Phalloplasty with Urethral Lengthening: Addition of a Vascularized Bulbospongiosus Flap from Vaginectomy Reduces Postoperative Urethral Complications

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Background: Phalloplasty with urethral lengthening is the procedure of choice for female-to-male transgender patients who desire an aesthetic phallus and standing micturition, but is associated with complications, including urethral stricture and fistula formation. Horizontal urethra construction can be accomplished with labia minora flaps covered with additional vascularized layers of vestibular tissue when vaginectomy is performed concomitantly with phalloplasty. However, vaginectomy is not a requisite step in phalloplasty, and some individuals may choose to retain their vagina. In these cases, extra layers of vascularized vestibular tissue are not used for horizontal urethra coverage. This study examined the effects of vaginectomy and the addition of extra layers of vascularized vestibular tissue on phalloplasty complication rates.

Methods: A single-center retrospective study of 224 patients who underwent phalloplasty with urethral lengthening was performed. Patients were sorted into vaginectomy and vaginal preservation cohorts and complication rates were assessed.

Results: Of 224 total phalloplasty patients, 215 underwent vaginectomy and nine underwent vaginal preservation. Urethral complications occurred in 27 percent of patients with vaginectomy and in 67 percent of patients with vaginal preservation (OR, 0.18; $p = 0.02$). Vaginectomy was associated with decreased urethral stricture (OR, 0.25; $p = 0.047$) and urethral fistula formation (OR, 0.13; $p = 0.004$). Non–urethra-related complications occurred in 15 percent of vaginectomy patients but were not statistically significant (OR, 3.37; $p = 0.41$).

Conclusion: Vaginectomy is associated with a significant decrease in urethral stricture and fistula formation, most likely because vaginectomy affords additional horizontal urethroplasty suture line coverage of labia minora flaps with vascularized vestibular tissue. (*Plast. Reconstr. Surg.* 140: 551e, 2017.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, III.

Phalloplasty is one of the primary reconstructive options available to transgender patients seeking female-to-male gender-confirming surgery. Regardless of reconstructive technique, the goals of phalloplasty include creating an aesthetic neophallus with tactile and erogenous sensation, allowing penetrative intercourse, and enabling micturition while standing.[1] The latter is often a priority for transgender men,[2] which requires phalloplasty to include urethral lengthening from local or distant tissues.[3]

Phalloplasty has very high satisfaction rates[1]; however, it can present several well-documented challenges to the reconstructive surgeon.[4,5] Specifically, urethral strictures and fistulas occur with complication rates quoted at 30 percent, and as high as over 50 percent.[1,4,6,7] Urethral complications are often a result of mechanical stress on

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the fixed/horizontal urethra that bridges the native female urethra to the neophallus urethra (Fig. 1).[8] A variety of techniques are available for horizontal urethra construction, including abdominal or labial skin flaps, pedicled flaps from the intestine or bladder, mucosal grafts from the bladder or vagina, or anterior vaginal wall flaps.[9] Our center routinely uses labia minora flaps for horizontal urethra reconstruction. Moreover, the labia minora flap suture line is covered with additional vascularized layers of vestibular bulbospongiosus muscle. However, these additional layers of vascularized vestibular tissue are not available when patients choose to retain their vagina. Although most patients elect for vaginectomy concomitantly with phalloplasty, this is not a requisite portion of the procedure. Several patients have desired to retain their vaginas, in our experience, most commonly for sexual gratification. In these instances, labia minor flaps without a vascularized muscular layer account for horizontal urethra reconstruction.

Because of these inherent differences in horizontal urethra reconstruction between patients who undergo phalloplasty and urethral lengthening with vaginectomy versus vaginal preservation, we endeavored to examine differences in urethral complication rates between these two groups. In addition, we examined non–urethra-related complications between the two groups to better understand the outcomes related to these two procedures.

PATIENTS AND METHODS

A single-center retrospective study of female-to-male patients who underwent phalloplasty with urethral lengthening from April of 2013 to July of 2016 was performed. Patients with phalloplasty without urethral lengthening or who were younger than 18 years were excluded. All operations were performed by surgeons associated with our center. Patients were sorted into treatment groups based on whether vaginectomy was performed concomitantly with phalloplasty and urethral lengthening. All patients had a follow-up of at least 6 months postoperatively to assess for complications. Outcomes assessed included patient demographics, urethral complications, and other non–urethra-related complications.

Vaginectomy Procedure

All patients were offered vaginectomy concomitantly with phalloplasty; however, some patients chose to retain their vagina. Patients who elected for vaginectomy underwent sharp demucosalization circumferentially of the distal 2 cm of vaginal mucosa. The remaining vaginal mucosa was fulgurated and the pelvic floor reconstruction was performed with cerclage sutures in series with

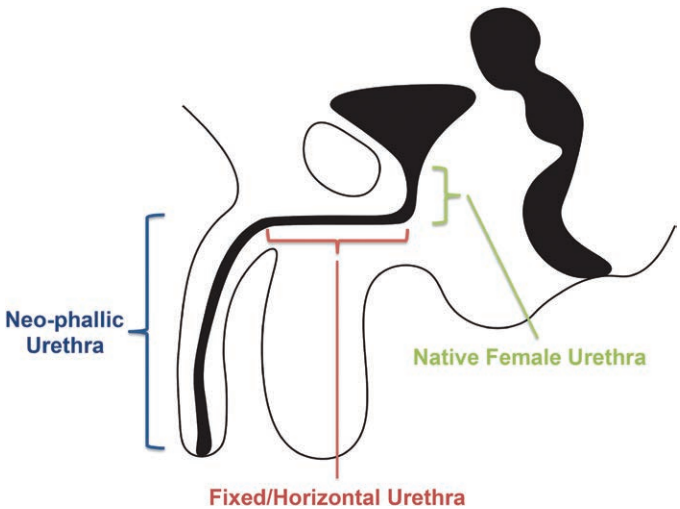

Fig. 1. The urethra in female-to-male transgender patients is composed of three parts: (1) the native female urethra (*green*); (2) the fixed/horizontal urethra (*red*), which requires urethroplasty reconstruction; and (3) the neophallus urethra (*blue*), which is part of phalloplasty design. Note the sharp angles the urine stream must make at the proximal (native to horizontal urethra) and distal (horizontal to neophallus urethra) urethroplasty lines. These are areas of particular mechanical stress.

0 Vicryl suture (Ethicon, Inc., Somerville, N.J.) on a heavily curved needle to completely close the canal. The remaining soft tissue, including the bulbospongiosus muscles, was closed over the vaginectomy site and the proximal horizontal urethral suture line (Fig. 2).

Urethral Lengthening Procedure

For patients who desired phalloplasty with the goal of standing micturition, urethral lengthening was required to bridge the native female urethra to the neophallus urethra (Table 1). Urethral lengthening was performed solely with labia minora flaps starting from the ventral aspect of the native urethral opening and extending to the clitoris. The labia minora tissue surrounding the ventrolateral aspects of the native urethral meatus was incised to create a 3-cm urethral plate, with incisions extended distally toward the clitoris. The flaps were then mobilized, taking care to preserve the subcutaneous tissue to maximize flap vascularization. Urethroplasty was accomplished using 5-0 polydioxanone suture in running and interrupted fashion. In vaginectomy patients, an additional layer of vascularized bulbospongiosus muscle was used to cover the entire urethroplasty suture line. Fasciolipomatous tissue was then used for additional coverage of the distal urethroplasty suture line (Fig. 2).

Without vaginectomy, urethral lengthening was performed in a similar fashion; however, additional layers of vascularized vestibular tissue, including the bulbospongiosus muscle, were not used for urethroplasty coverage. In these cases, labia minora tissue was used for horizontal urethra reconstruction, with the addition of vaginal mucosa tissue to cover the proximal urethroplasty suture line and fasciolipomatous tissue for coverage of the distal urethroplasty suture line.

Urethral Repair Procedures

In instances of urethral stricture formation, repair was necessary. Distal urethral strictures were addressed with first-stage Johansen urethroplasty, whereas proximal strictures were generally short and only required scar excision and primary reanastomosis. Urethral fistulas were less concerning, with the majority of fistulas healing spontaneously within a 3-month period. When fistulas failed to resolve spontaneously, we performed epidermal primary closure followed by a V-Y advancement flap of skin and connective tissue.

Statistical Analysis

Complication rates were assessed for vaginectomy and vaginal preservation using an odds ratio. Treatment groups were further stratified by reconstructive flap choice for phalloplasty and complication rates were reassessed. Data were analyzed using GraphPad Prism software (GraphPad Software, Inc., La Jolla, Calif.). Pairwise data were compared using a Mann-Whitney test for continuous variables and a Fisher's exact test for categorical variables. Statistical significance was held at $p < 0.05$.

RESULTS

Patient Selection and Demographics

Two hundred twenty-four patients were identified for inclusion in the study: 215 patients underwent phalloplasty with vaginectomy and nine patients underwent phalloplasty with vaginal preservation. Patients in the two groups were well matched in terms of age at the time of procedure, body mass index, and mean follow-up time (Table 2). Other demographic data, including smoking status, medical comorbidities, and length of hormone treatment, were available for a subset of patients. Overall, the vaginectomy group had a greater smoking history and more medical comorbidities than the vaginal preservation group.

Urethral Complications

Urethral complications occurred in 27 percent of patients with vaginectomy and in 67 percent of patients with vaginal preservation (Table 3). Specific urethra-related complications included meatal stenosis, urethral stricture, and urethral fistula. Of the nine patients who had vaginal preservation, four patients had two or more urethra-related complications, and two patients only had one urethra-related complication. Vaginectomy was associated with a decreased overall urethral complication rate (OR, 0.18; $p = 0.02$). Specifically, vaginectomy was associated with decreased urethral stricture formation [36 of 215 vaginectomy patients (17 percent) versus four of nine vaginal preservation patients (44 percent); OR, 0.25; $p = 0.047$] and decreased urethral fistula formation [30 of 215 vaginectomy patients (14 percent) versus five of nine vaginal preservation patients (56 percent); OR, 0.13; $p = 0.004$].

Other Complications

Vaginectomy required increased surgical dissection near the rectum and native urethra and

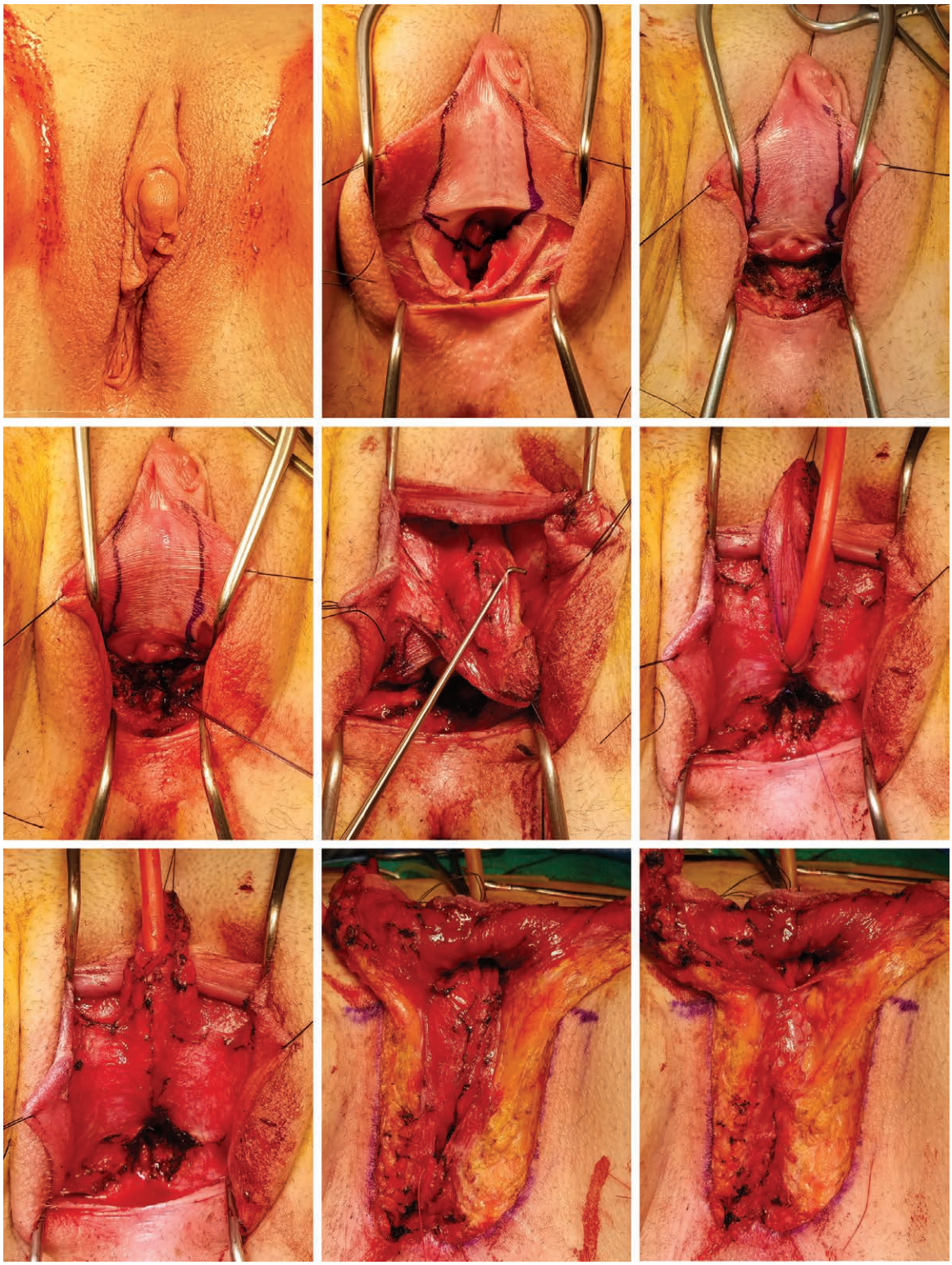

Fig. 2. Urethroplasty with vaginectomy. (*Above*, *left*) Preoperative appearance of the vestibule in a patient taking hormone therapy. (*Above*, *center*) Markings for labia minora flap urethroplasty. (*Above*, *right*) Release of the dorsal urethral plate, freeing the native female urethra. (*Center*, *left*) Complete demucosalization, fulguration, and closure of the vaginal canal. (*Center*, *center*) Incision and mobilization of labia minor flaps. (*Center*, *right*) Urethroplasty of labia minora flaps around a catheter. (*Below*, *left*) Completed urethroplasty with labia minora flaps. (*Below*, *center*) Vascularized bulbospongiosus flaps are mobilized to cover the urethroplasty suture line. (*Below*, *right*) The bulbospongiosus muscles are sutured together for complete urethroplasty suture line coverage.

Table 1. Tissue Layers for Horizontal Urethroplasty in Patients with Vaginectomy and Vaginal Preservation

	Vaginectomy	Vaginal Preservation
Urethroplasty	Labia minora flaps	Labia minora flaps
Full-length urethroplasty coverage	Vascularized bulbospongiosus muscle	None
Proximal urethroplasty coverage	Vascularized bulbospongiosus muscle	Vaginal mucosa
Distal urethroplasty coverage	Vascularized bulbospongiosus muscle, fasciolipomatous tissue	Fasciolipomatous tissue

therefore had an increased risk profile. Non–urethra-related injuries observed in the vaginectomy group included rectal injury (0.5 percent), partial flap loss (5 percent), hematoma (3 percent), dehiscence (4 percent), abscess (8 percent), loss of sensation (1 percent), and scrotal complications (0.5 percent) (Table 3). None of these complications were observed in the vaginal preservation group. Despite the incidence of non–urethra-related injuries in the vaginectomy group, this result was not found to be statistically significant (OR, 3.37; $p = 0.41$) but may reflect a type II error secondary to the small ($n = 9$) vaginal preservation cohort.

Table 2. Patient Demographic Data

	Vaginectomy (%)	Vaginal Preservation (%)	*p*
No. of patients	215	9	
Mean age ± SD, yr	37 ± 11	35 ± 7	0.91*
BMI, kg/m²†	26 ± 6	27 ± 5	0.67*
Race†			
White	74 (75)	2 (50)	
Black	4 (4)	1 (25)	
Hispanic	9 (9)	1 (25)	
Asian	6 (6)	0 (0)	
Other	6 (6)	0 (0)	
Smoking status†			
Never smoker	72 (73)	2 (50)	
Former			
0–10 pack-years	12 (12)	1 (25)	
11–20 pack-years	3 (3)	0 (0)	
>20 pack-years	3 (3)	0 (0)	
Pack-years unknown	7 (7)	1 (25)	
Current smoker	2 (2)	0 (0)	
Mean length of testosterone treatment ± SD, yr‡	4.8 ± 3.8	4	
Medical comorbidities§			
None	61 (64)	4 (100)	
Diabetes mellitus	3 (3)	0 (0)	
Hypertension	6 (6)	0 (0)	
Hyperlipidemia	6 (6)	0 (0)	
Depression	5 (5)	0 (0)	
Asthma	5 (5)	0 (0)	
Gastroesophageal reflux	12 (13)	0 (0)	
Hypothyroidism	9 (9)	0 (0)	
Prior metoidioplasty	1 (1)	0 (0)	
Prior phalloplasty	1 (1)	0 (0)	
Other	4 (4)	0 (0)	
Mean follow-up time ± SD, days	643 ± 308	511 ± 243	0.23*

*Two-sided Mann-Whitney test.
†Demographic data available for 99 vaginectomy patients (46%) and four vaginal preservation patients (44%); percentages are reported for available data.
‡Demographic data available for 50 vaginectomy patients (23%) and one vaginal preservation patient (11%); percentages are reported for available data.
§Demographic data available for 96 vaginectomy patients (45%) and four vaginal preservation patients (44%); percentages are reported for available data.

Reconstructive Flap Choice

Patients underwent phalloplasty by either radial forearm free flap (70 percent) or pedicled anterolateral thigh flap reconstruction (30 percent) (Table 4). Urethra-related complications occurred more frequently in the anterolateral thigh flap cohort (33 percent) than in the radial forearm free flap cohort (26 percent). Vaginectomy was associated with reduced urethral complication rates in the radial forearm free flap cohort (OR, 0.064; $p = 0.013$); however, there was not enough statistical power to examine the effects of vaginectomy in the anterolateral thigh flap cohort ($n = 3$) (Table 4).

DISCUSSION

Phalloplasty with urethral lengthening is the procedure of choice in female-to-male patients seeking gender-confirming genital surgery with the primary goal of standing micturition. However, neourethra reconstruction is challenging for the reconstructive surgeon and can lead to well-documented urethral complications, including urethral stricture and fistula formation in 30 to 70 percent of patients.[1,4,10–13] Construction of the fixed/horizontal urethra spanning the native female urethra to the neophallus urethra is particularly difficult but critical for avoiding complications. This is the point at which the urine stream must make a 90-degree turn from the native female urethra, resulting in mechanical stress on the urethral anastomotic line.[8] Construction of the horizontal urethra can be accomplished with a variety of reconstructive techniques including abdominal or labial skin flaps, pedicled flaps from the intestine or bladder, mucosal grafts from the bladder

Table 3. Complication Rates in Female-to-Male Patients Treated with Vaginectomy versus Vaginal Preservation in Phalloplasty with Urethral Lengthening

	Vaginectomy (%)	Vaginal Preservation (%)	OR	*p*
No. of patients	215	9		
All complications	76 (35)	6 (67)	0.27	0.072
Urethral complications	58 (27)	6 (67)	0.18	0.020*
Meatal stenosis	17 (8)	2 (22)	0.30	0.15
Urethral stricture	36 (17)	4 (44)	0.25	0.047*
Urethral fistula	30 (14)	5 (56)	0.13	0.004*
Other complications	32 (15)	0 (0)	3.37	0.41
Rectal injury	1 (0.5)	0 (0)	0.13	0.23
Partial loss	10 (5)	0 (0)	0.97	0.98
Hematoma	6 (3)	0 (0)	0.59	0.72
Dehiscence	9 (4)	0 (0)	0.87	0.93
Abscess	8 (4)	0 (0)	0.77	0.87
No sensation	2 (1)	0 (0)	0.22	0.34
Scrotal complication	1 (0.5)	0 (0)	0.13	0.23

*Statistically significant.

Table 4. Complication Rates Stratified by Reconstructive Flap Choice in Female-to-Male Patients Treated with Vaginectomy versus Vaginal Preservation in Phalloplasty with Urethral Lengthening

	Vaginectomy (%)	Vaginal Preservation (%)	OR	*p*
No. of patients	215	9		
Anterolateral thigh	64 (30)	3 (33)	—	—
All complications*	28 (44)	1 (33)	1.55	0.72
Urethral complications*	21 (33)	1 (33)	0.98	0.98
Other complications*	15 (23)	0 (0)	2.19	0.61
Radial forearm	149 (69)	6 (67)	—	—
All complications†	47 (32)	5 (83)	0.092	0.032‡
Urethral complications†	36 (24)	5 (83)	0.064	0.013‡
Other complications†	17 (11)	0 (0)	1.72	0.72

*Percent reported as events per number of anterior lateral thigh flaps performed.
†Percent reported as events per number of radial forearm flaps performed.
‡Statistically significant.

or vagina, or anterior vaginal wall flaps.[9] Our group consistently uses a tube-in-tube design for the construction of the neophallus urethra, and labia minora flaps for construction of the fixed/horizontal urethra. When vaginectomy is performed, additional localized vascularized layers of bulbospongiosus muscles are approximated in the midline and used for coverage of the labia minora tissue mobilized in urethral reconstruction. However, when vaginectomy is not performed, these additional layers of tissue are not available for suture line reinforcement. This led our group to believe that patients who underwent phalloplasty with vaginectomy would have fewer urethra-related complications than those patients who underwent phalloplasty with vaginal preservation.

Our results demonstrate that vaginectomy is significantly associated with decreased urethral stricture and fistula formation, despite greater medical comorbidities within our vaginectomy group. Vaginal preservation precludes the use of neighboring vascularized tissue including the bulbospongiosus muscle and its investing fascia for coverage of the urethroplasty suture line. This is likely a major reason why vaginal preservation was associated with increased urethral complication rates. Therefore, our results may not be indicative of whether vaginectomy is performed or not, but may better reflect differences in technique of horizontal urethra reconstruction. Our results suggest that the addition of extra layers of vascularized tissue in horizontal urethra reconstruction offers superior results to those that use fewer layers of tissue. Few studies have directly compared horizontal urethra reconstructive techniques, but a study by Rohrmann and Jakse compared vaginal flaps versus labia minora flaps versus Martius flaps.[4] The Martius flap uses vascularized vestibular tissue to form the horizontal urethra.[14] Their results found that using vestibular tissue resulted in the fewest urethral complications compared with labia minora or vaginal flaps. In addition, other groups have found that when horizontal urethra vaginal flaps were covered with an additional layer of vascularized gracilis flap, urethral stricture and fistula rates decreased.[15,16]

When considering these results in combination with those reported here, they ultimately suggest that the lowest rates of urethral complications are achieved when horizontal urethra reconstruction is performed with extra layers of vascularized muscle tissue. Our study participants were separated into groups based on whether vaginectomy was performed or not, but ultimately this was a surrogate for different techniques in horizontal urethra reconstruction. In the vaginectomy group, an additional layer of vascularized vestibular tissue (the bulbospongiosus muscle) was used for suture line coverage of our labia minora flaps. However, with vaginal preservation, this additional layer was not used. Further studies in the future directly comparing horizontal urethra reconstructive techniques would be of particular interest.

It is important to note that vaginectomy does require increased surgical dissection, and we did observe non–urethra-related complications in 15 percent of patients who underwent vaginectomy and in none of the patients who underwent vaginal preservation. However, this result was not found to be statistically significant. Because our vaginal preservation group consisted of only nine patients, and all of these complications individually occurred in less than 5 percent of patients, our study may not have been powered to detect these complications within the vaginal preservation group.

The size of our vaginal preservation group reflects a major limitation to our study. However, despite this limitation, statistically significant reductions in urethral stricture and fistula formation were found. In addition, follow-up time for patients in both groups was as little as 6 months. This may be too early to detect complications. However, overall, both groups were well matched in terms of mean follow-up time, with only 13 of 215 vaginectomy patients (6 percent) and one of nine vaginal preservation patients (11 percent) treated within the past 6 months. Given the few numbers of patients who elect for vaginal preservation, it was prudent to include all patients in the analysis at the current time and to report compiled results despite a small sample size given the interesting and statistically significant results already observed.

Overall, the effect of vaginectomy versus vaginal preservation on urethral complication rates in female-to-male patients seeking phalloplasty with urethral lengthening for gender-confirming surgery is profound. Vaginectomy is associated with a significant decrease in urethral stricture and fistula formation, most likely because patients with vaginectomy had additional horizontal urethroplasty suture line coverage of their labia minora flaps with vascularized vestibular tissue. It remains to be determined whether labia minora flaps, vaginal flaps, or other reconstructive options are ideal in horizontal urethral reconstruction. However, it is currently recommended that vaginectomy and additional horizontal urethral coverage with vestibular tissue be performed with phalloplasty when patients desire urethral lengthening.

CONCLUSIONS

Vaginectomy is associated with a significant decrease in urethral stricture and fistula formation, most likely because vaginectomy affords additional horizontal urethroplasty suture line coverage of labia minora flaps with vascularized vestibular tissue. Extra layers of vascularized muscle tissue should be used in horizontal urethra reconstruction when available.

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REFERENCES

1. Morrison SD, Shakir A, Vyas KS, Kirby J, Crane CN, Lee GK. Phalloplasty: A review of techniques and outcomes. *Plast Reconstr Surg.* 2016;138:594–615.
2. Salgado CJ, Fein LA, Chim J, Medina CA, Demaso S, Gomez C. Prelamination of neourethra with uterine mucosa in radial forearm osteocutaneous free flap phalloplasty in the female-to-male transgender patient. *Case Rep Urol.* 2016;2016:8742531.
3. Bouman FG. The first step in phalloplasty in female transsexuals. *Plast Reconstr Surg.* 1987;79:662–664.
4. Rohrmann D, Jakse G. Urethroplasty in female-to-male transsexuals. *Eur Urol.* 2003;44:611–614.
5. Hage JJ, Torenbeek R, Bouman FG, Bloem JJ. The anatomic basis of the anterior vaginal flap used for neourethra construction in female-to-male transsexuals. *Plast Reconstr Surg.* 1993;92:102–108; discussion 109.
6. Wilson SC, Stranix JT, Khurana K, Morrison SD, Levine JP, Zhao LC. Fasciocutaneous flap reinforcement of ventral onlay buccal mucosa grafts enables neophallus revision urethroplasty. *Ther Adv Urol.* 2016;8:331–337.
7. Lumen N, Monstrey S, Goessaert AS, Oosterlinck W, Hoebeke P. Urethroplasty for strictures after phallic reconstruction: A single-institution experience. *Eur Urol.* 2011;60:150–158.
8. Hage JJ, Bouman FG, Bloem JJ. Construction of the fixed part of the neourethra in female-to-male transsexuals: Experience in 53 patients. *Plast Reconstr Surg.* 1993;91:904–910; discussion 911–913.

9. Hage JJ, Bloem JJ. Review of the literature on construction of a neourethra in female-to-male transsexuals. *Ann Plast Surg.* 1993;30:278–286.
10. Fang RH, Kao YS, Ma S, Lin JT. Phalloplasty in female-to-male transsexuals using free radial osteocutaneous flap: A series of 22 cases. *Br J Plast Surg.* 1999;52:217–222.
11. Monstrey S, Hoebeke P, Selvaggi G, et al. Penile reconstruction: Is the radial forearm flap really the standard technique? *Plast Reconstr Surg.* 2009;124:510–518.
12. Garaffa G, Ralph DJ, Christopher N. Total urethral construction with the radial artery-based forearm free flap in the transsexual. *BJU Int.* 2010;106:1206–1210.
13. Kim SK, Moon JB, Heo J, Kwon YS, Lee KC. A new method of urethroplasty for prevention of fistula in female-to-male gender reassignment surgery. *Ann Plast Surg.* 2010;64:759–764.
14 Given F, Acosta AA. The Martius procedure: Bulbocavernosus fat flap. A review. *Obstet Gynecol Surv.* 1989;45:34–40.
15. Gilbert DA, Schlossberg SM, Jordan GH. Ulnar forearm phallic construction and penile reconstruction. *Microsurgery* 1995;16:314–321.
16. Salgado CJ, Nugent AG, Moody AM, Chim H, Paz AM, Chen HC. Immediate pedicled gracilis flap in radial forearm flap phalloplasty for transgender male patients to reduce urinary fistula. *J Plast Reconstr Aesthet Surg.* 2016;69:1551–1557.