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Vascular Anatomy of the Anteromedial Thigh Flap: A Systematic Review

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Background: While the anterolateral thigh (ALT) flap is the most commonly employed thigh-based flap for microvascular reconstruction, its counterpart, the anteromedial thigh (AMT) flap, is a useful but underdescribed alternative when ALT perforators are absent or lacking. This review aims to assess the existing literature describing the anatomy and vascular territories supplying the AMT flap.

Methods: A systematic review was performed in accordance with PRISMA guidelines. Ovid MEDLINE, Embase, and Web of Science were queried for records pertaining to the study question using Medical Subject Heading terms such as "anteromedial thigh flap" and "free tissue transfer." Study characteristics and anatomic descriptors (including number and type of perforators, origin, and pedicle course supplying the AMT flap) were collected.

Results: A total of 21 studies representing 723 AMT flaps were identified and included for analysis. Dominant perforators supplying the AMT flap most commonly included the descending lateral circumflex femoral artery (dLCFA; 35%) or the medial branch of the dLCFA (mdLCFA; 33.6%). Average pedicle length ranged from 7.5 to 10.6cm. The majority of AMT perforators were septocutaneous (n = 852, 63.8%) compared with musculocutaneous (n = 483, 36.2%). Perforators to the AMT were absent in 7.6 to 9.1% of clinical cases.

Conclusions: The variable vascular anatomy of the AMT flap has prevented its widespread adoption in reconstruction. As knowledge regarding pertinent perforator anatomy of the AMT flap increases, so may its utility as an alternative to the ALT flap. This review summarizes the spectrum of anatomy of the AMT vasculature described in the literature to date. *(Plast Reconstr Surg Glob Open 2022;10:e4546; doi: 10.1097/GOX.0000000000004546; Published online 24 October 2022.)*

INTRODUCTION

Since its original description by Song et al,[1] the anterolateral thigh (ALT) flap has become a mainstay in free tissue transfer reconstruction due to its highly reliable vascular anatomy. However, sizable perforators to the ALT are absent in 3%–6% of the Western population, and 2%–5% of ALT harvests result in flap loss.[2-5] The anteromedial thigh (AMT) flap, also originally described by Song et al in 1984,[1] serves as an alternative to the ALT flap. The AMT is especially useful in cases of absent or poor-quality ALT perforators, intraoperative or early flap failure, or for those patients requiring secondary reconstruction following an index ALT flap.[1] Additional benefits of the AMT flap include a large volume of tissue for transfer, sparse hair, a well-concealed scar, multiple venous systems, and the ability to close the donor site primarily without great risk for morbidity.[6] Moreover, the AMT flap can be harvested along the same incision planned for an ALT flap.

The variable vascular anatomy of the AMT flap has prevented its widespread use in microvascular reconstruction. According to multiple studies, AMT flaps are usually based on branches of the lateral circumflex femoral artery (LCFA).[7-11] The artery possesses three branches: ascending, transverse, and descending (dLCFA) branches. Incongruity exists in the literature regarding the main perforator supplying the AMT, with previous names for this branch including the *innominate* or *oblique branch* of the dLCFA. Given the variability of the vascular anatomical pattern and its potential contribution to reconstructive procedures, further investigation is required. Thus, this study aims to assess the current literature regarding the vascular anatomy of the AMT flap.

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METHODS

Search Strategy

This systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines[12] and 2009 checklist adopted from the Cochrane Collaboration.[13] The systematic search included Ovid MEDLINE, Embase, and Web of Science databases. Initial search terms included "surgical flaps," "free flaps," "free tissue transfer," "free tissue flap," and "anteromedial thigh flap."

Study Selection

Two independent reviewers (R.D. and A.A.S.) screened each citation for relevance based on title and abstract. A third reviewer (A.A.A.) was reconciled screening decisions. The remaining studies underwent full-text review. For inclusion, all articles met the following criteria: (1) provided data regarding the anatomy of AMT vasculature, (2) English language, (3) human research, (4) published after 1980, and (5) included more than five patients. Studies were excluded if they were systematic reviews, editorials, case reports/series with fewer than five patients, discussed technique only, or not written in the English language. Articles evaluating the vascular anatomy of several flaps were included if data regarding AMT vascular anatomy could be isolated. Data collected included study characteristics and anatomic descriptors, such as number, type, and dimensions of perforators, and origin and length of the pedicle supplying the AMT flap.

RESULTS

The initial search strategy yielded 154 articles. Following exclusion of 99 citations based on title and abstract screening, 55 manuscripts underwent full-text review. Ultimately, 21 manuscripts were included for review, subdivided into clinical, anatomic, and cadaveric studies (Fig. 1).

Perforator Origin

Clinical studies[3,6,14-24] accounted for the majority of existing data regarding perforator anatomy (Table 1). Cases ranged from five to 66 patients. Thirteen studies[3,6,14-24] described the origin of the perforators supplying the AMT flap, with the most common dominant vascular supplies including the dLCFA (range: 16.7–100% of flaps, n = 77) and medial branch of the dLCFA (mdLCFA; range 89.8%100%, n = 74).[6,22-24] One study reported the perforator origin from the common femoral artery (CFA) and the CFA "branches" in 153 perforators, but did not distinguish the named branches.[16,20] Perforators stemming from the LCFA were reported in 11.8 to 58.3% of flaps (n = 19)[14,18,20] and from the superficial femoral artery (SFA) in 8.3 to 47.1% of flaps (n = 16).[6,14,18,20] AMT perforators originated from the RF branch of the dLCFA (rfdLCFA) in 83.3% (n = 15),[17] the femoral artery in 100% (n=13),[14] the innominate branch of the LCFA in 23.5% (n = 4),[20] and the deep femoral artery (DFA) in 8.3% (n = 2).[18] One study denoted the branches of the perforator origins but did not specify distributions.[3]

Takeaways

Question: The anteromedial thigh (AMT) flap is a useful but underdescribed alternative to the anterolateral thigh flap. Based on the current literature, this study aimed to determine the anatomy and vascular territories supplying the AMT flap.

Findings: Dominant AMT perforators most commonly included the descending lateral circumflex femoral artery (dLCFA; 35%) or the medial branch of the dLCFA (33.6%). Average pedicle length ranged from 7.5 to 10.6 cm. Most AMT perforators were septocutaneous (63.8%).

Meaning: As knowledge regarding pertinent anatomy of the AMT flap increases, so may its utility as an alternative to the anterolateral thigh flap.

Four anatomic studies[14,19,25,26] described the AMT perforator origin, with cases ranging from 20 to 100 AMT flaps (Table 2). The SFA was most commonly reported in 9.1 to 79.9% of cases,[14,25,26] followed by the rfdLCFA in 7.9 to 61.5% of cases (n = 86).[25,26] Perforators originating from the unnamed branch of the SFA were reported in 12.2% of cases (n = 42),[25] the mdLCFA in 100% (n = 36),[19] in the oblique branch of the dLCFA in 54.5% (n = 24),[14] in the LCFA in 34.1% (n = 15),[14] and in the profunda femoris in 2.3% (n = 1).[14]

AMT perforator origin was identified in six cadaveric studies (Table 3).[8,14,27-30] Cases ranged from nine to 48 cadaveric thighs. The distal part of the DFA was most commonly reported in 62.3% of cases (n=127),[8] followed by the DFA in 6.7 to 25.5% of cases (n = 78).[8,14,27] Perforators arose from the SFA in 6.7 to 65.7% of cases (n = 71),[14,27,29] the dLCFA in 50 to 100% (n = 62),[14,28,30] the proximal portion of the femoral artery in 12.3% (n = 25),[8] the rfdLCFA in 84.6% (n = 11),[29] the LCFA in 36.7% (n = 11),[14] and the CFA in 10.8% (n = 11).[27]

Perforator Course

Nine clinical studies[3,6,14,16-18,21,22,24] described the presence of septocutaneous (SC) perforators within AMT cases. Of these studies, SC perforators constituted 18.5 to 100% of total perforators found (n = 171). Four anatomic studies[14,19,25,26] found SC perforators to constitute 70.8 to 77.8% of total perforators (n = 385). Five cadaveric studies[8,14,27,29,30] found SC perforators constituted 17.6 to 100% of total perforators (n = 296). An aggregate analysis of the 18 articles reporting SC perforator data found that SC perforators comprised 63.8% of 1335 total AMT perforators.

Musculocutaneous (MC) perforators were also described in the literature, taking a shorter course to pierce through muscle before supplying the overlying skin. Nine clinical studies[3,6,14,16-18,21,22,24] described perforating vessels as MC in their cases. Two studies reported an absence of MC perforators.[21,22] Of the remaining seven studies,[3,6,14,16-18,24] MC perforators were found to comprise 14.6 to 81.5% of total perforators (n = 243). Four anatomic studies[14,19,25,26] found MC perforators to comprise 22.2 to 29.2% of total perforators (n = 148). Of five cadaveric studies[8,14,27,29,30]

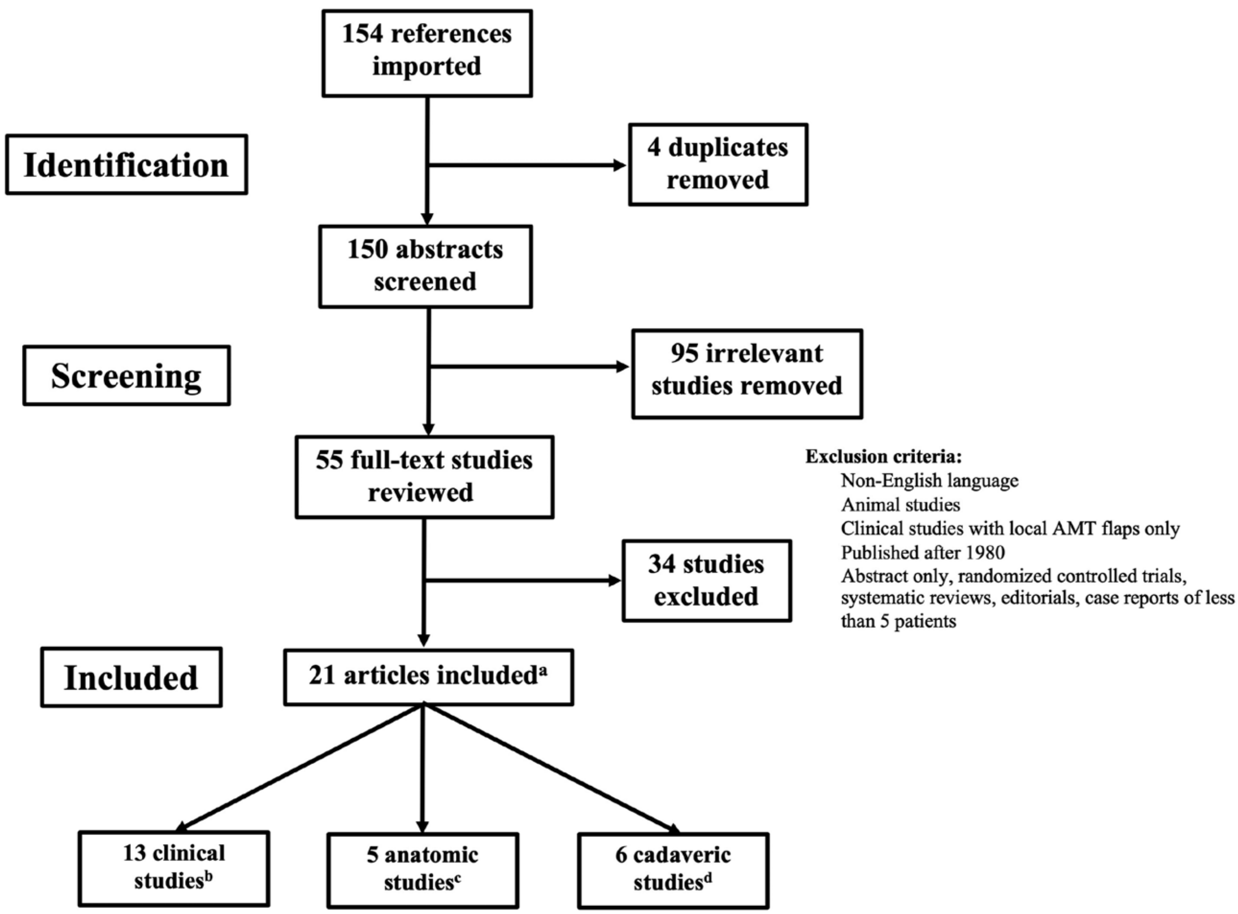


Fig. 1. Study screening and exclusion criteria. [a], Subcategorization of articles does not sum to 21 as some articles were categorized into multiple groups (e.g., an article with both clinical and anatomic aspects). [b], Clinical studies assessed vascularity of the AMT flap during cases in which patients underwent procedures utilizing the flap for defect reconstruction. [c], Anatomic studies assessed the vascularity during thigh dissection of patients during ALT/AMT flap harvest to explore pedicle patterns whether the AMT flap was utilized or not. [d], Cadaveric studies assessed vascularity of the AMT flaps using cadaver dissection models.

reporting MC perforator data, one[30] noted an absence of MC perforators. In the remaining four studies,[8,14,27,29] MC perforators constituted 18.1 to 82.4% of total perforators (n = 92). An aggregate analysis of the 18 articles reporting MC perforator data found that MC perforators comprised 36.2% of 1335 total AMT perforators.

Perforator Volume

Eight clinical studies[3,6,14,16-18,22,24] discussed the number of perforators found during AMT flap harvest. The mean number of perforators ranged from 1.0 to 3.3 per thigh. Each anatomic study[14,19,25,26,31] reported the number of perforators found during flap harvest, reporting a mean number ranging from 1.1 to 6.0 perforators per thigh. Five cadaveric studies[8,14,27,29,30] reported a mean number of perforators between 1.0 to 12.7 per thigh.

Perforator Presence

Eleven clinical studies[3,6,15-22] identified perforators in all cases, while two studies[14,24] did not identify perforators in one case each. The incidence of no perforator being found in the AMT flap ranged from 7.6 (of 12 flaps) to 9.1% (of 11 flaps). One anatomic study[25] identified perforators in every case, while four studies reported absent perforators 47 total cases.[14,19,26,31] The incidence of perforator absence ranged from 8.5% (of 48 flaps) to 38.5% (of 52 flaps). Three[14,28,29] cadaveric studies reported cases without suitable perforators during the flap harvest. The incidence of perforator absence ranged from 7.1% (of 14 flaps) to 54% (of 37 flaps).

Anteromedial Thigh Pedicle

Pedicle length was discussed in nine clinical studies,[3,6,14,15,17,20-22,24] with an average length documented in seven clinical studies ranging from 7.5 to 10.6 cm. Three clinical studies[6,20,24] reported cases of pedicle lengths greater than 10 cm, with the greatest length up to 13 cm in two studies.[6,24] Six clinical studies[3,14,15,17,21,22] reported pedicle lengths between 5 and 10 cm. Only one anatomic study[19] discussed pedicle length, reporting a mean length

Table 1. Summary of Clinical Studies Identified

Study	LOE	No. AMT Flaps	Cases Without Perforators (n, %)	Mean No. Perforators*	SC Perforators (n, %)	MC Perforators (n, %)	Perforator Origin	Mean Pedicle Length (cm) (range)	Flap Size
Cigna et al. 2014[14]	IV	12	1 (7.6%)	1.5	13 (76.5%)	4 (23.5%)	LCFA (n = 3, 27.3%) dLCFA (n = 7, 63.6%) SFA (n = 1, 9.1%)	7.7 (6.0-10.0)	Mean 16.75cm × 7.5cm
Gong et al. 2013[16]	IV	66	0 (0%)	3.3 + 1.1 (1-6)	40 (18.5%)	176 (81.5%)	dLCFA (n = 51, 23.6%) CFA/branches (n = 153, 70.8%) Not specified (n = 12, 5.6%)	±	–
Gong et al. 2014[17]	IV	18	0 (0%)	1.1	14 (70%)	6 (30%)	rfdLCFA (n = 15, 83.3%) dLCFA (n = 3, 16.7%)	± (5.0–10.0)	Range 4×6cm to 9×10cm
Gong et al. 2021[15]	IV	13	0 (0%)	±	±	±	FA (n = 13, 100%)	± (4.0–8.0)	Range 5×6cm to 7×13cm
Jaiswal et al. 2017[18]	IV	24	0 (0%)	1.7	35 (85.4%)	6 (14.6%)	LCFA (n = 14, 58.3%) dLCFA (n = 6, 25.0%) DFA (n = 2, 8.3%) SFA (n = 2, 8.3%)	±	Range 12–20cm × 6–7.5cm
Jia et al. 2015[19]	IV	5	0 (0%)	±	±	±	dLCFA (n = 5, 100%)	±	Range 8×7cm to 18×9cm
Liang et al. 2013[20]	IV	17	0 (0%)	±	±	±	LCFA (n = 2, 11.8%) iLCFA (n = 4, 23.5%) SFA (n = 8, 47.1%) CFA (n = 3, 17.6%)	7.5 (5.0–12.0)	Range 6–20cm × 4–9cm
Ma et al. 2022[6]	IV	49	0 (0%)	1.0	38 (77.6%)	11 (22.4%)	mdLCFA (n = 44, 89.8%) SFA (n = 5, 10.2%)	8.7 (6.0–13.0)	Range of length of skin paddle 7 to 23cm
Riva et al. 2013[3]	IV	41	0 (0%)	1.0	11 (26.8%)	30 (73.2%)	FA, LCFA, mdLCFA, ldLCFA, or iLCFA†	8.0 (6.0–10.0)	Mean 14 × 6.2cm
Schoeller et al. 2004[21]	IV	5	0 (0%)	±	5 (100%)	0 (0%)	dLCFA (n = 5, 100%)	8.0	Range 13–25cm × 5–9cm
Shen et al. 2019[22]	IV	12	0 (0%)	1.0	12 (100%)	0 (0%)	mdLCFA (n = 12, 100%)	8.0 + 0.8 (6.0–9.0)	Flap size ranged from 7×3.5 cm to 25 × 11 cm (mean,15.3 × 7.8cm)
Wang et al. 2014[23]	IV	8	0 (0%)	±	±	±	mdLCFA (n = 8, 100%)	±	–
Xu et al. 2013[24]	IV	11	1 (9.1%)	1.3	3 (23.1%)	10 (76.9%)	mdLCFA (n = 10, 100%)	10.6 (7.0–13.0)	Mean 12.2 × 5.1cm

*Mean number of perforators among the AMT flaps that had sizeable perforators.
†Distributions not specified.
Abbreviations: LOE, level of evidence; SC, septocutaneous; MC, musculocutaneous; aLCFA, ascending branch of the LCFA; CFA, common femoral artery; DFA, deep femoral artery; dLCFA, descending branch of the LCFA; FA: femoral artery; iLCFA; innominate branch of the LCFA; LCFA, lateral circumflex femoral artery; mdLCFA, medial branch of the descending branch of the LCFA; rfdLCFA: rectus femoris branch of the descending branch of the LCFA; SFA, superficial femoral artery; tLCFA, transverse branch of the LCFA.

Table 2. Summary of Anatomic Studies Identified

Study	LOE	No. AMT Flaps	Cases without Perforators (n, %)	Mean No. Perforators*	SC Perforators (n, %)	MC Perforators (n, %)	Perforator Origin	Mean Pedicle Length (cm) (range)	Flap Size
Cigna et al. 2014[14]	IV	48	4 (8.5%)	1.3	44 (75.9%)	14 (24.1%)	LCFA (n=15, 34.1%) oblique branch of dLCFA (n = 24, 54.5%) SFA (n = 4, 9.1%) PF (n = 1, 2.3%)	±	–
Jia et al. 2015[19]	IV	52	20 (38.5%)	1.1	28 (77.8%)	8 (22.2%)	mdLCFA (n = 36, 100%)	11.0 + 2.7 (7.0–15.0)	–
Visconti et al. 2013[31]	IV	20	2 (10%)	1.4	±	±	±	±	–
Visconti et al. 2015[25]	IV	68	0 (0%)	6.0 + 1.8	243 (70.8%)	100 (29.2%)	rfdLCFA (n = 27, 7.9%) SFA (n = 274, 79.9%) Unnamed SFA branch (n = 42, 12.2%)	±	–
Yu and Selber 2011[26]	IV	100	21 (21%)	1.2	70 (72.9%)	26 (27.1%)	rfdLCFA (n = 59, 61.5%) SFA (n = 37, 38.5%)	±	range 6×15cm to 9.5×20cm

*Mean number of perforators among the AMT flaps that had sizeable perforators.

Abbreviations: aLCFA: ascending branch of the LCFA; CFA, common femoral artery; DFA, deep femoral artery; dLCFA, descending branch of the LCFA; iLCFA; innominate branch of the LCFA; LCFA, lateral circumflex femoral artery; mdLCFA, medial branch of the lateral branch of the LCFA; rfdLCFA: rectus femoris branch of the descending branch of the LCFA; SFA, superficial femoral artery; tLCFA, transverse branch of the LCFA; PF, profunda femoris.

of 11.0 cm (range: 7.0–15.0 cm). Four cadaveric studies[27-30] discussed pedicle length. The average length ranged from 5.7 to 13.7 cm. One study[27] reported a mean pedicle length of 12.1 cm in the DFA compared with 9.7cm in the SFA, and 8.4 cm in the CFA when isolating for perforator origin. Additionally, in this study, MC perforators had an average pedicle length of 11.2 cm compared with SC perforators (9.5 cm).[27]

Perforator Location

Five studies[6,25-27,30] described perforator locations in relation to the anterior superior iliac spine (ASIS). One study[8] plotted perforator locations with the *x*-axis defined as the line joining the midpoint of the inguinal ligament to the medial border of the patella, and the *y*-axis defined as the vertical line crossing the *x*-axis at its midpoint. Of perforators plotted, 61.5% were located proximal to the *y*-axis on the medial thigh, while 38.5% were located distally.[8] A second study[26] applied the "ABC system," which described perforator patterns in ALT flaps. AMT perforators near the midpoint of the AP line were designated as perforator B, proximal perforators as A, and distal perforators as C, each approximately 5cm apart. The majority of perforators were concentrated near the midpoint of the AP line. Of perforators originating from the rfdLCFA, the majority were type B (55.9%) located 23.2cm from the ASIS. Perforators from the SFA were typically type B (43.2%) or C (48.6%), located 23.6 cm or 28.3 cm from the ASIS, respectively.[26] Other studies[6,25] determined perforator location using CT angiography.

Four studies[16,19,27,30] reported location by dividing the AMT into thirds. One study[30] reported dLCFA perforators to appear between the middle and lower thirds of the thigh, while another[17] described them exiting from the middle or upper parts of the AMT. CFA perforators were found to occur most commonly in the proximal AMT, DFA in the proximal and middle AMT, and SFA in the middle and distal thirds of the AMT. A significantly higher proportion of MC perforators were located in the middle third of the AMT (51%) compared with the proximal (11%) or distal (37%) thirds,[27] a finding corroborated by another study[19] that reported 75% of MC perforators to occur within the middle third. Comparatively, a study reported the majority of SC perforators to occur in the proximal (42.9%) or middle third (50%) compared with the distal third (7.1%).[19] However, a second study[27] found no significant difference in the distribution of SC perforators among the thirds of the thigh.

Six studies[8,17,19,26,28,30] described perforators in relation to the musculature. One study[28] reported that 46% of cases found the SC perforator of the dLCFA to run immediately along the medial aspect of the RF, while another[30] described all dLCFA SC perforators to exit laterally to the sartorius, approximately within the small triangle formed by the sartorius, RF, and VM in the midthigh, with each perforator accompanied by branches of the anteromedial cutaneous nerve and two innominate cutaneous veins. The mdLCFA was described to run medially below the RF, ending as a perforator to the AMT; the rfdLCFA was described traveling within the RF or along its medial edge and through the intermuscular space between the RF and

Table 3. Summary of Cadaveric Studies

Study	LOE	No. of AMT Flaps	Cases without Perforators (n, %)	Mean no. of Perforators*	SC Perforators (n, %)	MC Perforators (n, %)	Perforator Origin	Mean Pedicle Length (cm) (range)	Flap Size
Cigna et al. 2014[14]	IV	48	18 (37.5%)	1.2	29 (82.9%)	6 (17.1%)	LCFA (n = 11, 36.7%) dLCFA (n = 15, 50%) SFA (n = 2, 6.7%) DFA (n = 2, 6.7%)	±	–
Comert et al. 2011[8]	IV	16	0 (0%)	12.7	167 (81.9%)	37 (18.1%)	DFA (n = 52, 25.5%) prFA (n = 25, 12.3%) diDFA (n = 127, 62.3%)	±	–
Hupkens et al. 2010[27]	IV	9	0 (0%)	11.3	67 (65.7%)	35 (34.3%)	SFA (n = 67, 65.7%) DFA (n = 24, 23.5%) CFA (n = 11, 10.8%)	10.1 (7.3–13.6)	–
Shimizu et al. 1997[28]	IV	37	20 (54%)	±	±	±	dLCFA (n = 17, 100%)	13.70 + 2.3	–
Sun et al. 2017[29]	IV	14	1 (7.1%)	1.3	3 (17.6%)	14 (82.4%)	rfdLCFA (n = 11, 84.6%) SFA (n = 2, 15.4%)	8.9 + 1.3	–
Tayfur et al. 2016[30]	IV	30	0 (0%)	1.0	30 (100%)	0 (0%)	dLCFA (n = 30, 100%)	5.71 (3.7-9.0)	–

*Mean # of perforators among the AMT flaps that had sizeable perforators.

Abbreviations: aLCFA: ascending branch of the LCFA; CFA: common femoral artery; DFA: deep femoral artery; diDFA, distal part of the DFA: dLCFA, descending branch of the LCFA; iLCFA: innominate branch of the LCFA; LCFA: lateral circumflex femoral artery; mdLCFA: medial branch of the lateral branch of the LCFA; prFA: proximal part of the FA; rfdLCFA: rectus femoris branch of the descending branch of the LCFA; SFA: superficial femoral artery; tLCFA: transverse branch of the LCFA.

sartorius/VM muscles, accompanied by two venae comitantes.[19,26] MC rfdLCFA perforators traversed the medial edge of the RF to reach the skin, with none traveling through the sartorius or VM. Regarding SFA perforators, its MC perforators travel through the lateral edge of the sartorius near the septum.[26] A study[25] noted all rfdLCFA and unnamed branch perforators to pierce the fascia lateral to the sartorius, and all SFA perforators to pierce the fascia both medial and lateral to the sartorius. Another study[8] reported that of 37 MC perforators, 64.9% arose from the gracilis, 18.9% from the sartorius, 16.2% from the adductor magnus, and 5.4% from the adductor longus. The 167 SC perforators arose from the intermuscular septa between the sartorius and adductors magnus and longus (44.9%), adductor magnus and gracilis (16.8%), and between the sartorius and RF (38.3%).[8]

Flap Size

Twelve studies[3,6,14,15,17-22,24,26] (one anatomic, 11 clinical) reported AMT flap size. The majority of AMT flaps ranged from 4 to 9 cm by 6 to 20 cm. Notably, Shen et al achieved the largest reported viable flap size up to 25×11 cm.[22] Only one anatomic study reported on flap size reaching up to 9.5×20 cm.[26]

DISCUSSION

Since its original description, ambiguity remains in regard to the anatomy of the AMT flap. In 1984, Song et al described the perforator of the AMT flap as the "innominate" branch of the LCFA that arises from the descending branch and exits in a triangle formed by the VM, sartorius and RF.[1] This was followed by a report of three AMT flaps in 1988, performed by Koshima et al,[11] that described the origin of the perforator as the LCFA and not its descending branch. Based on clinical studies, our review found the dLCFA (35.0%) and mdLCFA (33.6%) perforators to serve as the most common dominant vascular supplies for the AMT flap. Other less common perforators include the LCFA (8.6%), SFA (7.3%), rfdLCFA (6.8%), femoral artery (5.9%), innominate branch of the LCFA (1.8%), or the DFA (0.9%). An awareness of the variations in dominant vascular supply to the AMT will help surgeons prepare for events when the AMT flap must be utilized. Figure 2 illustrates common perforator origin variants.

A 1988 cadaveric study[32] by Xu et al first reported the division of the dLCFA into medial and lateral branches. An anatomical review added that the "medial" branch supplied the anteromedial skin of the thigh.[10] Although great debate exists concerning the vascular anatomy of the AMT flap, origin of the pedicle, and perforator nomenclature, our extensive review suggests that the mdLCFA described by Jia et al[19] is the same as the oblique branch of the dLCFA described by Cigna et al[14] and the rfdLCFA by Yu and Selber.[26] We believe the variations in naming of this branch have arisen due to the anatomic variability in the points at which it branches from the dLCFA, with some variations branching proximally or distally (Fig. 3). We emphasize that further anatomic studies must be completed to determine the frequencies of the various branch points of this

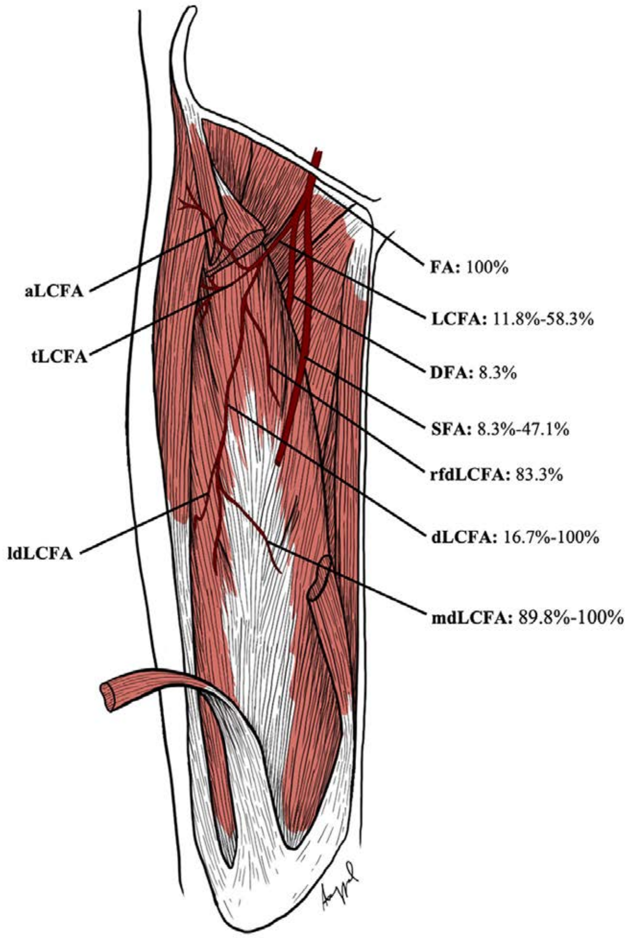


Fig. 2. Typical vascular anatomy of the anteromedial thigh. Percent prevalence of dominant perforators to the AMT flap across clinical studies included in this review. The innominate branch of the dLCFA, occurring in 23.5% of cases reported by Liang et al, was not represented in the figure since its relative location could not be determined. This vessel was described as "a minor branch of the rectus femoris muscle." (Illustration by Adaah Sayyed). Abbreviations: FA, femoral artery; LCFA, lateral circumflex femoral artery; DFA, deep femoral artery; SFA, superficial femoral artery; rfdLCFA, rectus femoris branch of the dLCFA; dLCFA, descending branch of the LCFA; mdLCFA, medial branch of the dLCFA; aLCFA, ascending branch of the LCFA; tLCFA, transverse branch of the LCFA; ldLCFA, lateral branch of the dLCFA.

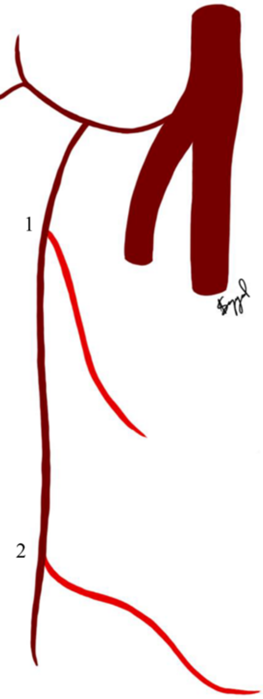
vessel, and recommend use of a single name to describe this branch moving forward to reduce confusion.

Septocutaneous perforators comprise the majority of cutaneous perforators to the AMT flap (63.8%), with a prevalence of 18.5 to 100%. Musculocutaneous perforators occurred less commonly (36.2%) with a prevalence of 0 to 81.5%. SC perforators occurred most frequently in the proximal (43%) or middle third (50%) of the thigh, while MC perforators most commonly occurred in the middle third (51 to 75%).[19,27] An average of 3.99+1.44 SC perforators occur per thigh compared to 1.97+1.41 MC perforators.[25] SC perforators allow for quick and less tedious dissection, but in cases where MC perforators are present, they commonly course superficially through the muscle, still allowing for easy elevation of the AMT flap.[16,17] Unlike ALT flaps, AMT perforators are usually associated with straightforward SC courses, with the caveat that variable perforator origins and locations require preoperative perforator mapping if this flap is chosen for primary reconstruction.[6,21-23]

Seven articles[14,19,24,26,28,29,31] cited an absence of suitable perforators in 7.1 to 54% of cases. The overall ratio of cases without suitable perforators to those with them was 12.2%, suggesting that most harvested AMT flaps likely contain adequate perforators. In cases without AMT or ALT perforators, however, tensor fasciae latae and lateral thigh flaps may serve as alternative options, being previously demonstrated as adequate alternatives to ALT flaps in cases of missing perforators.[33,34] Interestingly, Yu et al[35] reported a reciprocal relationship between the number and size of AMT and ALT perforators; patients with absent ALT perforators had a four-fold increase in having at least one AMT perforator, and in cases of small or nonexistent ALT perforators, patients had a six-fold increase in likelihood of having a large or medium AMT perforator. These findings potentially support the utility of the AMT flap as an alternative in cases of inadequate ALT perforators; however, additional studies are necessary to confirm the prevalence of this pattern.

The AMT has potential for sizable vascular pedicles comparable to the ALT.[2,28] The majority of pedicles ranged between 5 and 10 cm; however, when harvested medially the mean length reached up to 13.6 cm.[27,28] With a more proximal harvest, mean AMT pedicle length was reduced compared with the middle or distal third of the thigh.[19,27] The longest reported pedicle length extended up to 15 cm,[19] demonstrating its equal capability for vascular supply as the ALT flap. Using CT angiography and Doppler Ultrasound with 3D reconstruction, Ma et al[6] found no significant difference in mean pedicle length for AMT versus ALT flaps. While MC perforators were found to be present less frequently than SC perforators, they were found, on average, to have a longer pedicle length of 11.2cm compared to SC perforators (9.5 cm).[27] One should consider the varied anatomy of the perforator origin when determining the pedicle length that can be harvested, as the DFA and the SFA allow for longer pedicles compared to the CFA.[27] Further investigation is warranted into the pedicle length based on perforator origin, as Hupkens et al[27] was the only study to provide in-depth analysis regarding pedicle anatomy of the AMT.

A limitation of the current review is the possibility of selection bias in the cases represented within each study. Additionally, when discussing absent AMT perforators, some studies[6,24,29] only included perforators that were equal to or larger than 0.5 mm, whereas others[27] defined sizeable perforators to be equal to or larger than 1.0 mm. Another study[24] required that perforators have discrete pulsations adequate to perfuse the flap. Therefore, the perforator absence reported in this review may overestimate the true frequency, as some surgeons had stricter definitions of suitable perforators. Following 2009, studies defined suitable perforators to include those greater than



#	Study Referenced	Perforator Name
1	Visconti et al., 2013[31]	Rectus femoris branch of the dLCFA
	Visconti et al., 2015[25]	Rectus femoris branch of the dLCFA
	Yu and Selber, 2011[26]	Rectus femoris branch of the dLCFA
	Gong et al., 2014[17]	Rectus femoris branch of the dLCFA
	Cigna et al., 2014[14]	Oblique branch of the dLCFA
2	Riva et al., 2013[3]	Innominate branch or medial branch of the dLCFA
	Xu et al., 2013[24]	Medial branch of the dLCFA
	Zhu et al., 2018[36]	Rectus femoris branch of the dLCFA
	Jia et al., 2015[19]	Medial branch of the dLCFA

Fig. 3. Illustration of the variations in AMT perforator takeoff from the dLCFA. The table lists citations of studies that described the specific perforator title and relative location of takeoff from the dLCFA. 1) Perforators from the proximal dLCFA were commonly described as either the rectus femoris or the oblique branch of the dLCFA. 2) Perforators from the distal dLCFA were commonly described as the innominate, medial, or rectus femoris branch of the dLCFA. (Illustration by Adaah Sayyed.) Abbreviations: dLCFA, descending branch of the lateral circumflex femoral artery.

or equal to 0.5 mm, likely following microsurgical innovations allowing for greater anastomotic precision with smaller vessels.

CONCLUSIONS

The variable vascular anatomy of the AMT flap has prevented its widespread adoption in microvascular reconstruction. As knowledge regarding the pertinent perforator anatomy of the AMT flap increases, so may its utility as an alternative to the ALT flap. This systematic review provides a summary of the variable anatomy of the AMT flap described in the literature to date.

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