

Planned and Unplanned Delayed Anterolateral Thigh Flap Phalloplasty

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Background: Pedicled anterolateral thigh (ALT) flap phalloplasty can be limited by inadequate perfusion. Vascular delay increases perfusion, as delay causes blood vessel formation by limiting the blood supply available to a flap before transfer. We hypothesized that delayed ALT flap phalloplasty would decrease rates of partial flap or phallus loss and other postoperative complications when compared with previously reported complication rates of undelayed single-stage ALT phalloplasty in our practice.

Methods: A retrospective medical record review was performed on all phalloplasty patients in our practice between January 2016 and September 2019. We found those patients who had completed delayed ALT flap phalloplasty with at least 6 months of delay and 12 months of follow-up. For these patients, we recorded postoperative complications, simultaneous surgeries, subsequent surgeries, and demographic characteristics.

Results: Five female-to-male transsexuals underwent delayed ALT flap phalloplasty (two were unplanned procedures, three were planned). Planned delay: The average time between Stage 1 and Stage 2 was 6.5 months. Complications for the planned delay cohort were as follows: partial loss of the neophallus not requiring repair (33%), urethral stricture requiring surgical repair (33%). Unplanned delay: The average time between Stage 1 and Stage 2 was 9.1 months. The following complication was seen in the unplanned delay cohort: urethral stricture requiring surgical repair (50%).

Conclusions: Vascular delay of ALT flap phalloplasty is a successful emergency salvage procedure. Planned delay of ALT flaps provided similar results compared with those previously reported by our practice with standard single-stage approach. (*Plast Reconstr Surg Glob Open* 2021;9:e3654; doi: [10.1097/GOX.0000000000003654](https://doi.org/10.1097/GOX.0000000000003654); Published online 22 June 2021.)

INTRODUCTION

Anterolateral thigh (ALT) flap phalloplasty was first described in 2006. Early techniques used a free flap, where tissue is completely detached from its donor site blood supply and reattached to the recipient site, and were not always suitable because of inadequate perforator vessels.¹ Free flaps require microsurgical attachment of flap vascular structures, known as microvascular anastomosis, which poses the risk of complete flap loss.² Because of the risks associated with free flaps, the pedicled ALT flap technique

was introduced, where tissue is left partially attached to the donor site blood supply. This technique allows for all of the benefits of the ALT free flap without the downsides of a microvascular anastomosis of nerves and blood vessels.^{2,3} This is the ALT phalloplasty technique generally used in our practice. Although this is a suitable flap for phalloplasty, especially in those who cannot or do not wish to use the radial forearm free flap (RFFF), the ALT flap can be limited by poor perfusion or, rarely, by the lack of adequately sized perforators to keep the flap perfused after surgery, which can lead to flap necrosis.⁴ Although complete flap loss is rare, partial flap loss, especially at the distal tip or base, occurs at a higher rate (8%) than seen after RFFF phalloplasty (3%).^{5,6}

Vascular delay, also called the delay phenomenon or ischemic preconditioning, was first described in the 15th century and causes the development of new blood vessels, referred to as neovascularization, by limiting the blood supply available to a flap before transfer, improving vascularization.⁷ In delayed flaps, the size of blood vessels increases.

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This change occurs when choke vessels, which connect adjacent vascular territories (where the flap is most likely to become necrotic), increase in size.^{8,9} The ischemic tolerance of the flap is also increased through alterations in arachidonic acid metabolites, through an interruption of the usual equilibrium between the vasodilating metabolite prostaglandin E₂ and the vasoconstricting metabolite prostaglandin F_{2α}, and through an increase in the vasoconstrictive substance thromboxane.^{8,10} These metabolites are produced as part of an inflammatory, vasoconstrictive response immediately following delay, which is normally associated with ischemia and necrosis. However, the pedicled blood supply of the delayed flap prevents tissue necrosis while allowing the flap to adapt to this inflammatory response. When the flap is ultimately transferred after delay, the surgical trauma of transfer results in an additional inflammatory response. Because the flap is already adapted to such a response, rates of flap survival increase.¹⁰

Vascular delay has been utilized in other complicated flap surgeries, such as in deep inferior epigastric artery perforator (DIEP) free flap breast reconstruction, where delay has been linked to decreased rates of fat necrosis and flap loss.¹¹ We hypothesized that a two-stage delayed ALT flap phalloplasty would decrease rates of partial flap or phallus loss and other postoperative complications when compared with the previously reported complication rates of undelayed single-stage ALT phalloplasty in our high-volume practice.⁶ The two stages of this procedure occur as follows: during Stage 1, the locations of perforators are identified and marked using doppler ultrasound. All edges except the proximal edge of the flap are then incised, and the blood supply of the flap is isolated save for a few perforators. After this point, the flap is sutured closed. During Stage 2, phalloplasty is completed with the previously isolated flap after a period of delay using the standard tube-within-a-tube approach.^{2-6,12} We present two patient cohorts: unplanned delayed ALT flap phalloplasty (where the surgical plan was changed intraoperatively to delay the ALT flap when the blood supply was found to be compromised) and planned delayed ALT flap phalloplasty. This is the first report on the utility of vascular delay in ALT phalloplasty of which we are aware.

METHODS

Study Information

This study received human subjects committee (IRB) approval. After human subjects committee approval, a retrospective medical record review was performed on all phalloplasty patients in our practice between January 2016 and September 2019. We found those patients who had completed both stages of a two-stage delayed ALT flap phalloplasty with at least 6 months of delay between Stage 1 and Stage 2 and 12 months of follow-up.

The primary variables studied in these patients were as follows: postoperative complications, simultaneous surgeries performed in Stage 1 or Stage 2, subsequent surgeries performed, and demographic characteristics.

The postoperative complications that were recorded include hematoma, urethral stricture, urethral fistula, dehiscence, meatal stenosis, abscess, and flap or phallus loss.^{6,13,14} We also noted the number of surgeries required to affect cure for the above postoperative complications. Subsequent surgeries performed include liposuction and escutcheonectomy.

Operative Technique: Planned Delayed Flap ALT Phalloplasty

Stage 1 of the planned delayed ALT flap phalloplasty is performed in the following way: Preoperative hysterectomy, in which the uterus is removed and the vagina is left intact, is completed before surgery. Thigh hair removal is also completed in advance to limit hair growth inside of the neourethra after phalloplasty. A 22-cm wide by 16-cm long ALT flap is marked starting 5 cm cephalad to the upper edge of the patella, centered over the line created by the lateral patellar edge and the anterior superior iliac spine, per classical description of the ALT pedicle.¹⁵ Doppler ultrasound is used to locate and mark the location of expected perforators preoperatively, usually while the patient is awake (Fig. 3). No other radiology technologies are used to locate perforators. During surgery, all edges except the proximal edge of the planned ALT flap are incised, and the blood supply of the flap is isolated save for a few perforators. The proximal edge is left unincised to limit subsequent edema of the flap after delay, where tissues swell due to excess fluid. After this point, the flap is closed, and two closed suction drains are placed and are later removed when their daily output falls below 20 cm³/day.¹⁶ Simultaneous vaginectomy is completed during Stage 1 by a second operating team, when desired.

After a healing period of 6 months, Stage 2 of planned delayed pedicled ALT phalloplasty is performed using a standard tube-within-a-tube method for urethral creation (Fig. 1).^{2-6,12} A benefit of delaying the ALT flap is that partial flap necrosis, usually of the flap edge, can occur relatively harmlessly, as necrotic tissue can then be excluded from the subsequently created phallus (Fig. 2).

Operative Technique: Unplanned Delayed Flap ALT Phalloplasty

The ALT flap is marked as described above (Fig. 3). All four edges of the ALT flap are incised to proceed with normal, undelayed ALT phalloplasty. However, when the surgical team finds the blood supply to be insufficient, with apparent inadequately sized perforators (Fig. 4), which appear to be less than 1 mm in diameter, or clinical evidence of poor perfusion after vessel isolation (nonbleeding edge, blanched skin appearance), the decision is made to delay the flap. Doppler ultrasound may also be used to assess perfusion. Following the decision to delay the flap, perfusion is not further assessed with techniques such as indocyanine green (ICG) fluorescence imaging, and no radiology technologies other than doppler ultrasound are used. The second team performing vaginectomy/scrotoplasty/urethral lengthening is then alerted to pause their surgery and only vaginectomy is completed. After a delay

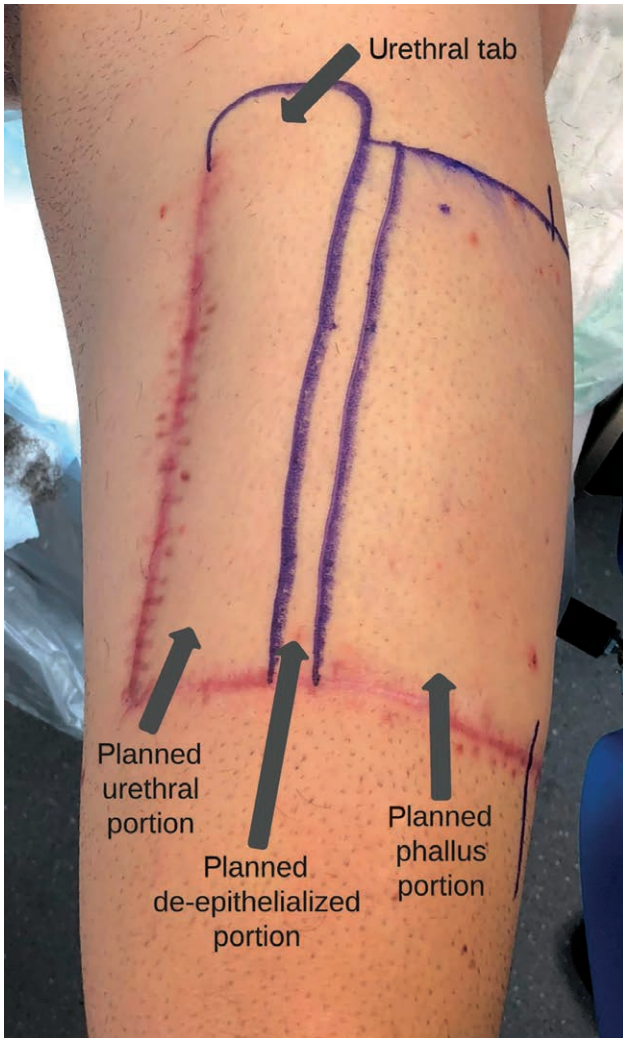


Fig. 1. Planned delayed ALT flap marking showing planned urethral portion (lateral, left of photograph), de-epithelialized portion, and phallus portion (medial, right of photograph).

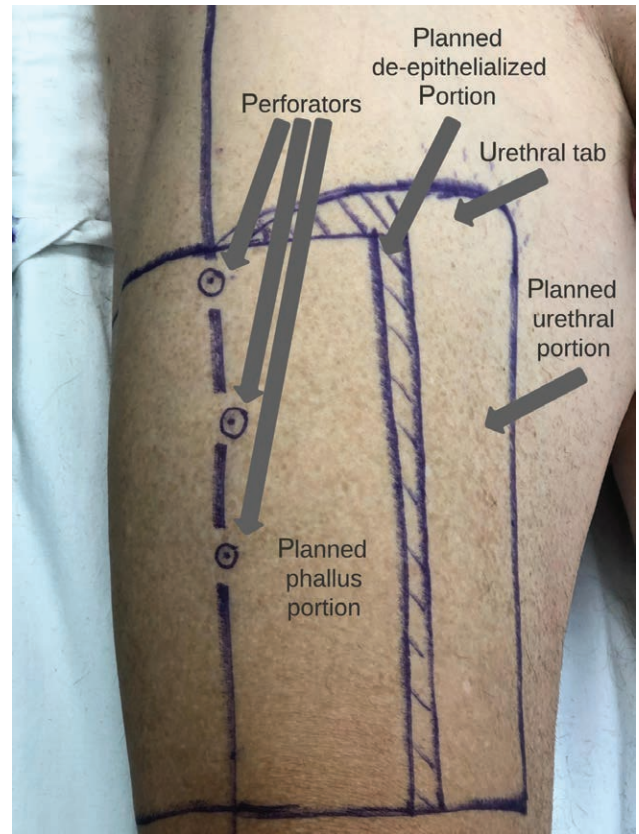


Fig. 3. Example of preoperative ALT phalloplasty markings (non-delay patient) showing perforators detected by Doppler (dots), urethral portion (medial, right of photograph), de-epithelialized portion, and phallus portion (lateral, left of photograph).

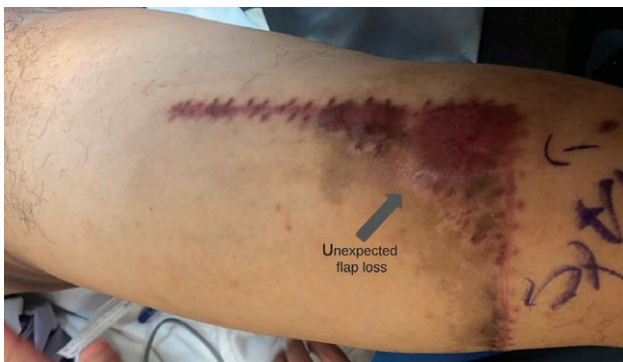


Fig. 2. Planned delayed ALT with unexpected flap loss which can be excluded from the subsequent phalloplasty. Presumably this portion of the flap would have necrosed if a primary, nondelayed phalloplasty had been performed.

period of 6 months, pedicled ALT flap phalloplasty is performed using the standard tube-within-a-tube approach, during which time scrotoplasty/urethral lengthening are completed.^{2-6,12}

Patient Characteristics

Five female-to-male transgender patients underwent two-stage delayed ALT flap phalloplasty between January 2016 and January 2020, during a time when we completed approximately 110 phalloplasties per year. Two were unplanned, and three were planned procedures. The patient mean age was 32.5 (range 27.7–38.5 years) at the first stage. All five patients completed a vaginectomy in the first stage and elected for scrotoplasty/urethral lengthening in the second stage.

RESULTS

Planned Delay

For the three patients undergoing planned delayed ALT flap phalloplasty, we arbitrarily chose an interval of 6 months between stages 1 and 2 to allow for maximum healing and complete resolution of flap edema. The average time between the delayed ALT flap (Stage 1) and the completion phalloplasty (Stage 2) was 6.5 months (range 6.4-6.6 months). After Stage 1 delay, only

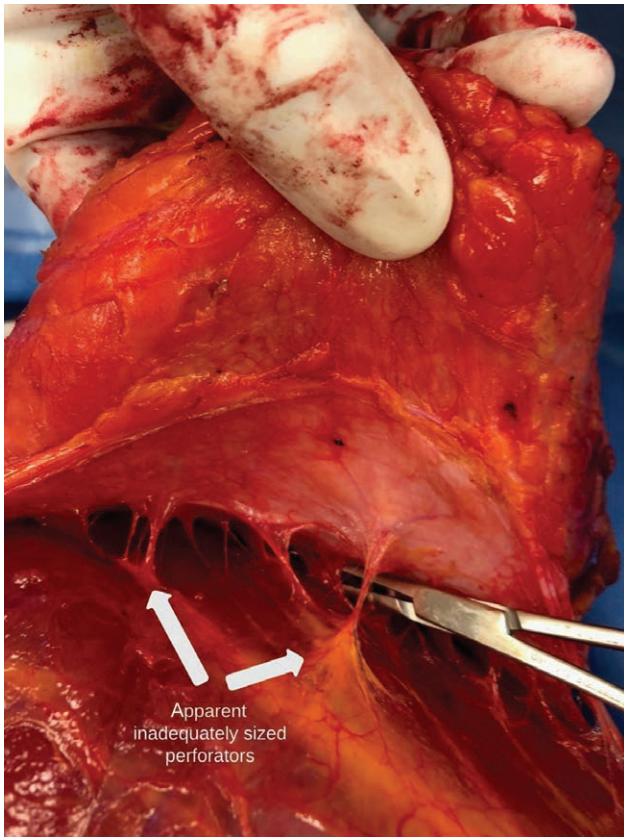


Fig. 4. ALT flap with small and inadequate perforators, for which a salvage delay procedure was chosen. Note the flap was mottled, appeared poorly perfused, and lacked edge bleeding.

one complication was seen: superficial dehiscence not requiring surgery [1/3 (33%)]. After Stage 2, one complication was seen in these patients that required surgical repair: urethral stricture [1/3 (33%)]. Additionally, one postoperative complication that did not require repair was seen after Stage 2: partial loss of the neophallus [1/3 (33%)]. For the patient that developed a urethral stricture, one surgery was required to affect cure. One patient [1/3 (33%)] elected to have liposuction of the phallus 4 months after phalloplasty to decrease the girth of the phallus, a commonly required surgery after ALT phalloplasty. This patient required a second liposuction to sufficiently reduce the size of the phallus. No patients developed partial flap loss, partial loss phallus requiring surgery, dehiscence, hematoma, urethral fistula requiring surgical repair, meatal stenosis, abscess, or symptomatic/persistent lymphocele. All patients had self-reported light touch and erogenous sensation in the neophallus.

Unplanned Delay

For the two patients undergoing unplanned delayed ALT flap phalloplasty, we arbitrarily chose to perform the second stage after 6 months of healing time, and the average time between Stage 1 and Stage 2 was 9.1 months (range 6.1–12 months). After flap delay, no complications were seen in these patients. After completion

Table 1. Summary of the Characteristics, Complication Rates, and Subsequent Surgeries for Planned and Unplanned Delayed ALT Flap Phalloplasty Patients

	Complication Rates and Results for Planned and Unplanned Delayed Anterolateral Thigh Flap Phalloplasty Patients	
	Planned	Unplanned
No. patients	3	2
Mean age at Stage 1	31.8	33.6
Mean length of delay (months)	6.5	9.1
No. complications after Stage 1	1	0
Superficial dehiscence not requiring repair (%)	1 (33)	0 (0)
No. complications after Stage 2	2	1
Urethral stricture requiring repair (%)	1 (33)	1 (50)
No. surgeries required to affect cure after stricture	1	2
Partial loss neophallus not requiring repair (%)	1 (33)	0 (0)
No. additional surgeries after phalloplasty	1	4
Liposuction (%)	1 (33)	2 (100)
Second liposuction (%)	0 (0)	1 (50)
Escutcheonectomy (%)	0 (0)	1 (50)

phalloplasty, the following complication was seen: urethral stricture requiring surgical repair [1/2 (50%)]. This patient required two surgeries to affect cure. Both patients [2/2 (100%)] elected to have liposuction of the phallus, and one (1/2 [50%]) required a second liposuction. One patient [1/2 (50%)] required an escutcheonectomy. No patients developed dehiscence, partial loss of the delayed ALT flap, partial loss of the neophallus, hematoma requiring surgery, urethral fistula requiring surgical repair, meatal stenosis, abscess, or symptomatic/persistent lymphocele. All patients had self-reported light touch and erogenous sensation in the neophallus. A summary of the results for both planned and unplanned delayed ALT flap phalloplasty is presented in [Table 1](#).

DISCUSSION

Pedicled ALT flap phalloplasty has historically made up around 43% of the phalloplasties we perform at our high-volume center (110–140 phalloplasties/year). Single stage pedicled ALT flap phalloplasty is performed without delay using the standard tube-within-a-tube approach.^{2–6,12} Vascular delay has been shown to increase rates of flap survival, as it causes neovascularization by rendering tissue partial ischemic, meaning the blood supply available to a flap is limited to a few perforators before transfer.^{7–10} We hypothesized that planned ALT flap delay would provide several benefits over the classical one-stage approach, including improved flap blood supply and identification/exclusion of flap tissue that did not survive the first stage delay procedure, while allowing vaginectomy to be completed at a point in time distant from the phalloplasty, thus decreasing the impact of this procedure on the patient. We also realized that delayed ALT flap phalloplasty could be used as a salvage procedure for patients who lack the vascularity

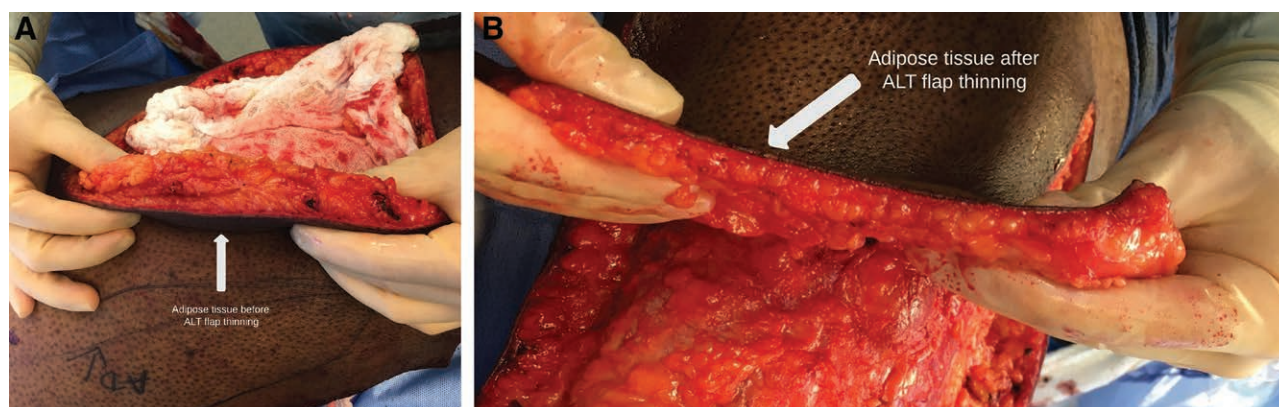


Fig. 5. A defatting procedure has been used, along with vascular delay, to decrease the girth of the phallus after phalloplasty. A, Planned delayed ALT flap before flap thinning in the first stage. B, Planned delayed ALT flap after flap thinning in the first stage.

to safely undergo a single-stage ALT flap phalloplasty. We found that ischemic preconditioning before ALT phalloplasty was a successful emergency salvage procedure in those rare patients with perceived inadequate vascularity in the flap. We also found that ALT flap delay provided similar results compared with those previously reported by our practice with the standard one-stage phalloplasty approach. In a previous study by our practice, single-stage pedicled ALT flap phalloplasty was found to have a rate of urethral stricture of 22%, which is comparable to our results in this report. Additionally, we had one patient with partial flap loss in this study, consistent with the 8% rate previously reported by our practice with undelayed pedicled ALT flap phalloplasty patients.⁶ We chose not to undertake a comparison with data from other practices, as these data are less directly applicable to our results than those previously reported by our practice.

Highlights of Technique

Although the data are too sparse to make firm recommendations, we used a 6-month delay period between flap creation and completion phalloplasty to allow for complete healing before additional surgeries are completed. In planned delay operations, we would advise leaving the proximal edge of the flap unincised to decrease flap edema. We are currently considering techniques to allow easier exhumation of the lateral femoral cutaneous nerve (which we coapt to a clitoral nerve during phalloplasty to innervate the phallus), and plan to cloak the nerve in medical grade implantable silicone sheeting to allow its easy dissection in the future.^{2,3}

Another Use of Delay in ALT Phalloplasty: Staged Flap Thinning/Defatting

We hypothesize that this delay ALT flap principle can be expanded for use in patients with too much adipose in the flap, which would otherwise result in a very large/girthy phallus. We are evaluating this technique with the addition of defatting in the first and second stages, to decrease the thickness of the flap (Fig. 5) and create a more normal size phalloplasty. This may be a promising

technique to improve outcomes in patients with known large amounts of adipose in the ALT flap.

LIMITATIONS

This preliminary case series has several limitations. As a proof of principle study, its population is necessarily small. Larger series are needed to further establish the performance characteristics of delayed flap in ALT phalloplasty, in either planned or emergency procedures.

CONCLUSIONS

Ischemic preconditioning of ALT flap phalloplasty is a successful emergency salvage procedure, when needed. Planned delay of ALT flaps provided similar results compared with those previously reported by our practice with standard one-stage phalloplasty approach.

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