

Preoperative Computed Tomography Angiography for ALT Flaps Optimizes Design and Reduces Operative Time

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Abstract

Background Computed tomography angiography (CTA) has been widely used for perforator mapping in abdominal-based reconstruction, but it is less widespread in the anterolateral thigh (ALT) flap. However, CTA may be quite useful for ALT planning, as this flap has demonstrated substantial variability in inpatient bilateral vascular anatomy. This study investigated whether standard use of preoperative CTA resulted in selection of the donor extremity with preferential perforator anatomy, and whether this affected operative time and postoperative outcomes.

Methods A retrospective review of 105 patients who underwent proposed ALT flap reconstruction was performed. Seventy-nine patients received bilateral lower extremity CTAs, which were evaluated for dominant perforator anatomy (septocutaneous, musculoseptocutaneous, or musculocutaneous). Donor extremity selection was noted, and predicted perforator anatomy was compared with that encountered intraoperatively.

Results Among the 73 patients who received bilateral imaging and ultimately received an ALT, congruent findings between imaging and surgical exploration were observed in 51 (69.8%) patients. Thirty (37.9%) patients had asymmetric perforator anatomy between their bilateral extremities on imaging. Among these, the leg with optimal perforator anatomy was selected in 70% of cases. There were no significant reductions among postoperative complication rates, but selection of the donor site with preferential anatomy was associated with a decrease in operative time ($p = 0.049$) among patients undergoing extremity reconstruction.

Conclusion CTA is a useful tool for optimizing donor site selection for ALT flaps and reducing operative time. We believe that standard use of preoperative CTA in ALTs warrants further consideration.

Keywords

- CTA
- ALT flap
- perforators

The anterolateral thigh (ALT) flap's versatile design has made it a workhorse flap with a broad range of clinical applications. First described anatomically by Song et al¹ and clinically by

Koshima et al,² the classic ALT is a fasciocutaneous flap supplied by the descending branch of the lateral femoral circumflex artery (dbLFCA) and its perforators. With a long

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vascular pedicle, a large skin paddle, and minimal donor site morbidity, the ALT is an excellent option for soft-tissue coverage of the extremities, head and neck, and elsewhere following trauma, infection, or malignancy. It has proven useful for the reconstruction of complex defects as it can be harvested with variable thickness, incorporate the lateral femoral cutaneous nerve of the thigh, and can generate chimeric flaps to reconstruct multiple defects simultaneously.^{3,4} However, this significant versatility is countered by substantial variability in perforator anatomy, which can complicate flap dissection for even the experienced microsurgeon.^{5,6}

Despite a consistently large caliber pedicle, multiple reports have detailed wide variation in cutaneous perforator course.⁷ Although some perforators may take a purely septocutaneous course and are relatively easy to dissect, others may have a more difficult intramuscular course—either partially or through their entire length—within the substance of the vastus lateralis. Under those circumstances, elevating the flap can become quite tedious to avoid damage to the muscle and vascular pedicle.

Indeed, previous cadaveric and imaging studies have shown substantial intra- and interlimb perforator asymmetry within individual patients^{7,8} and among individuals of different races and ethnicities.^{9–11} Studies have revealed between one to four perforators emerge from the dbLFCA around the midpoint between the anterior superior iliac spine and the lateral patellar border.^{6,9} Perforators may also less commonly emerge from the oblique or transverse branches of the LFCA, which may also serve as effective options.^{12–14} Nevertheless, there are ways to mitigate what might otherwise be a difficult dissection with proper flap design and donor site selection. If perforator size and course can be evaluated preoperatively, selection of the preferential donor extremity and optimum perforators may theoretically decrease intraoperative time, cost, and surgical complication rates.

Various imaging modalities have been utilized to map cutaneous perforators in other perforator flaps, most notably in autologous breast reconstruction.^{5,15,16} Computed tomography angiography (CTA) is relatively noninvasive, rapid, and can be easily and accurately read by the reconstructive surgeon. Abundant literature supports the routine use of preoperative CTA to identify the dominant perforator in abdominal flaps—including the widely utilized deep inferior epigastric perforator flap (DIEP), which has been shown to decrease operative times and complication rates.¹⁴ Use of these technologies has expanded to the ALT as well, with several recent clinical studies exploring the role of preoperative CTA in assisting with ALT flap harvest.^{5,10,15,17–20} However, these studies have differed in purpose, with most of their emphasis focused on selecting individual perforators to customize flap design, rather than a broader focus on donor extremity selection; preoperative CTA has yet to be adopted as standard practice. As such, we believe that a detailed description and review of the processes behind donor thigh selection for the ALT flap is warranted. In this study, we seek to demonstrate the clinical utility of the

standardized preoperative planning with CTA imaging to guide ALT flap donor site selection.

Methods

Patient Selection and Chart Review

Following institutional review board approval, we performed a retrospective review of 105 consecutive thigh-based perforator free flap reconstructions at our center from 2017 to 2020. All procedures were performed by the senior authors (D.J.W., C.T.T., and M.W.S.).

Per current institutional protocol, all patients undergo a bilateral CTA prior to these procedures. All senior surgeons contributing to this report examine the CTA preoperatively and actively develop the surgical plan based on identification of perforators and their course. These scans are obtained at varying times prior to the procedure, depending on the nature of the case. Consultation with a radiologist is not standard for these cases but occurs occasionally when questions arise. No radiographic markers or software are used.

Charts were reviewed for patient demographics, reconstructive indications, imaging, operative description of the perforator anatomy, operative time, and postoperative complications. Operative time was defined as the time from donor site exposure and ALT harvest to final closure; we did not document flap harvest time independently. Cases in which ALT start time was not documented separately from procedures performed by orthopaedic or otolaryngology colleagues within the same case were excluded from this measure. As a result, mean operative time was primarily representative of upper and lower extremity reconstruction. Patients were not “double-counted” if they underwent a second ALT due to total flap failure.

Preoperative and Intraoperative Evaluations of Perforator Anatomy

Bilateral lower extremity CTA scans obtained for preoperative planning and donor site selection were reviewed. CTA was performed using a 128-slice, 64-detector-row Philips IQon Spectral CT scanner (Amsterdam, The Netherlands) with the following parameters: 120 kVp; 228 mA; pitch: 0.579; rotation time: 0.75 seconds; mean scan time: 40.8 seconds; and 512 × 512 matrix. Scans were obtained following rapid administration of a 100-mL intravenous bolus of nonionic iodinated contrast (iohexol) at a concentration of 3.5 mg/mL. Volumetric data were used to reconstruct images with a slice width of 1 mm. Three-dimensional volume rendered and maximal intensity projection images were obtained as well.

CTA scans were retrospectively evaluated by a single reviewer blinded to case information to record the dominant perforator anatomy within each extremity as septocutaneous, musculoseptocutaneous (short intramuscular), or musculocutaneous (long intramuscular). CTA-defined perforator anatomy was compared with the anatomy encountered intraoperatively as documented in the operative note. Each case with asymmetric perforator anatomy per imaging was stratified into two categories based on whether the limb with

more preferential/optimal or less preferential/suboptimal anatomy was chosen. Septocutaneous perforators were considered most preferential, followed by musculoseptocutaneous and musculocutaneous perforators. This assumes that the chosen extremity was selected exclusively due to preoperatively mapped perforator course at that time and is a limitation of our study.

Statistical Analysis

Patients with unilateral CTAs, no CTA, or with planned bilateral ALTs for reconstruction of two simultaneous defects were excluded from statistical comparison when inappropriate. Patients were also excluded from certain analyses if they received a vastus lateralis myofascial flap or a tensor fascia lata (TFL) flap, and the mapped cutaneous perforators were subsequently not documented. Statistical analyses were performed using RStudio 2020 (Boston, Massachusetts). Interlimb anatomic variability of dominant cutaneous perforators identified on bilateral imaging was evaluated. The relationships were evaluated between patients undergoing preoperative imaging, expected versus observed anatomy, and the perceived ideal donor extremity selection with outcomes including complications and operative time using Fisher's exact and Mann-Whitney tests for categorical and continuous variables.

Results

Flap characteristics can be seen in ► **Table 1**. Out of a total 105 patients included in the study, preoperative bilateral lower extremity CTA scans were obtained for 79 (75.7%) patients (158 total extremities), whereas 4 (3.8%) patients received unilateral scans and 22 (20.9%) patients did not undergo preoperative imaging. The 19 (73.1%) patients who had

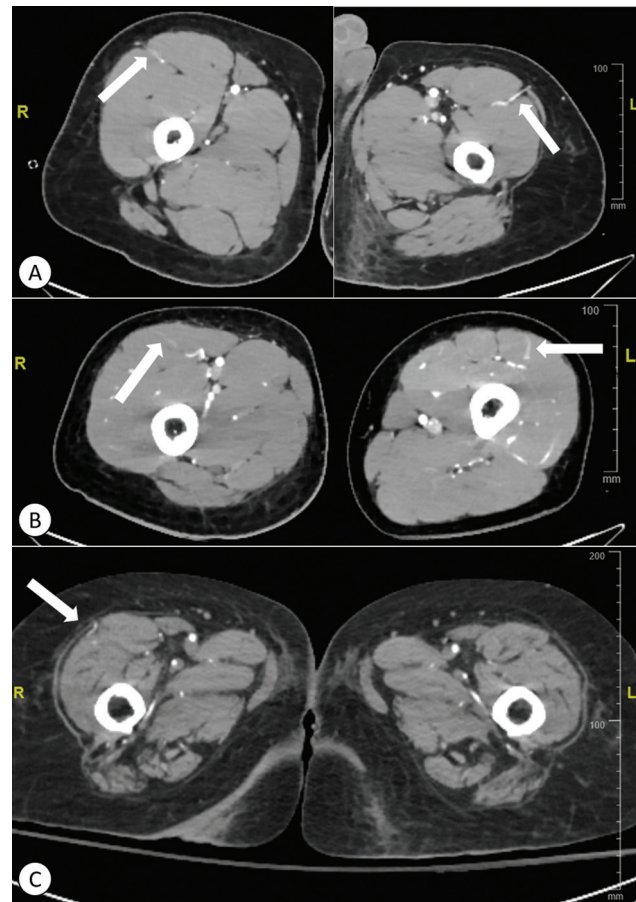


Fig. 1 (A) Lower extremity computed tomography angiography (CTA) in a patient with dominant septocutaneous perforators bilaterally (interlimb symmetry). The depicted perforators are not on the same CT slice. (B) Lower extremity CTA in a patient with dominant musculocutaneous (long intramuscular) perforators bilaterally (interlimb symmetry). The depicted perforators are not on the same CT slice. (C) Bilateral lower extremity CTA in a patient with a dominant musculoseptocutaneous (short intramuscular) perforator on the right and no perforators on the left (interlimb asymmetry).

Table 1 Flap characteristics (N = 105)

Defect location	n (%)
Lower extremity	57 (53.3)
Head and neck	37 (34.6)
Upper extremity	11 (10.2)
CTA performed	
Bilateral	79 (75.7)
None	22 (21.0)
Unilateral	4 (3.8)
Donor extremity	
Left	54 (51.4)
Right	51 (48.6)
Donor site	
ALT	98 (93.3)
Vastus lateralis	4 (3.8)
TFL	3 (2.9)

Abbreviations: ALT, anterolateral thigh flap; CTA, computed tomography angiography; TFL, tensor fascia lata flap.

either a unilateral scan or no scan were operated on in 2017 or 2018, with all but one of the remaining 7 (26.9%) occurring in early 2019. On CTA, 47 (59.5%) patients demonstrated symmetric bilateral dominant perforator anatomy (► **Table 2**). These were found to be musculocutaneous in 21 (26.6%) patients, septocutaneous in 17 (21.5%) patients, and musculoseptocutaneous in 9 (11.3%) patients (► **Fig. 1A, B**). Conversely, 32 (40.5%) patients were found to have significantly asymmetric dominant perforator anatomy between extremities that could reasonably be expected to influence the surgical plan or operative course. Several variants with significant disparity were observed. There were 10 (12.7%) patients in total who entirely lacked a visible perforator in one limb, 7 (8.9%) patients with a unilateral musculoseptocutaneous perforator (► **Fig. 1C**), and 3 (3.8%) patients with a unilateral septocutaneous perforator. Additionally, there were 11 (13.9%) patients with a dominant septocutaneous perforator in one extremity and a dominant musculocutaneous perforator contralaterally (► **Fig. 2**).

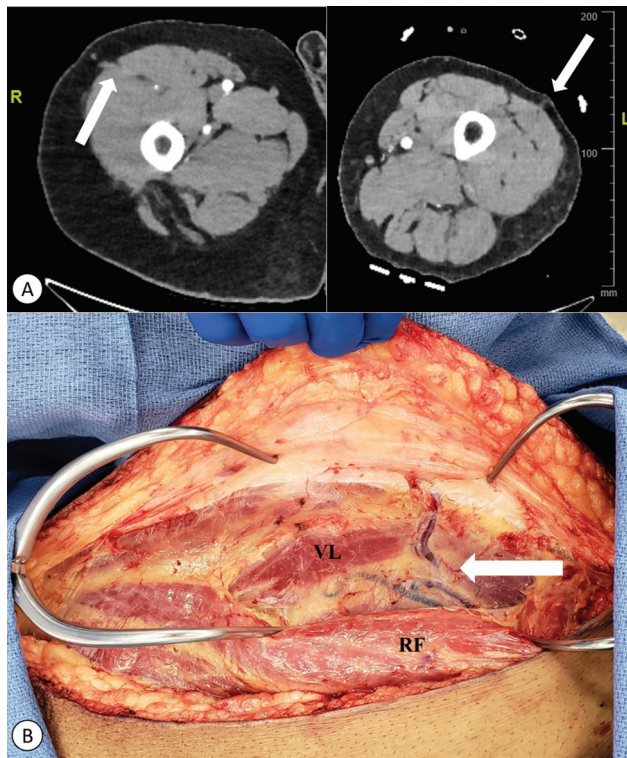


Fig. 2 (A) Lower extremity computed tomography angiography (CTA) in a patient with a dominant septocutaneous perforator on the right. This was chosen as the donor site over a suboptimal dominant musculocutaneous perforator on the left. (B) Intraoperative photograph demonstrating a septocutaneous perforator between the rectus femoris (RF) and the vastus lateralis (VL). This is an example of congruency between preoperative imaging and the intraoperative findings.

Table 2 Distribution of inpatient bilateral perforator anatomy by CT angiography ($N = 79$)

Predicted perforator course pairs	<i>n</i> (%)
<i>Symmetric pairs</i>	47 (59.5)
Musculocutaneous: musculocutaneous	21 (26.6)
Septocutaneous: septocutaneous	17 (21.5)
Musculoseptocutaneous: musculoseptocutaneous	9 (11.3)
<i>Asymmetric pairs</i>	32 (40.5)
Septocutaneous: musculocutaneous	11 (13.9)
Musculoseptocutaneous: musculocutaneous	7 (8.9)
Musculoseptocutaneous: none	7 (8.9)
Septocutaneous: musculoseptocutaneous	4 (5.1)
Septocutaneous: none	3 (3.8)

Abbreviation: CT, computed tomography.

► **Table 3** illustrates the congruency between preoperative imaging and dominant perforator anatomy encountered in the operating room among the 73 patients who received ALT

Table 3 Distribution of perforator anatomy by congruency ($n = 73$)

Course (expected: encountered)	<i>n</i> (%)
<i>Congruent pairs</i>	51 (69.8)
Musculoseptocutaneous: musculoseptocutaneous	19 (25.7)
Musculocutaneous: musculocutaneous	18 (24.3)
Septocutaneous: septocutaneous	14 (18.9)
<i>Incongruent pairs</i>	22 (30.1)
Septocutaneous: musculoseptocutaneous	9 (12.3)
Septocutaneous: musculocutaneous	7 (9.6)
Musculocutaneous: septocutaneous	3 (4.1)
Musculocutaneous: none	2 (2.7)
Musculocutaneous: musculoseptocutaneous	1 (1.4)

flaps following bilateral imaging. Imaged perforator anatomy was found to accurately correlate with operative findings in 51 (69.8%) patients. The most common discrepancy was a preoperatively identified septocutaneous perforator having a musculoseptocutaneous course (12.3%). Encountering an unexpected musculocutaneous (9.6%) perforator or a complete absence of perforators (2.7%) was infrequent overall. Ultimately, 53% of preoperatively identified dominant septocutaneous perforators were found to be incongruent during operative exploration versus only 5% of selected musculoseptocutaneous perforators and 25% of selected musculocutaneous perforators. A more difficult dissection based on perforator course was encountered in 19 (26.0%) patients, whereas an easier dissection was encountered in 4 (5.4%) patients. Including those with unilateral or no scans, 98 (93.3%) patients received an ALT flap as planned, whereas 3 (2.8%) were converted to TFL flaps and 2 (1.4%) to vastus lateralis flaps. Flap conversion occurred due to an inability to locate perforators in two cases, vessel size mismatch in one case, and aberrant perforator anatomy to the TFL instead of the ALT in another.

Associations between preoperative CTA/donor site selection and postoperative outcomes can be seen in ► **Table 4**. There were no significant decreases in complication rates, although patients undergoing bilateral preoperative imaging trended toward a lower incidence of any complication ($p = 0.065$). Additionally, selection of the donor extremity with preferential anatomy in patients with asymmetric dominant perforators led to a statistically significant decrease in operative time (352.6 vs. 460.9 minutes, $p = 0.049$) among those undergoing extremity reconstruction, as well as nearing significance among all patients who had bilateral CTAs (384.7 vs. 478.0 minutes, $p = 0.072$).

Discussion

Donor extremity selection for the ALT flap can potentially have a significant impact on the course and outcome of a

Table 4 Impact of CTA and donor extremity selection on postoperative outcomes

Outcome	CTA (N = 105 total patients)			Congruency between findings (n = 73 ALTs with bilateral imaging)			Donor extremity perforator anatomy (n = 30 asymmetric LE pairs)		
	None/unilateral (%), n = 26	Bilateral (%), n = 79	p-value	Incongruent (%), n = 21	Congruent (%), n = 52	p-value	Suboptimal ^a (%), n = 9	Optimal ^a (%), n = 21	p-value
Any complication	15 (57.7)	28 (35.4)	0.065	9 (42.9)	16 (30.8)	0.415	1 (11.1)	9 (42.8)	0.204
Total flap failure	5 (19.2)	6 (7.6)	0.135	3 (14.3)	2 (0.0)	0.140	0 (0.0)	4 (19.0)	0.287
Partial flap failure	1 (3.8)	2 (2.5)	1.000	2 (9.5)	0 (0.0)	0.080	0 (0.0)	1 (4.8)	1.000
Exposed hardware	0 (0.0)	1 (1.3)	1.000	0 (0.0)	1 (1.9)	1.000	0 (0.0)	0 (0.0)	–
Take-back	5 (19.2)	6 (7.6)	0.687	1 (4.8)	5 (9.6)	0.666	0 (0.0)	5 (23.8)	0.286
Dehiscence	7 (27.0)	10 (12.7)	0.123	1 (4.8)	7 (13.5)	0.425	0 (0.0)	3 (14.3)	0.535
Infection	4 (15.4)	9 (11.4)	0.732	4 (19.0)	4 (7.7)	0.216	1 (11.1)	1 (4.8)	0.517
Seroma	2 (7.7)	3 (3.8)	0.595	2 (9.5)	0 (0.0)	0.079	0 (0.0)	0 (0.0)	–
Hematoma	1 (3.8)	4 (5.1)	1.000	0 (0.0)	4 (7.7)	0.318	0 (0.0)	0 (0.0)	–
Operative time (min), mean ± SD ^b	478.0 ± 161.3	384.7 ± 123.9	0.072	418.6 ± 146.8	372.1 ± 114.8	0.334	460.9 ± 96.9	352.6 ± 101.3	0.049 ^c

Abbreviations: ALTs, anterolateral thigh flaps; CTA, computed tomography angiography; LE, lower extremity; SD, standard deviation.

^aOptimal perforator course for ease of surgical dissection is considered septocutaneous > musculoseptocutaneous > musculocutaneous

^bOmits combined cases where the reconstructive component was not documented separately.

^cp < 0.05.

reconstructive procedure. Two critical anatomic criteria to consider when evaluating each potential donor site are the course and caliber of the perforators present. The ideal perforator has both the largest diameter and the shortest intramuscular course; septocutaneous perforators are significantly easier and safer to dissect than musculocutaneous perforators. Presumptive perforators should also be assessed for adequate length, which may be especially important in situations such as the vessel-depleted neck or severe lower extremity trauma when recipient vessels may be located far from the primary defect. Although trained microsurgeons may be comfortable elevating an ALT flap without preoperative imaging,²¹ we believe that a CTA can assist in optimizing the dissection and potentially mitigate surgical risk and postoperative morbidity. However, despite many anecdotal reports of preoperative ALT perforator mapping with CTA, there are surprisingly few empirical studies that have directly attempted to assess the impact of this approach on donor extremity selection.^{5,15,17,20,22} Garvey et al performed one such study, reporting CTA guidance to alter leg selection in 19% of cases.²⁰

The findings from our study, which to our knowledge is the largest series of patients undergoing preoperative CTA for ALT planning, are consistent with previous reports in the literature^{5,10,15,17,19,20,22,23} that preoperative CTA accurately predicts ALT perforator course by confirming congruency between imaged anatomy and operative findings in 70% of cases. We also identified a high rate of dominant perforator asymmetry between lower extremities in 32 patients (40.5%), a finding shared by several anatomic studies.^{7,8} This is particularly important when there may be extreme differences in perforator anatomy between each side. There were 10 (12.7%) patients who entirely lacked visualized perforators on one side, and we theoretically avoided a poor operative course by seeing this on imaging. We were also able to recognize the distinction between extremities

with septocutaneous versus musculocutaneous perforators in 11 patients (13.9%), a disparity undetectable via traditional techniques of perforator selection such as handheld Doppler device. The impact of these findings is substantiated further by a recent report by Cohen et al, who found that up to 58.8% of patients possess a septocutaneous or musculoseptocutaneous perforator in only one extremity.²² Although incongruence was encountered in 30% of cases, we believe that several of these inconsistencies were the result of an initial learning curve using this technique, and likely represent an inaccurate interpretation of the CTA leading to improper perforator selection. Furthermore, there were only nine cases (12.3%) in which a long intramuscular course (9.6%) or no perforators (2.7%) were encountered unexpectedly. In other words, bilateral CTA imaging may allow us to avoid these especially egregious circumstances in 90% of ALT harvests.

Historically, patient positioning and operative logistics have been major factors driving donor limb selection. From a practical perspective, dissection of both donor and recipient sites simultaneously may save operative time and cost. As such, surgeons commonly select the thigh contralateral to the recipient site so that two teams can work without compromising space.¹⁷ Alternatively, some practices have adopted standard use of the right extremity as it is more ergonomic for right-handed surgeons.²⁰ However, without consideration of potential asymmetric vascular anatomy between the extremities, this approach may bring a higher risk of encountering suboptimal or even a complete absence of amenable perforators, potentially extending operative time, and perhaps even resulting in unnecessary surgical morbidity. Furthermore, if the tissue defect in question is itself located in the lower extremity, it may be preferential to use the same leg to abstain from inducing morbidity on an otherwise pristine leg. Given the risk of flap elevation without a known perforator, CTA may help in overcoming

this limitation. If the perforators are found to be inadequate, then an alternate reconstructive plan can be implemented.

As previously mentioned, the vascular anatomy of the LFCA shows remarkable variation, confounding the ability of reconstructive surgeons to rely on consistent perforator anatomy. Preoperative CTA allows for selection of the donor extremity with the anatomy most conducive for operative success and efficiency, and that allows for maximum potential of the ALT donor site. The design of chimeric flaps with multiple skin paddles can be much simplified via preoperative planning with imaging. Given that chimeric flaps incorporate multiple vascular pedicles, a detailed understanding of perforator anatomy can have substantial impact on donor site selection. Additionally, a negative exploration can result in significant surgical morbidity, resulting in conversion to a vastus lateralis muscle flap or even to a second donor site. This muscle represents the largest component of the quadriceps femoris, and functional loss is more likely if greater than half the muscle is sacrificed.^{22,24–26} At worst, if the ALT cannot be salvaged or successfully converted, it could lead to total flap failure. Preoperative CTA minimizes the risk of encountering these undesirable scenarios.

Another secondary benefit of preoperative imaging is that it provides an appraisal of predicted flap thickness.^{6,18,22} The ALT can demonstrate significant variation in subcutaneous fat based on body habitus and ethnic and regional populations.^{18,27} This is a factor that must be considered in flap design, and thus as the subcutaneous tissue becomes significantly thinner with distal progression, perforators can be actively selected based on subcutaneous course and corresponding reconstructive needs. If additional bulk is needed in patients with minimal tissue, then muscle can be incorporated at cost. On the other hand, flap thinning has been met with mixed results. Although authors have had success with single-stage thinning in Asian populations,²⁸ other groups have advocated against flap thinning in Western populations due to an observed reduction in subdermal plexus dye filling seen in cadaveric studies.²⁹ Given the complicating variables associated with either situation, alternative options may be considered if flap thickness is found to be suboptimal on imaging.

Preoperative CTA also allows the reconstructive surgeon to identify potential secondary or bailout options. For example, in addition to delineating the perforators of the dbLCFA, ascending branch perforators that supply the TFL flap will also be visualized. If there are no adequate ALT perforators on imaging, but there exists an objectively superior TFL perforator, then alteration of the surgical plan may be considered ahead of time. Additionally, in cases of ALT-based lower extremity reconstruction, potential recipient vessels will be mapped simultaneously, and this is already commonly performed in the setting of traumatic etiology. In these cases, ensuring an adequate collateral blood supply is imperative prior to flap transfer.

Of course, although objective imaging findings provide excellent anatomic data to help guide donor extremity selection, it is still necessary to consider clinical factors prior to final planning. These include extremity injury or surgical

history, tissue quality, and at times patient preference. Prior trauma, radiation, or procedures at a potential donor site should receive due consideration. Tattoos covering the thigh may also exert some mild influence, particularly if the recipient site is in a conspicuous area such as the face or neck. Our observation that the optimal perforator as assessed on imaging was not used in 30% of our cases certainly illustrates that anatomy alone is not the only factor involved in decision-making.

Finally, our findings suggest that detailed preoperative knowledge of perforator course and caliber may reduce the time needed for flap harvest.¹⁷ Selection of the optimal donor extremity among our cohort was associated with a decrease in total operative time in extremity reconstruction in comparison to those with suboptimal donor site selection. Prior studies have theorized that CTA may assist in minimizing complications by allowing for smaller skin paddles and targeted pedicle dissection that avoid excessive damage to fascia and nerves.²⁶ Likewise, this may be due to intraoperative adjustments that must be made to flap design to include an eccentric perforator, thus potentially creating suboptimal anatomy for perforator inclusion or even primary closure of the donor site. However, it is important to reiterate that our retrospective review only allowed for assessment of the cumulative operative time. An ideal appraisal of our hypothesis would target flap harvest time specifically, as case-specific variables certainly influence the time associated with microvascular anastomosis and flap inset. A recent comparative study established that the time from skin incision to first perforator identification, time to perforator decision-making, and time to pedicle isolation and division were reduced among DIEP flaps when CTA was utilized.³⁰ More accurately mapping these timeframes in a prospective study would best evaluate the impact of CTA on ALT flap harvest. Nevertheless, several studies have utilized mean operative time as a proxy for procedural efficiency,^{14,17,30,31} and we believe it is a relevant measure here.

Despite its advantages, CTA is an imperfect system of assessing perforator anatomy. Even at peak contrast concentration, perforators may be difficult to capture on CTA given their small size; signal attenuation values of peripheral perforators can be very close to that of surrounding soft tissues.^{5,32} To maximize contrast concentration within all perforators, some authors have experimented with catheter-based CTA, in which targeted administration is performed via a catheter positioned directly within the LCFA; preliminary results suggest potential improvements in perforator identification.³¹ However, this procedure is significantly more invasive, costly, and results in greater radiation exposure,³¹ potentially limiting its applicability for standard practice. Vessels may also undergo vasospasm as a reaction to iodinated contrast medium, confounding accurate assessment of small-caliber vessels.³³ Our finding that over half of preoperatively identified septocutaneous perforators were at least partially intramuscular on dissection illustrates these challenges. One study has suggested that lean patients may be more likely to have misleading perforator courses because vessels display more prominently in fatty tissue than in muscle; seemingly

septocutaneous vessels may possess an intramuscular course if there is very little fat in the intermuscular septum.¹⁰ Perforators may be obscured by intense artifact if internal hardware is present. Finally, the use of CTA is not without risk, with radiation exposure and contrast-induced nephrotoxicity or immunogenic reactions well-known drawbacks.^{14,33} However, advancements in CT technology, protocols, and patient-specific optimization of radiation and contrast dosing have continued to reduce the dangers of a single scan.^{34,35} Although CTA extends the workup time and is more expensive than doppler or color duplex ultrasound, one cost-benefit analysis revealed calculated cost savings of up to US\$3,410 for a 90-minute reduction in operative time following DIEP mapping with CTA.³⁶ As most of the reduced expenditures were related to personnel, we suspect that these same cost reductions might apply to the ALT as well; this warrants further evaluation. Therefore, despite its limitations, the numerous benefits provided by CTA have been quite useful in our experience, and we have adopted the standard use of CTA for preoperative planning of the ALT flap in all patients without a contraindication.

This study suffers from several limitations. Given its retrospective nature, we were unable to account for all variables that went into extremity selection on an individual basis. As previously mentioned, we falsely assume that extremity selection was based solely on imaging. We also cannot be sure that each CT was utilized in every case or read in the same manner at the time of surgery. These limitations may have therefore influenced the congruency observed between imaged and operative findings. As we have previously noted, our operative notes did not document periods such as oncologic resection or flap harvest time independently, and it is additionally possible that they do not offer a complete description of perforator anatomy at the time of dissection. Finally, a learning curve bias could influence the trend toward decreased complications and shorter operative times among patients given that the standard use of bilateral imaging was not adopted until partway through the period examined.

Conclusion

Preoperative mapping of bilateral lower extremity donor site vascular anatomy with CTA allows for selection of the donor extremity with the optimum vasculature for reconstructive success. The significant percentage of patients found to have asymmetry of interlimb perforator anatomy can potentially increase operative difficulty, time, and risk. In addition to vascular mapping, CTA also allows for assessment of other anatomic parameters of the proposed donor site that can be useful in optimizing the reconstructive outcome. For these reasons, we believe that the standard use of CTA for preoperative imaging in the setting of ALT flap harvest is justified and should be considered.

Conflict of Interest
None declared.

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