

SURGERY

Penile and Scrotal Skin Measurements to Predict Final Vaginal Depth With Penile Inversion Vaginoplasty



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ABSTRACT

Introduction: No nomogram exists to predict maximum achievable neovaginal depth before penile inversion vaginoplasty (PIV) based on available penile & scrotal skin (SS). Maximal depth is important to patients and is determined by available skin and available anatomic space within the pelvis and varies with surgical technique.

Aim: We endeavored to create a nomogram to predict expected postoperative vaginal depth.

Methods: Retrospective review of all patients undergoing primary PIV at a single institution from June 2017 to February 2020 (n = 60). Pre-op: Dorsal penile and midline scrotal skin length were measured. Intra-op: Tubularized scrotal skin length measured on a dilator. Immediate post-op: Final vaginal depth measured with a dilator.

Outcomes: The amount of available penile and scrotal skin was not associated with vaginal depth. The only variable that did significantly increase depth was the use of penile + scrotal skin, as compared to penile skin alone. ($P < .001$)

Results: In patients who underwent PIV-SS, the final vaginal depth (13.3 ± 1.9 cm) was 87% of pre-op measured penile skin length (15.3 ± 3.0 cm). In patients who underwent PIV+SS, pre-op penile skin length was 11.1 ± 4.7 cm and pre-op midline scrotal length was 22.8 ± 2.6 cm. with a final post-op vaginal canal depth of 15.2 ± 1.3 cm. In 45/46 (98%) surgeries utilizing SS grafts, SS tube length exceeded the length necessary to achieve maximal vaginal depth, and required trimming and discard. Given that in most cases there was an excess of SS, final post-op depth equaled the maximal vaginal depth that could be surgically dissected, and was not limited by the amount of available skin.

Clinical Implications: Our findings suggest that for most patients it should not be necessary to include additional tissue sources (eg, peritoneum) to create a vaginal canal during primary vaginoplasty.

Strengths and Limitations: Any penile skin that was discarded due to poor quality (eg, tight phimosis, poor viability) was not measured and accounted for. This likely resulted in a slight overestimation of the contribution of the penile skin to the final vaginal depth, but did not change the overall finding that final depth was not limited by available skin.

Conclusion: SS grafts, when harvested and tubularized using optimized technique, supplied an excess of skin necessary to line a vaginal canal space of maximal achievable depth. We found that additional tissue sources can, instead, be reserved for future salvage surgery if it becomes necessary to augment depth. **Smith SM, Yuan N, Stelmar J, et al. Penile and Scrotal Skin Measurements to Predict Final Vaginal Depth With Penile Inversion Vaginoplasty. Sex Med 2022;10:100569.**

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Key Words: Gender Affirming Surgery; Feminizing Surgery; Vaginoplasty

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INTRODUCTION AND OBJECTIVE

For transgender women seeking surgery, the choice of whether to undergo vaginoplasty with or without creation of a vaginal canal is an important one. It can be helpful to ask whether they plan to have vaginal receptive intercourse.¹ Whether to have vaginoplasty with or without creation of a vaginal canal is important for the patient to choose, but this provides an excellent opportunity to explain risks and benefits, as well as practical advantages and disadvantages of both options. Those patients who choose vaginoplasty with creation of a neovaginal canal must be aware that this choice provides the potential benefit of the ability to undergo vaginal receptive intercourse, but also then requires a lifelong commitment to vaginal dilation and douching, which some patients may wish to forego. Should the patient later become unable to dilate or douche regularly, failure to do so can, and likely will, lead to complications which can include stenosis, infection, pain, and may eventually require surgical revision of the canal, or in some cases, vaginectomy.¹ For many transgender women who choose vaginoplasty with a vaginal canal, the degree of vaginal depth that can be achieved is very important. For those patients who desire a canal to have penetrative intercourse, the neovaginal canal must be of sufficient depth and width. With penile inversion vaginoplasty, maximum neovaginal depth is determined by both the amount of skin available and the maximum depth that can be dissected within the pelvis. These presumably vary across individuals and by surgical technique. We sought to answer the question, can preoperative measurements of available penile and scrotal skin be used to predict the final post operative vaginal depth in transgender women undergoing vaginoplasty with creation of a neovaginal canal?

The average vaginal length in cisgender women has been reported to be 7–10 cm.²⁻⁴ Mean erect cisgender penis length has been reported to be about 12.9–14.15cm.⁵⁻⁸ The vaginal canal in a cisgender woman is composed of an elastic muscular tube, that can stretch to accommodate as needed. The average vaginal length in post-operative transgender women with a vaginal canal has been shown to be longer than that of a cisgender vagina, between 11 and

12 cm.⁹⁻¹¹ Because the canal space must be surgically created, it does not stretch to accommodate in the same way, and the canal dissection should be of sufficient length and width to accommodate most partners. To ensure that the neovaginal canal will allow for penetrative intercourse, the vaginal canal should have a depth of at least 12cm, and a width of at least 3.5cm in diameter.¹¹

Some patients have abundant penile skin (shaft ± foreskin), which may allow the vaginal canal to be lined using only the penile skin, without requiring additional skin from other sources (eg, scrotal skin, peritoneum). However, for many patients the use of penile skin alone will not provide sufficient skin for the lining of the neovagina. Etiologies of insufficient penile skin include biological variation, acquired penile skin insufficiency due to circumcision, genital trauma, self-mutilation, and/or penoscrotal hypoplasia due to the use of hormonal puberty blockers.¹¹

For penile inversion vaginoplasty, the penile skin flap should be long enough to line at least 12 cm of vaginal canal space.^{11,12} Some centers give the option to add additional full-thickness skin grafting in patients with penile skin length between 7 and 12 cm.¹² When planning the operative approach to the creation of the neovaginal canal, the surgeon should also consider the effects of post-operative neovaginal shortening. In one study examining intraoperative depth achieved and the post-operative neovaginal length, the mean intraoperative neovaginal depth was 13.8 ± 1.4 cm. After 1 year, the measured depth had decreased to 11.5 ± 2.5 cm.¹² Therefore, keeping in mind the potential for neovaginal shortening, for a desired post-operative canal depth of 11–12cm., the ideal intraoperative neovaginal depth should be about 14 cm. In a large series of over 300 patients, to reach the desired intraoperative depth of 14 cm, 85.7 percent of patients required a full-thickness skin graft from the scrotum and/or abdomen.¹³

During pre-operative counseling, it would be useful to be able to estimate “achievable vaginal depth”, in order to better guide discussions with patients regarding surgery options, risk considerations, surgical planning, and hair removal. To date, no nomogram is available to assist with patient counseling and pre-operative estimation of the maximal neovaginal depth that can be achieved via

Table 1. Pre-op penile and scrotal skin measurements compared to post-op vaginal depth, stratified by vaginoplasty technique

Vaginoplasty:	Mean pre-op dorsal penile skin length, cm (SD)	Mean vaginal depth immediately postoperatively, cm (SD)
Penile inversion vaginoplasty, penile skin only (no scrotal skin) n = 14	15.3 (3.0)	13.3 (1.9)
Penile inversion vaginoplasty with penile AND scrotal skin n = 46	11.1 (4.7)	15.6 (1.1)
Uncircumcised (n=12)	17.5 (2.8)	16.1 (0.7)
Circumcised (n = 34)	8.5 (2.6)	15.4 (1.4)

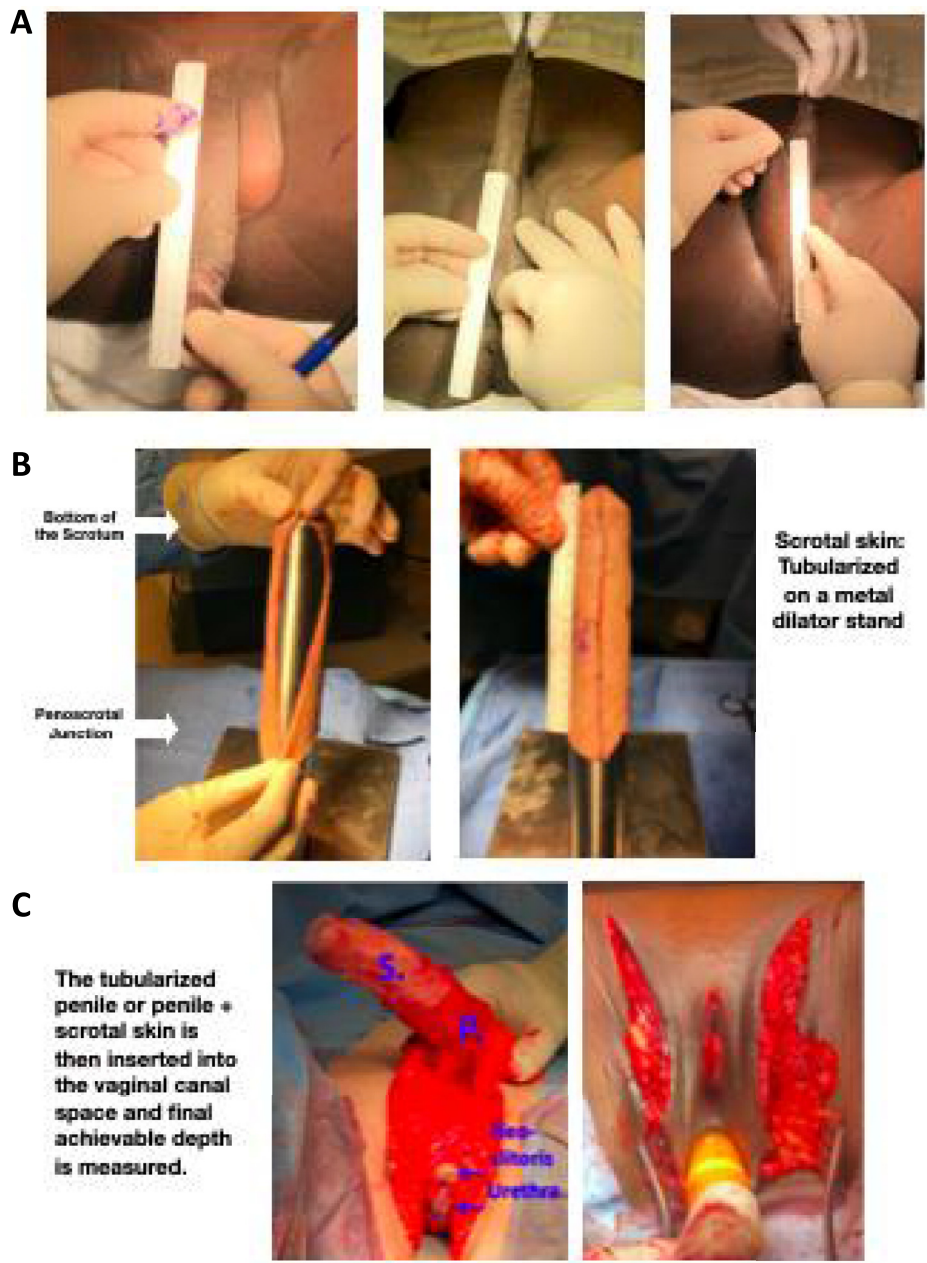


Figure 1. Penile and scrotal skin measurements. Penile skin length is measured from the dorsal base of the penis shaft, to a point 1 cm. proximal to the dorsal midline of the coronal ridge (*left picture*). Midline scrotal skin length is measured in two parts, by first measuring the distance between the scrotal-perineal junction to the midscrotum (*middle picture*), and then from the midscrotum to the junction of the scrotum and the ventral penile shaft. **B.** By the technique we use, the scrotal skin graft is harvested as a single piece of skin. The graft is de-fatted to the Dermis layer on a back-table. Relative to its original orientation on the body, the skin-graft is then flipped upside down and what was the midline dependent-most portion of the scrotum is laid onto the end of a metal dilator (12 cm circumference) which can be rotated upon a stand. The skin-edges of the scrotal skin are sutured together longitudinally using a running-locking 3-0 Vicryl suture, to create a tube. **C.** The base of the now tubularized scrotal skin tube is then sutured to the distal end of the penile skin-tube flap (*left picture*) and the scrotal-end of the resulting single-tube is inserted into the vaginal canal space over a dilator (*right picture*).

penile inversion vaginoplasty (PIV) with the amount of penile and scrotal skin (SS) available. We sought to explore how preoperative penile and scrotal skin measurements (performed in clinic) could be used to create a nomogram to more accurately estimate expected maximum post-operative vaginal depth, to guide patient and surgeon decision making.

METHODS

We conducted a retrospective review of all patients undergoing primary penile inversion vaginoplasty at a single institution from June 2017 to February 2020 (n = 60). The Institutional Review Board approved this retrospective review (IRB approval number

PRO00055933). All patients were otherwise healthy, of mean age 37.4 (range 18–68), mean BMI 26.33 (range 15.33–38.88), and all met WPATH SOC 7 standards of care guidelines for vaginoplasty surgery. Several measurements were recorded, including whether patients underwent vaginoplasty using penile skin alone, versus use of a combination of penile and scrotal skin (Table 1).

Preoperatively, dorsal penile shaft skin length was measured with the penis on gentle stretch from the base to 1 cm proximal to the coronal ridge (Figure 1A). Midline scrotal skin length was measured on gentle stretch in 2 parts: first from the penoscrotal junction to mid-scrotum, and then from the mid-scrotum to mid-perineum.

Intra-operatively, the scrotal skin tube length was measured on a dilator (Figure 1B). The tubularized penile + scrotal skin is then inserted into the newly dissected neovaginal space. The final achievable vaginal depth is measured using a vaginal dilator 12 cm in circumference (Figure 1C). We noted and recorded any cases where the scrotal skin tube length exceeded the amount of skin necessary to line the neovaginal canal.

In our series, a total of 60 patients were reviewed. Fourteen patients underwent PIV-SS (ie, penile skin without scrotal skin), and 46 patients underwent PIV+SS. Of the 46 patients who underwent PIV+SS, 34/46 (74%) were circumcised and 12/46 (26%) were uncircumcised. (Table 1)

Statistical Analysis

Differences between groups were tested with a Chi-square for count data and with a *t*-test for continuous measurements (age,

BMI, and anatomical measurements). ANOVA was used to test for anatomical differences across race/ethnicity. Pearson's correlations (*r*) were computed to determine associations between continuous measurements. Data was confirmed normally distributed with the Kolmogorov-Smirnov test. All testing was performed at the two-tailed 0.05 significance level. Analysis performed using SAS v9.4 software (Cary, NC, USA).

RESULTS

For all patients, maximum achievable depth was defined as the space which could be dissected from the neovaginal introitus to the rectovesical fold. If the penile skin was sufficient to line the entire vaginal canal, scrotal skin was not used. In all other cases, scrotal skin was used to ensure that the final neovaginal depth was the maximum depth which could be achieved.

In the 14 patients who underwent PIV only, the average pre-operative dorsal penile skin length measurement was 15.3 (\pm 3.0 cm). The average post-operative vaginal depth was 13.3 cm (\pm 1.9 cm). In those patients who did not require the use of scrotal skin grafts, the mean final vaginal depth was, on average, equal to 87% the penile skin length measured preoperatively. However, it should be noted that we did not prospectively record the length of any penile foreskin that necessitated excision and discarding secondary to phimosis or poor tissue health. Also, we did not prospectively record when, and to what degree, it was necessary to detubularize the distal portion of the penile skin tube

Table 2. Correlation of patient variables with vaginal depth

	PI (N = 14)	PI+S (N = 46)	Total (N = 60)	<i>P</i> value			
Age				.7518*			
Mean (SD)	38.4 (15.9)	37.1 (12.1)	37.4 (13.0)				
BMI				.7440*			
Mean (SD)	25.9 (4.2)	26.4 (5.5)	26.3 (5.2)				
Race/Ethnicity				.3584			
White	8 (57.1%)	20 (43.5%)	28 (46.7%)				
Hispanic	5 (35.7%)	11 (23.9%)	16 (26.7%)				
Asian	0 (0.0%)	6 (13.0%)	6 (10.0%)				
Black	1 (7.1%)	4 (8.7%)	5 (8.3%)				
Other	0 (0.0%)	5 (10.9%)	5 (8.3%)				
Vaginal Depth				.0001*			
Mean (SD)	13.3 (1.9)	15.2 (1.3)	14.8 (1.7)				
	Asian (N=6)	Black (N=5)	Hispanic (N=16)	Other (N=5)	White (N=28)	Total (N=60)	<i>P</i> value
Penile Length							.1258 [‡]
Mean (SD)	10.4 (5.5)	12.4 (4.3)	14.8 (4.3)	12.4 (7.6)	11.0 (4.2)	12.2 (4.9)	
Scrotal Skin Length							.3813 [‡]
Mean (SD)	21.7 (2.2)	17.6 (9.9)	15.2 (10.8)	21.8 (2.3)	15.2 (10.1)	16.6 (9.5)	
Vaginal Depth							.7282 [‡]
Mean (SD)	14.1 (1.4)	14.2 (2.2)	14.8 (1.8)	15.3 (0.8)	14.9 (1.8)	14.8 (1.7)	

*T-Test[†]Chi-Square

[‡]ANOVA F-Test

secondary to the skin tube having a narrow lumen that would not allow passage of a medium (11cm) circumference dilator.

In the 46 patients who had PIV+SS, the average pre-operative dorsal penile skin length measurement was 11.1 (± 4.7cm) and the average immediate postoperative vaginal depth was 15.6± 1.1cm. For circumcised patients, the average pre-operative dorsal penile skin length measurement was 8.5 ±2.6 cm, and for uncircumcised patients this measurement was 17.5 ± 2.8 cm. (Table 1) Cases of PIV-SS had significantly greater pre-operative penile length than cases with PI+SS. PIV-SS cases were significantly more likely to be uncircumcised than cases with PI+SS.

Analysis across all cases penile length was not significantly associated with vaginal depth (r = -0.02, P = .85). The significant predictor of greater vaginal depth was the use of any SS graft tissue: the use of PI+SS had significantly greater post-operative vaginal depth 15.6 ± 1.1 cm than cases with PI only 13.3 ± 1.9 cm (P < .0001). There was no significant association of other patient factors considered with final vaginal depth. (Table 2)

In the 45/46 (98%) surgeries utilizing SS grafts, there was an excess of SS, which was trimmed off and discarded. Among this cohort of 45/46 patients who underwent PI+SS, availability of skin to line the canal was not the “depth-limiting” factor; instead, final postoperative vaginal depth reflected the maximum neovaginal depth that could be created by surgical dissection of the vaginal canal space within the pelvis.

Post-operatively, the patients had vaginal packing in place until post-operative day #6, when the dressing and packing were removed. Patients then underwent dilation and douching teaching, and began dilating the neovagina on post-operative day 6.

DISCUSSION

With the present work we sought to create a nomogram that could use a patient’s pre-operative penile shaft skin and scrotal skin lengths to predict post-op neovaginal depth. Despite appropriate statistical analysis, however, we found no such correlation. In our data set penile shaft skin length did not predict final depth with PIV. The length of the pre-op scrotal skin measurement was correlated with the intraoperative skin tube length. (Figure 2)

Instead, the key findings from our study data were: (i) The only significant predictor for greater vaginal depth was whether or not scrotal skin was used. (ii) Whenever we combined use of scrotal skin with PIV, in the majority of cases (45/46 = 98%) there was extra scrotal skin that needed to be trimmed and discarded, suggesting that the depth limiting factor was not the availability of genital skin, but rather the anatomic limits of pelvic dissection to create the vaginal space (distance between the vaginal introitus and the rectovesical fold) is what determined vaginal canal depth.

It is counterintuitive that pre-op measurements of penile and scrotal skin length should not be able to estimate final neovaginal depth. However, after careful analysis of our study methods and results, we believe that the following factors contributed to this finding. First, though we measured the available penile and scrotal skin preoperatively, we did not measure how much penile and scrotal skin were discarded intra-operatively when these were found to be either of unsuitable quality and/or in excess of what was needed, respectively.

Second, among the PI+SS cohort we did not account for cases where it was necessary to partially detubularize the distal end of

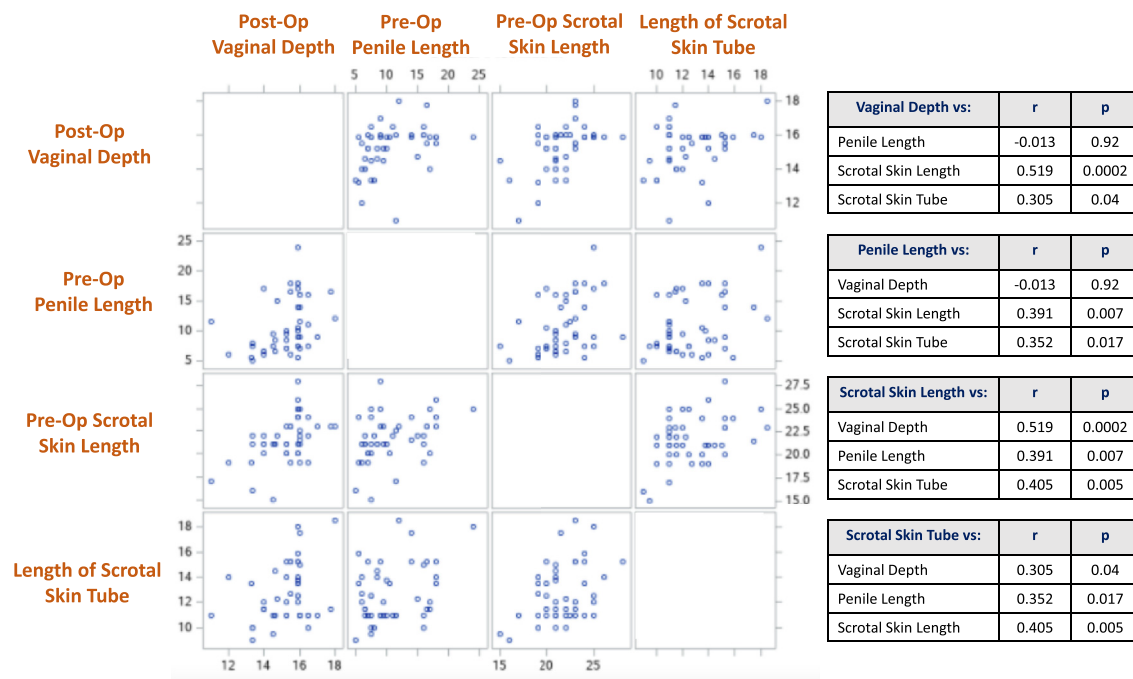


Figure 2. Correlation between post operative vaginal depth, pre operative penile skin length, pre operative scrotal skin length, and the length of the intraoperative scrotal skin tube.

the penile skin tube because we found it to be too narrow to allow passage of a ≥ 11 cm circumference dilator.

Third and perhaps most importantly, given that in almost all cases we had excess skin available, the limiting factor for final vaginal depth was not the amount of skin available to line it, but rather the maximal dissectable length of the space between the neovaginal introitus and the rectovesical peritoneal fold. We then looked at other potential contributing factors, such as age, weight, height, BMI, race, and ethnicity, but found that none of these variables was significantly correlated with depth. (Table 2)

Previous work by our group where among 22 trans women who underwent salvage laparoscopic right colon vaginoplasty, visual confirmation by laparoscopic view confirmed that the distance from the vaginal introitus to the rectovesical fold was 10.8 cm (± 0.91 cm).¹⁴ We speculate that reason that our present work found that the mean maximal vaginal depth was greater than this (15.6 cm ± 1.1 cm) (Table 1) is because after maximal canal dissection to the rectovesical peritoneal fold, the peritoneal fold itself can be pushed into the abdomen.

In sum, our results suggest that creation of an accurate nomogram to predict immediate post-op neovaginal depth in the pre-op setting is simply not feasible because: (i) It is often not possible to predict whether, and how much, penile and scrotal skin may need to be discarded during surgery, and (ii) The maximal depth of the vaginal canal space that can be dissected is not limited by available skin, but the anatomic limits of dissection, and varies from patient to patient.

It is notable that the post-op vaginal depth resulting from using combined penile and scrotal skin in our series (15.6 cm. ± 0.91) was comparable to the mean vaginal depth that other series have reported. (Table 3) Interestingly, when peritoneum is also utilized (together with penile and scrotal skin) during the same primary surgery, the resulting mean depth is over 1.4 cm less than what we found we could achieve using penile and scrotal skin alone (14.2 vs 15.6 cm).

The authors who utilize peritoneum report that by their estimate the peritoneum component alone contributes ~ 5 cm to the final vaginal depth. Given the vaginal depth they reported (14.2 cm), by extrapolation the mean contribution to depth from the penile plus scrotal skin they used was 9.2 cm (ie, 14.2-

5 = 9.2). In our series, the harvested scrotal skin graft *alone* provided a mean usable scrotal skin tube of 12.7 cm. length. (Again, in 45/46 cases in our series we found the length of the scrotal skin tube we could create by our graft arrangement technique exceeded the amount of skin we needed, and so the excess portion was trimmed and discarded).

This led us to question whether the technique by which we harvest and then tubularize the scrotal skin graft could account for the slightly greater mean final vaginal depth in our series. We found only one other publication describes the technique by which the scrotal skin graft is arranged and tubularized.¹³ Opsomer *et al* describe harvesting scrotal skin as two separate pieces and then arranging and suturing these together to create a tube. Though the authors did not describe whether and how much skin needed to be cut and discarded by this technique, we have used this technique and found that this technique typically requires cutting/discarding portions of the grafts, and, it results in abundance of suture lines.

For these reasons we developed (by exhaustive trial and error) the technique for arranging and tubularizing the scrotal skin graft we describe in Figure 3. By this technique, typically only one single straight, lengthwise suture line is needed, and we typically do not have to cut or discard portions or corners of the graft to achieve a tubular shape. The key features of this technique are (i) The portion of scrotal skin which will be used to line the canal is harvested as a single piece of skin (Figure 3, A–C), and (ii) The midline of the dependent and posterior-most portion of the scrotum (Figure 3, *red asterisk*) becomes the vault of the vaginal canal.

The graft is arranged over the tip of a dilator (Figure 3, D), and the lateral edges of the skin graft sutured together at midline (Figure 3, F). For instances where the patient's scrotum is too narrow for the lateral edges at the end of the tube to be approximated at midline, we found that the pointed end of the graft's midline (Figure 3E, *red asterisk*) can be pulled towards the base of the tube (see *blue hatched line*) to a point where all skin edges come together without excessive tension in a "Y-shape" design. The 2 sets of skin edges of the "Y" are then sutured together Table 4.

It is important to note that while scrotal skin grafts remain a valuable source of skin to augment neovaginal depth, they should

Table 3. Review of published reports of vaginoplasty vaginal depth outcomes stratified by author, graft source, and method of measurement

Author	Date	Patients	Tissue source	Depth	How measured
Amend ⁹	2013	24	Urethral Flap	11cm	By surgeon, intraoperative
Buncamper ¹²	2017	32	Scrotal Skin Graft	13.8 +/- 1.4cm	By surgeon, intraoperative
Jacoby ¹⁵	2019	41	Scrotal Skin + Peritoneum	14.2 +/- 0.7cm	By surgeon, post op w/dilator
Nijhuis ¹¹	2020	42	Pedicled Scrotal Skin Flap	13.5 +/- 1.3 cm	Not described
Opsomer ¹³	2021	243	Scrotal Skin Graft	14 cm	By surgeon, intraoperative
Opsomer ¹³	2021	83	Abdominal Skin Graft	14 cm	By surgeon, intraoperative
Garcia	2022	32	Scrotal Skin Graft	15.6 +/- 1.1cm	By surgeon, intraoperative

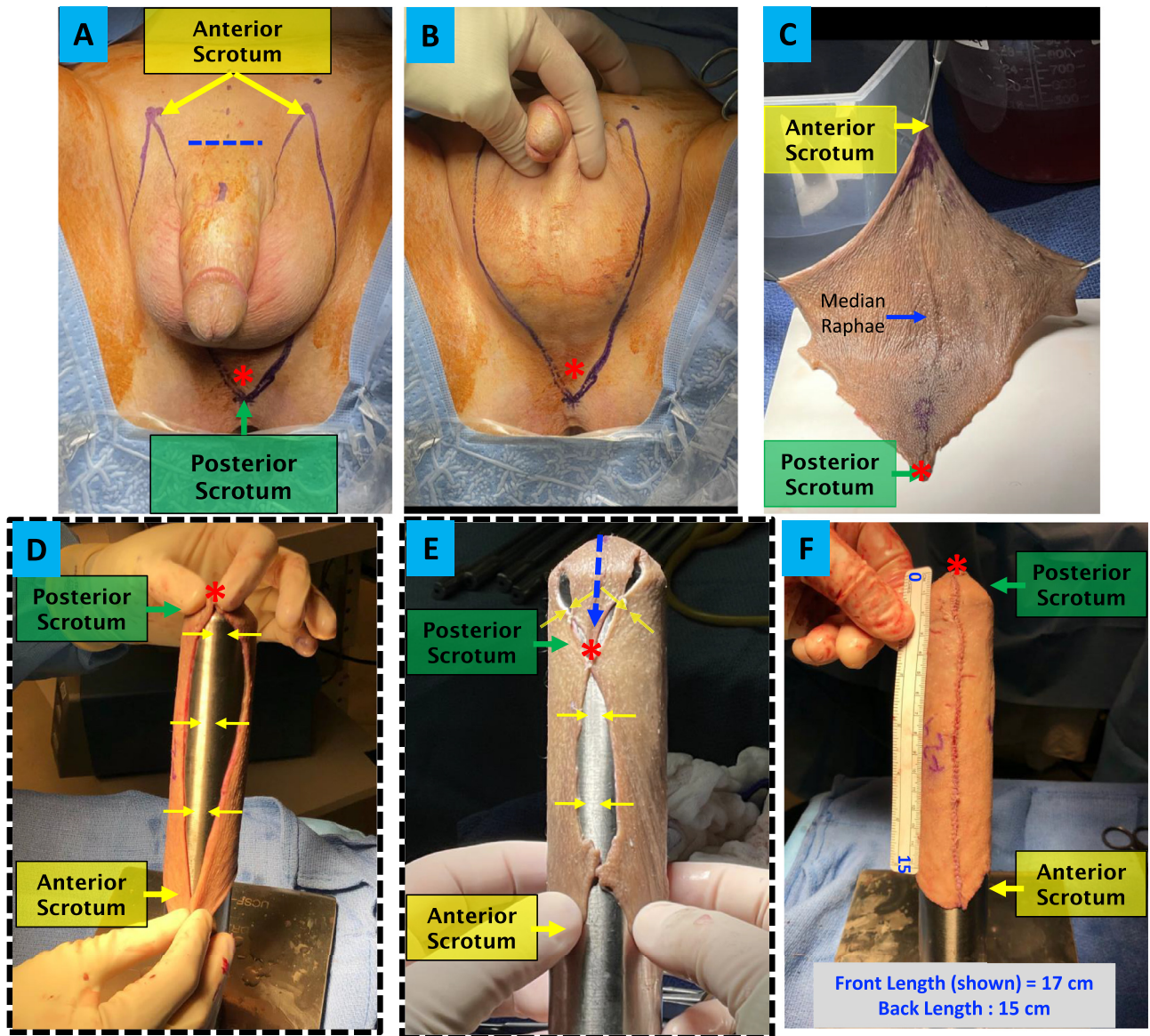


Figure 3. Outline of the scrotal skin graft harvest site. The dorsal base of the shaft is marked in ink (*blue hatched line*). The posterior-most limit of the graft is marked with a red asterisk. **B.** We extend the scrotal skin graft donor site to 2 cm anterior to the anus’ anterior anal ridge (*red asterisk*). **C.** The scrotal skin graft (shown here oriented as it resides on the scrotal sac) is harvested and defatted to Dermis on a back-table. **D.** We then flip the graft upside-down, and orient the midline on the tip of our metal dilator stand. If the scrotal skin graft is sufficiently wide, the skin edges at the tip of the dilator can simply be approximated at midline (*yellow arrows*). **E.** When the patient’s scrotum is too narrow to allow the lateral edges of the skin graft closest to the tip of the dilator to be approximated, one can simply pull the tip of the midline posterior-most portion (*red asterisk*) towards the base (*purple arrow*), to a point where there is sufficient skin to allow the skin edges of each arm of the resulting “Y” to be approximated together. While this shortens the net tube slightly, it makes it possible to not have to cut the graft and discard portions of it during rearrangement. **F.** The skin edges of the graft are sutured towards from tip-to-base using a 3-0 Vicryl suture in a running-locking fashion.

Table 4. Scrotal skin length measured during pre-op clinic visit, and intra-op scrotal skin tube length

Pre-Op Midline Scrotal Skin Length & Intra-Op Tubularized Scrotal Skin Length (n = 46)			
Mean Pre-Op Scrotal Skin Length cm (SD)	Mean Intra-Op Scrotal Skin-Tube Length cm (SD)	Ratio of Intra-op Scrotal Skin Tube Length to Pre-Op Midline Scrotal Skin Length	Correlation Coefficient
21.6 cm (2.5)	12.7 cm (2.3)	0.59	0.41 (P = .005)

not be used in cases where they are not needed, as their use comes at a cost. There is an inherent (albeit low) risk of graft loss, which is morbid, and may manifest as granulation tissue, pain and/or bleeding with dilation, and subjects the pedicled portion of the vaginal canal (ie, inverted penile skin), to which the former is connected, to loss of viability. The use of SS grafts requires extra time to harvest, and for meticulous back table preparation and de-fattening, which leads to increased operative time. When use of scrotal skin grafts are necessary, the patient should undergo a more extensive pre-operative permanent hair removal process with either laser or electrolysis to ensure that the skin that will be used in the graft is completely and permanently hair free. Additional treatment time for permanent hair removal of SS adds a longer lead time to the surgery. This also adds a significant expense to the patient, as well as being inconvenient and uncomfortable.

At our center, we avoid using peritoneum in primary operations for several reasons. First, there is almost always sufficient penile and scrotal skin available to create the neovaginal canal at the initial surgery and use of other tissue sources (peritoneum, intestine) is not required. When needed, SS grafts almost always provide more than adequate coverage when harvested and tubularized in an optimal technique. We compared the vaginal depth achieved with our technique to the mean depth obtained by other authors and found that we achieve a depth that is equal to, or greater than that reported by others.^{9,11-13,15} Second, use of peritoneum adds the risks associated with intra-abdominal surgery, including bowel injury and ileus, to the patient's surgical risks. Third, peritoneal harvesting adds additional costs in the form of increased OR time, and costs associated with robotic surgery, if performed robotically. Fourth, and in our view most importantly, use of peritoneum at the primary surgery limits the patient's options for revision surgery in the future. For those patients who develop neovaginal shortening after surgery, peritoneal vaginoplasty to augment depth is a very useful option. For those who have already had peritoneal vaginoplasty but still have inadequate vaginal canal depth, we are hesitant to attempt to deepen the vaginal canal by addition of additional full-thickness grafts, and in our view the most suitable option is intestinal vaginoplasty using the right colon.¹⁴

A limitation of our study is that any of the penile skin that was discarded due to poor quality (eg, tight phimosis, poor viability) was not measured and accounted for. This likely resulted in a slight overestimation of the contribution of the penile skin to the final vaginal depth. While usable penile skin length can be measured pre-operatively in clinic, a requirement for any skin length-based nomogram is that the surgeon be able to confirm during the pre-op exam whether or not all of the measured penile shaft skin and foreskin is usable during subsequent surgery (ie, healthy, without phimosis). Such detailed measurements are often not feasible to make. Also, it is not always possible to predict whether the maximal stretched circumference of the penile shaft skin and foreskin will provide an adequate vaginal canal width.

In conclusion, our work suggests that while neither the amount of available penile or penile+scrotal skin predicted post-

op vaginal depth, the use of scrotal skin grafts, when harvested and fashioned using our optimized technique, reliably supplies more skin than necessary to achieve maximum neovaginal depth. Furthermore, we showed that the measured pre-op midline scrotal skin length does correlate with the intraoperative scrotal skin-tube length ($p < .001$). For most patients, the available penile and scrotal skin will be sufficient to cover the neovaginal canal and most patients will not require the use of other tissue sources, such as peritoneum, for primary vaginoplasty.

DISCLOSURES

None.

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