance of transgender individuals grows, so has demand for gender-affirming surgeries, or procedures geared towards aligning an individuals' physical appearance with their gender identity.

Genital reconstructive surgery (GRS) for transgender women (transfeminine, male-to-female [MTF] patients) may include labiaplasty, clitoroplasty, and vaginoplasty. Reconstructive procedures for transgender men (transmasculine, female-to-male [FTM] patients) may include vaginectomy, phalloplasty or metoidioplasty, scrotoplasty, and placement of erectile and testicular prostheses. These operations are dependent on preservation of delicate vascular supply and often complex tissue transfer techniques to create functional, esthetic results. Complications pose unique technical challenges to reconstructive urologists and plastic surgeons.

We describe reconstructive management pearls in the care of transgender patients.

This article is part of the Topical Collection on *Surgery*

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Feminizing Procedures

The goals of GRS for transgender women are both cosmetic and functional: to create a perineogenital complex that is feminine in appearance, and if desired, suitable for receptive intercourse. As such, feminizing procedures include orchiectomy, penectomy, external labiaplasty, clitoroplasty, and vaginoplasty. This review focuses on common reconstructive challenges in vaginoplasty.

Vaginoplasty

The ideal neovagina is moist, elastic, and hairless with a depth of at least 10 cm and a diameter of at least 3 cm. The urethra is shortened to allow the urinary stream to face downward in the seated position [2]. Numerous vaginoplasty techniques have

been described, including non-genital skin grafts or flaps and pedicled intestinal transplants, though currently, the most prevalent technique is the penile inversion vaginoplasty with scrotal graft.

Early descriptions of non-genital skin grafts for vaginoplasty involve draping of skin grafts over sponge forms or perforated plastic molds [3, 4].These single-stage approaches are capable of creating a sufficiently deep, wide, and non-hair-bearing neovagina, but they are associated with donor-site scarring, a circular scar at the vaginal introitus, as well as poor sensation and lack of natural lubrication from the grafts. As with skin grafts to other sites, there is a tendency for graft shrinkage, which necessitates post-operative dilation. Non-genital skin flaps approaches include the medial thigh flap and inguinal pedicled flaps [5]. These flaps have a decreased risk of contraction, however are subject to donor-site morbidity, scarring, and increased technical complexity. Non-genital skin flaps also tend to be bulkier than genital skin flaps, decreasing the functional dimensions of a neovagina within a narrower male pelvis [2].

Penile skin inversion, described by Gillies and Millard in 1957, is the most commonly utilized vaginoplasty technique [6]. This approach can be performed in a single stage and uses the penile shaft skin, foreskin, and scrotal skin to create the vagina, labia minora, and labia majora, while the glans penis is used to create the neoclitoris [7] (Fig. 1). Electrolysis is recommended preoperatively to reduce risk of hair-bearing skin in the vagina when scrotal skin grafts are used. Patients will often undergo concurrent bilateral simple orchiectomy if this has not been previously performed. Techniques used in other urologic surgeries are valuable in vaginoplasty, including the following: deep perineal dissection, as required in perineal prostatectomy or posterior urethroplasty; penectomy, as in penile cancer; as well as urethroplasty, with creation of a urethral opening between the neoclitoris and neovaginal introitus. The penile-scrotal skin flap is less prone to contraction, virtually hairless, and well-innervated. The major disadvantage is limitation of vaginal depth by the amount of genital skin available.

Reconstructive complications include vaginal stenosis, excess bulk or filling of the neovaginal canal, inadequate sensation of the neoclitoris, development of urethral- or rectal-neovaginal fistulae, urethral stricture, wound-related complications such as necrosis, wound separation or granulation tissue, and poor cosmetic appearance [8, 9, 10•, 11–15]. Rectal injury and resultant recto-neovaginal fistula are uncommon but devastating intraoperative complications, reported in 1–4% of vaginoplasties [9, 10•, 13, 15].

A robotic-assisted approach to penile inversion vaginoplasty, preferred by the authors, may aid in minimizing these complications. With a transperitoneal approach similar to that of a radical prostatectomy, the surgeon is able to perform precise dissection between the prostate and rectum to safely create space for a neovaginal cavity, while maximizing depth and proximal width with neocolpopexy to the posterior peritoneum. This technique begins with a circumcising incision to deglove

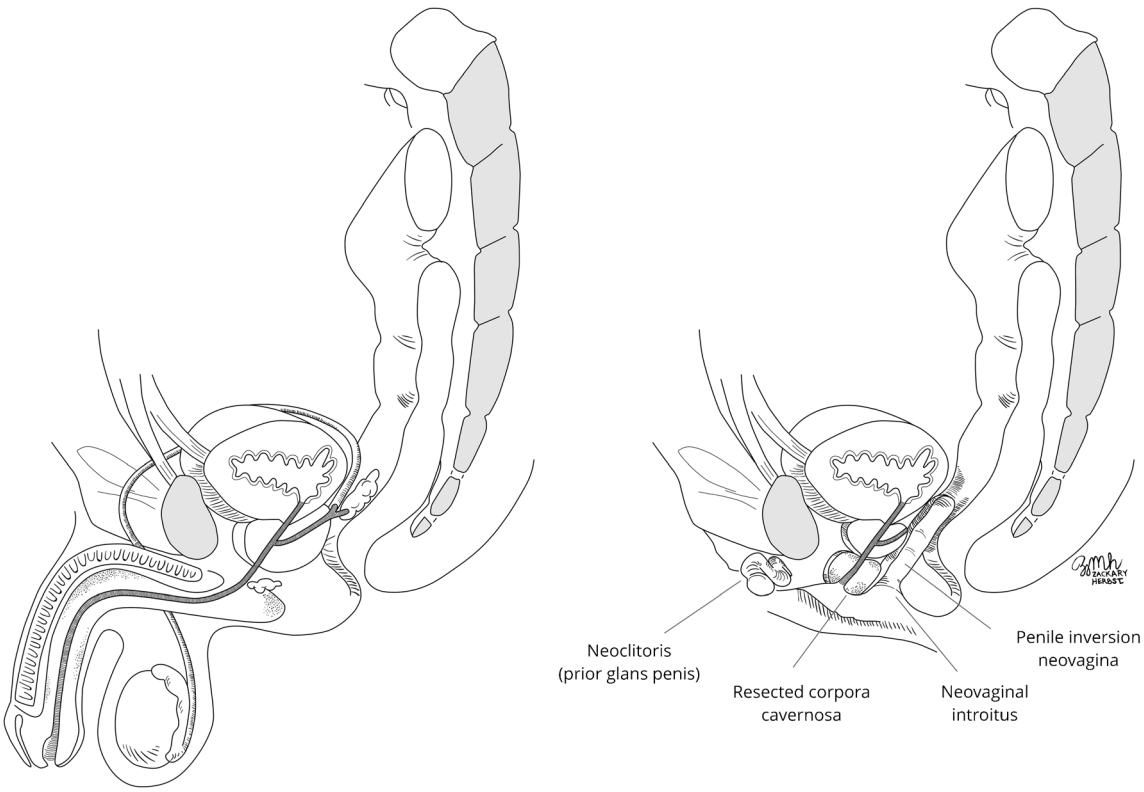

Fig. 1 Penile inversion vaginoplasty (left: preoperative male anatomy, right: postoperative anatomy)

the penis, with dissection down to the bulbar urethra. The neurovascular bundle is kept affixed to the dorsal aspect of the corpora cavernosa to preserve sensitivity and sensation of the neoclitoris, with excision of only the lateral and ventral tunica during corporal body resection. Resection of the corporal bodies is necessary to prevent occlusion of the neovagina with bulk from these structures. The bulbar urethra is incised ventrally, and the dorsal aspect is used to form the anterior vaginal wall.

The daVinci robot (Intuitive Surgical, Sunnyvale, CA, US) is then docked, and dissection is initiated with an incision through the posterior peritoneum akin to a posterior approach in radical prostatectomy. The neovagina is then passed from the perineal field into the abdominal cavity, and sewn to the anterior edge of the posterior peritoneum to optimize depth and width. The labiaplasty and clitoroplasty are completed at the perineum.

The proposed advantages of a robotic-assisted vaginoplasty include safer dissection to minimize risk of rectal injury and better proximal vaginal fixation. There have been no rectal injuries or fistulae to date in the authors series of 15 patients, with mean follow-up of 12 months. The average postoperative vaginal depth is 11.3 cm, within the reported range (10–13.5 cm) in current literature [10•]. When adequate vaginal canal depth cannot be achieved due to insufficient penile and scrotal skin, a secondary abdominal full-thickness skin graft with abdominoplasty may be utilized. Karim and colleagues described using a 30 cm by 6 cm graft from the lower abdomen above the pubic hair line, for an average neovaginal depth of 12 cm, allowing for sexual intercourse in these patients [16].

Enteric Vaginoplasty

Pedicled intestinal vaginoplasties (sigmoid, ileum, jejunum) are typically reserved for individuals with inadequate tissue for penile inversion vaginoplasty, or for salvage procedures [17–22]. By using bowel, the surgeon is able to construct a neovagina with sufficient depth without being constrained by the available length of penile and scrotal skin. Intestinal-lined neovaginas have texture that more closely approximates natural vaginal mucosa. There is also some lubrication from the mucus produced by bowel segment, although the mucus production does not correlate with sexual stimulation, and the fluid drainage may be bothersome in some patients. Disadvantages include those associated with enteric surgery—diversion colitis, ulcerative colitis, peritonitis, intestinal obstruction, anastomotic leaks and fistulae—as well as introital stenosis, mucocele, constipation, and potentially increased susceptibility to sexually transmitted infections [21]. As a growing number of transgender adolescents choose pubertal suppression, inadequate genital skin may limit their ability to undergo penile inversion vaginoplasty. Advances in laparoscopy and robotic-assisted surgery may prove helpful in minimizing the morbidity of bowel vaginoplasties.

Masculinizing Procedures

For the purposes of this review, we focus on reconstructive management pearls in patients undergoing phalloplasty with urethral reconstruction and erectile prosthesis placement, acknowledging that many other techniques exist for GRS in this population.

Colpectomy

At the time of phalloplasty or metoidioplasty, patients often undergo colpectomy (vaginectomy), or removal of the vaginal epithelium with closure of the perineum. Benefits include cessation of vaginal discharge, which increases during sexual arousal and may be disturbing to transgender men, as well as decreased risk of fistula from incorporation of vaginal tissue into the urinary tract during phalloplasty with urethral lengthening. Risks of the procedure include bleeding requiring transfusion, as well as injury to adjacent structures leading to vesicovaginal or rectovaginal fistula.

Colpectomy is typically performed via transvaginal approach, with similarities to colpocleisis for natal women with pelvic organ prolapse. The major anatomic difference is the widened genital hiatus in women with prolapse, which allows for vaginal eversion and ample exposure to the mucosa requiring excision. Surgical exposure is more limited in transgender patients without prolapse. Additional challenges include adherence of the bladder to the vaginal apex following hysterectomy, increasing risk of cystotomy.

The technique of excoriation of the vaginal tissue using electrocautery may result in incomplete resection and re-epithelialization of remnants. If the vaginal introitus is then surgically closed, this may lead to accumulation of secretions and a draining vaginal sinus or mucocele in the previous location of vagina. Remnants may become incorporated into the urinary tract, acting as false passages or urethral diverticulae. Moreover, the presence of a distal urethral stricture and resultant back pressure in the fixed urethra can increase the risk of developing a fluid collection in the remnant vaginal cavity. Symptoms may include obstructive voiding, urinary incontinence, and recurrent urinary tract infections.

Groenman and colleagues [23] describe robotic-assisted laparoscopic colpectomy (RaLC) in 36 transgender male patients with the potential for safer, more complete excision. Immediately following total hysterectomy and salpingo-oophorectomy, the vaginal epithelium is dissected first anteriorly then circumferentially to 1 cm proximal to the urethra, removing as thin an epithelial layer as possible to prevent injury to adjacent structures and bleeding from the perivaginal plexus. The defect of the vesicovaginal space is then closed by

suturing remnants of the rectovaginal septum to the endopelvic fascia of the vesicovaginal space. Residual epithelium at the level of the introitus is removed vaginally, and the bulbocavernosus muscles are approximated to narrow the introitus. Minor urinary complications including acute urinary retention and urinary tract infection occurred in 19% of patients. Use of a gracilis muscle flap to reinforce colpectomy also shows promise for decreasing vaginal remnant incorporation into the urinary tract.

Phalloplasty

The ideal neophallus should be a single-stage, reproducible procedure that allows for standing urination, tactile (protective) and erogenous sensation, sufficient girth to accommodate an erectile prosthesis, and an esthetically acceptable result [24]. Numerous phalloplasty techniques have been described, including the radial forearm free flap (RFFF) [25–28], anterolateral thigh (ALT) pedicled or free flap [29–32], inferiorly based abdominal flaps [33, 34], latissimus dorsi [35, 36], and fibular osteocutaneous free flaps [37, 38], among others [39, 40]. These approaches vary in their degrees of donor-site morbidity, capacity for tactile and erogenous sensation, risk of long-term urologic complications after urethral construction, and potential for penetrative intercourse [37, 40, 41].

Radial forearm free flap phalloplasty, the most widely published technique, involves dissection of donor tissue with preservation of arterial supply, venous drainage, and local nerves [25, 27, 41] (Fig. 2). Receptor vessels are dissected in the groin, typically the common femoral, lateral circumflex femoral, circumflex iliac, or inferior epigastric artery and venae comitantes; the deep inferior epigastric or greater saphenous veins; and the ilioinguinal and clitoral nerves. The flap is then tubularized, the urethral tube constructed, and the glans sculpted, either immediately or in a later stage. The neophallus pedicle and nerves are anastomosed to the recipient region, which is typically prepared with vaginectomy, scrotoplasty, and urethral mobilization.

Urethroplasty

The urethra in an individual who has undergone neophallus creation with urethral lengthening includes five segments: native (female) urethra, fixed urethra, anastomotic urethra, phallic urethra, and meatus [42, 43]. The urethroplasty involves two components: proximal/pars fixa urethroplasty from local vaginal or labia minora flaps, regional flaps, and skin or mucosal grafts, and anastomosis of the skin flap urethra from the donor-site neophallus to the distal aspect of the pars fixa urethra [42, 44]. The phallic urethra may be constructed using tube-within-tube techniques, prelamination, or pedicled flaps [42, 44, 45].

Urethral stricture and fistulae are common and may occur simultaneously, with overall urethral complications rates ranging from 25 to 58% [27, 32, 41, 43, 46, 47]. Urethrocutaneous fistula is reported in 22–75% of RFFF phalloplasties, usually located immediately proximal to a urethral stricture [46, 48, 49]. While fistulas sometimes heal spontaneously, strictures can be more difficult to manage owing to poor blood supply of the urethra and surrounding tissue [43, 45, 50].

Although strictures may occur at any level of the urethra, the most common site is the anastomosis site between the fixed and phallic portions of the urethra (Fig. 2) [43, 46, 51]. Ischemia is the greatest contributor. Mechanical force of the urinary stream upon this fixed horizontal urethral segment as it curves to meet the neophallus has also been suggested as a factor [52]. Underperfusion at the distal flap may result in contracture of neourethral tissue, as it meets the neophallic skin leading to meatal stenosis, or strictures elsewhere along the length of the urethra.

Several steps may be taken to help minimize urethral complications. In addition to placement of a suprapubic catheter for urinary diversion during initial healing, and meticulous dissection of flaps for maximal preservation of vascular supply, various centers have described use of a bulbospongiosus coverage layer over labia minora flaps [32, 53•], prelamination of the neourethra with uterine or vaginal mucosa [54, 55], and immediate pedicled gracilis flap during RFFF as reinforcement of the native-neourethral anastomosis [46, 56]. In a recent series of 224 patients, urethral complication rates were 67% in nine patients who chose vaginal preservation vs. 27% in vaginectomy patients whose vascularized vestibular tissue was utilized for a bulbospongiosus coverage layer [53•].

Neophallus Prosthesis Placement

Penile prosthesis implantation has become the most common approach to achieving phallic rigidity in transgender men, though alternatives such as osteocutaneous grafts [38, 57–60], implantable splints [61], and external prosthetic epithesis [62, 63] have been described. The malleable and inflatable erectile devices typically used in patients with neophallus were developed for natal male anatomy, however. Due in large part to the delicate neurovascular supply of the neophallus, lack of native corpora cavernosa, and presence poorly vascularized scar tissue within the neophallus, prosthesis-related complications are considerably higher in transgender men than in natal men [48, 64–67].

These complications include the following: infection, ranging from 8 to 50% [66, 68, 69, 70•]; extrusion or erosion, particularly through the glans in 4–8% [66, 71]; injury to the urethra and rarely, the neurovascular supply of the neophallus [67]; device migration in 15–30% [66, 67, 69, 71]; pain; patient dissatisfaction in 19% [70•]; and early mechanical failure

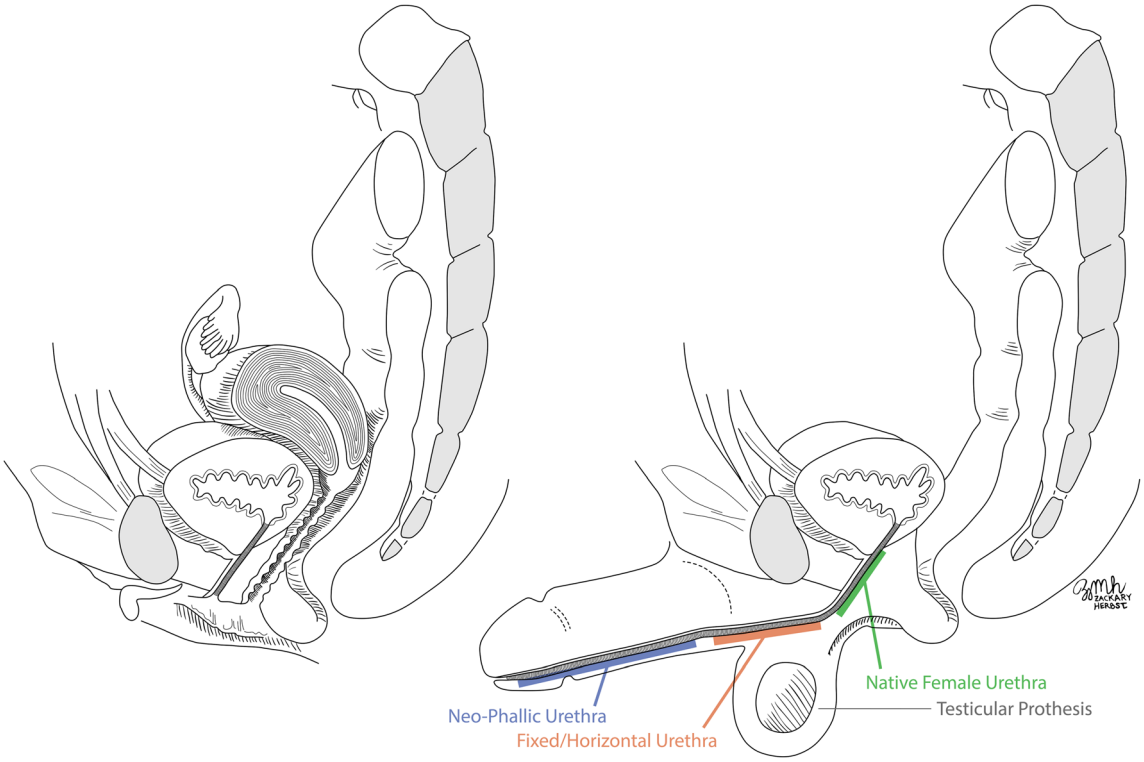

Fig. 2 Radial forearm free flap phalloplasty (left: preoperative female anatomy, left: postoperative anatomy). Urethral strictures often occur at the junction of the pars fixa (fixed/horizontal urethra) and neophallic urethra. Illustrations by Zackary Herbst

in 11–15%, potentially exacerbated by friction against vascular grafts [66, 70•, 71].

Several principles of neophallus prosthesis placement have grown out of these challenges. Most series describe a minimum 6- to 9-month delay between phalloplasty and prosthesis implantation to ensure restored sensation and complete urethral healing [48, 65–69, 72, 73]. With widespread adoption of microvascular techniques in phalloplasty, a sensate neophallus is now achievable. Sensation in the neophallus helps to prevent distal erosion and should be achieved prior to prosthesis placement. The surgeon must aim to maximize rigidity and size in the erect state, while balancing risks of risk of extrusion due to chronic pressure and distortion of the neophallus. Malleable prostheses have a decreased risk of mechanical failure, yet create a chronic pressurized state that may contribute to erosion [72, 74–76]. The decision to use single vs. dual cylinders depends on girth of the neophallus [66, 69, 76]. Although dual cylinders provide improved rigidity, they may also distort the neophallus, leading some to conclude that a single inflatable cylinder is esthetically superior [73].

To recapitulate corpora cavernosa, many institutions have utilized neotunical "socks" made of Gore-Tex (polytetrafluoroethylene, PTFE; Gore Medical, Flagstaff, AZ, US) or dacron vascular grafts [65–68, 70•, 71, 73, 76]. In addition to providing distal glans cushioning, these socks serve as scaffolding for proximal anchoring to the pubic bone. The sheaths are sewn around the proximal portion of the implant or rear-tip extenders then fixed to the inferior aspect of the pubic symphyseal periosteum or ischial tuberosity [67] using non-absorbable suture. Another technique involves drilling a corticotomy into the anterior pubic ramus which complements the shape of the rear-tip extender, anchoring the proximal portion of the implant directly into the pubic ramus [69, 77].

Scrotoplasty

Scrotoplasty is performed with a goal of creating a pouch-like scrotum positioned anterior to the medial thighs, with capacity for future testicular prosthesis placement if this is desired by the patient. The labia majora are typically used for scrotoplasty flaps, as the embryologic homolog with similar color, texture, hair-bearing nature, and erogenous sensation. Older techniques describe midline closure of the labia with placement of testicular prostheses, V-Y plasties to bring the scrotum more anterior, and tissue expander-based techniques [78–80]. Many of these approaches, however, create scrotums that are esthetically reminiscent of labia majora and undesirable to patients, unnatural appearing or positioned between the legs rather than anterior.

Selvaggi and colleagues describe a novel approach to scrotoplasty at the time of RFFF phalloplasty in 240 patients, with no major complications and good patient satisfaction regarding scrotal volume, shape, and position [81]. In this

adaptation of V-Y plasty, two inverted triangular labia majora flaps are created, leaving the fat in situ. Each labium is rotated 90° medially and bent on itself superiorly then the tips of each triangle are sutured to each other, while the dorsal clitoral skin is pulled down to recreate the anterior scrotum. Any excess tissue laterally and anteriorly on the labia, and horizontally on the clitoris, is then excised or corrected. Reabsorbable sutures are used to close the deep perineal donor area, as well as the subcutaneous layer and scrotal skin [81].

In cases of inadequate tissue at the penoscrotal junction, a fasciocutaneous flap from the median thigh may be used to support the urethra and create additional bulk to the scrotum [82].

Silicone testicular implants may be placed once the scrotoplasty has healed [81]. If performed with erectile prosthesis, a single scrotal implant is placed through a separate incision opposite the inflatable penile prosthesis pump [66]. The labial fat pads provide protection from implant extrusion.

Conclusions

Many current principles in feminizing and masculinizing gender confirming surgery were initially described decades ago. However, as the number of transgender individuals seeking care expands, so must our understanding of their healthcare needs. Complication rates remain high following phalloplasty and other masculinizing procedures. Innovation of existing techniques using modern technology and rigorous evaluation of patient outcomes are needed to provide higher quality care for this underserved population.

Compliance with Ethical Standards

Conflict of Interest Geolani W. Dy, Jeff Sun, Michael A. Granieri, and Lee C. Zhao each declare no potential conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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