

# A systematic review of anterolateral thigh flap donor site morbidity

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**PURPOSE:** The anterolateral thigh (ALT) flap is widely used in reconstruction. Its advantage over other flaps is its purported minimal donor site morbidity. The present systematic review summarizes the types of complications and their incidence with this flap. A secondary objective is to delineate factors that influence these complications and make recommendations to avoid them.

**METHOD:** Two independent assessors undertook a systematic review of the literature using multiple databases. All patients with ALT flap reconstruction for any defect were included. Donor site complications including lateral thigh paresthesia, musculoskeletal dysfunction, hypertrophic scarring, wound breakdown, infection, donor site pain, seroma, hematoma, compartment syndrome and muscle necrosis were extracted from identified articles and tabulated. Based on the number of pooled events and the number of cases performed, an incidence rate was calculated.

**RESULTS:** Forty-two relevant articles were identified that included 2324 flaps. Of the 2324 flaps, the majority were fasciocutaneous (n=737), and 1303 of the flaps were used in head and neck reconstruction. The incidence of complications were: lateral thigh paresthesia (24.0%); musculoskeletal dysfunction (4.8%); hypertrophic scarring or wound dehiscence (4.8%); donor site pain (3.3%); seroma (2.4%); infection (2.2%); hematoma (0.7%); compartment syndrome (0.09%); and partial muscle necrosis (0.09%).

**CONCLUSION:** Lateral thigh paresthesia is the most common complication. Severe complications such as compartment syndrome and muscle necrosis can occur, but are rare. Preservation of the lateral cutaneous nerve of the thigh, femoral motor nerve branches and deep fascia decreases the risk of complications. The degree of vastus lateralis disruption did not show a significant impact on musculoskeletal dysfunction.

**Key Words:** *Anterolateral thigh flap; Complications; Donor site*

The anterolateral thigh (ALT) flap, first described as a septocutaneous perforator-based flap by Song et al (1) in 1984, has recently gained popularity (2-43) and has become an important option for reconstruction of multiple anatomical locations such as the head and neck (3-7,9,10,12-14,16,18-23,25-30,32,34,36,38,39,41-43), upper (15-19,26,32,35,37,38,42) and lower (8,16-19,22,24,26,31,32,38,42) extremities, trunk (2,14,18,22,30,32,33,38) and perineum (11,18,22). The popularity of the 'work-horse' ALT flap is often attributed to its multiple advantages, which can be divided into three categories: pedicle, flap design and operative technique (1,2,6,7,13,14,21,26,38,44-46). With regard to the pedicle, the ALT flap has a long pedicle with good calibre, which can be located and dissected out before committing to the final flap design. Furthermore, there is the potential for converting to another type of flap, such as a tensor fascia lata flap, with only minor changes to the skin paddle (47) if needed due to anatomical variation in the vascular pedicle. Flap design benefits include

## Une analyse systématique de la morbidité d'un lambeau de la partie antérolatérale de la cuisse au foyer du donneur

**OBJECTIF :** Le lambeau de la partie antérolatérale de la cuisse (PALC) est largement utilisé en reconstruction. Par rapport aux autres lambeaux, il a l'avantage de s'associer à une morbidité minimale présumée au foyer du donneur. La présente analyse systématique contient un résumé des types de complications et de leur incidence à l'égard de ce lambeau. Un objectif secondaire consiste à déterminer les facteurs qui influent sur ces complications et à présenter des recommandations pour les éviter.

**MÉTHODOLOGIE :** Deux évaluateurs indépendants ont procédé à une analyse systématique des publications à l'aide de multiples bases de données. Tous les patients ayant subi une reconstruction par lambeau de la PALC pour corriger une anomalie y ont participé. Dans les articles retenus, les évaluateurs ont extrait les complications au foyer du donneur et en ont fait des tableaux, y compris une paresthésie de la cuisse latérale, une dysfonction musculosquelettique, une cicatrice hypertrophique, une dégradation de la plaie, une infection, une douleur au foyer du donneur, un sérome, un hématome, un syndrome des loges et une nécrose musculaire. D'après le nombre d'événements regroupés et de cas exécutés, ils ont calculé un taux d'incidence.

**RÉSULTATS :** Les évaluateurs ont repéré 42 articles pertinents, qui incluaient 2 324 lambeaux, dont la majorité était d'origine fasciocutanée (n=737), 1 303 ayant été utilisés pour une reconstruction de la tête et du cou. L'incidence de complications s'établissait comme suit : paresthésie de la cuisse latérale (24,0 %), dysfonction musculosquelettique (4,8 %), cicatrice hypertrophique ou déhiscence de la plaie (4,8 %); douleur au foyer du donneur (3,3 %), sérome (2,4 %), infection (2,2 %), hématome (0,7 %), syndrome des loges (0,09 %) et nécrose musculaire partielle (0,09 %).

**CONCLUSION :** La paresthésie latérale de la cuisse est la complication la plus courante. De graves complications, telles qu'un syndrome des loges et une nécrose musculaire, se produisent, mais rarement. La préservation du nerf cutané latéral de la cuisse, des branches nerveuses du fémur et du fascia lata réduisent le risque de complications. Le degré de perturbation du muscle vaste externe n'avait pas de répercussions importantes sur la dysfonction musculosquelettique.

a large and pliable skin territory with the ability to design more than one skin paddle depending on the perforator anatomy; the ability to modify flap thickness by elevating a thin fasciocutaneous flap, or providing bulk by incorporating muscle (vastus lateralis), or further thinning the flap by removal of the deep fascia and subcutaneous fat tissues; versatility, because it can be customized with the addition of bone (ileum), tendon, fascia (tensor fascia lata) or nerve (lateral femoral cutaneous); and the ability to tailor the flap as a pedicle or free flap, using vessels as a single anastomosis or as flow-through. In terms of operative technique, advantages of the ALT flap include the ability of two teams to work on the donor and recipient sites at the same time because the patient can be placed in a supine position; and the feasibility of performing the procedure under epidural anaesthesia for lower extremity reconstruction in a patient unfit for a general anaesthetic.

One final advantage of the ALT flap is the seemingly minimal donor site morbidity, which can be as important as the result at the

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**TABLE 1**  
**Flap demographics**

Reference, year	Flaps, n	Types of flap	Indication	Size of flap, cm	Skin graft	Use of drains
Addison et al (2), 2008	2	2 FC	C	30×10 – 25×12	0/2	0/2
Amin et al (3), 2006	18	7 FC, 11 MC	HN	10×6 – 23×12	5/18	NR
Bianchi et al (4), 2009	8	8 MC	HN	6–7 × 9–12	0/8	NR
Camaioni et al (5), 2008	31	NR	HN	NR	NR	NR
Chang et al (6), 2010	9	4 FC, 5 MC	HN	8×3 – 20×15	3/9	NR
Chen et al (7), 2005	20	3FC, 17 MC	HN	8×3 – 20×15	4/20	Yes
Demirtas et al (8), 2010	5	5 FC	LE	8×5 – 12×7	NR	NR
de Vicente et al (9), 2008	10	1 FC, 9 MC	HN	NR	0/10	NR
Farace et al (10), 2007	10	NR	HN	NR	0/10	Yes
Felici et al (11), 2006	6	6 C	P	10×12 – 11×14	0/6	NR
Genden et al (12), 2005	12	4 MC, 8 other	HN	NR	0/12	NR
Huang et al (13), 2004	21	21 C	HN	24–150 cm <sup>2</sup>	1/21	NR
Kimata et al (14), 2000	35	35 FC	30 HN, 4 A, 1 B	4×7 – 21×35	5/35	NR
Koshima et al (15), 2003	3	3 C	UE	NR	2/3	NR
Kuo et al (16), 2002	140	90 MC, 34 FC, 16 C	82 HN, 45 LE, 13 UE	10–33 × 4–14	15/140	NR
Kuo et al (17), 2001	38	34 MC, 4 C	28 LE, 10 UE	10–26 × 4–12	NR	NR
Lee et al (18), 2010	127	64 FC, 36 C, 24 MC, 3 other	95 LE, 15 HN, 13 UE, 2A, 1 C, 1 P	6×6 – 30×15	17/127	NR
Lipa et al (19), 2005	21	17 C, 4 FC	7 HN, 5 UE, 7 LE, 2 NR	15×30 max	10/21	Yes
Loreti et al (20), 2008	25	25 FC	HN	8×13 – 11×13	1/25	NR
Lueg et al (21), 2004	34	NR	HN	7–12 × 8–19	1/34	NR
Mosahebi et al (22), 2008	15	15 FC	12 HN, 1 LE, 1 GU, 1 T	341; range: 240–480	14/15	NR
Novak et al (23), 2007	18	8 C, 10 FC	HN	~12.5×7.8	5/18	NR
Özkan et al (24), 2004	31	3 MC; 28 other	LE	6×11 – 13×34	18/31	NR
Özkan et al (25), 2005	11	11 FC	HN	6×15 – 15×27	6/11	NR
Pribaz et al (26), 1995	44	28 MC, 16 FC	25 LE, 10 UE, 9 HN	5×8 – 22×32	17/44	NR
Ross et al (27), 2003	18	18 FC	HN	NR	1/18	NR
Sagar et al (28), 2010	20	NR	HN	NR	NR	NR
Shieh et al (29), 2000	37	NR	HN	10×17.5 max	8/37	NR
Spyriounis et al (30), 2006	5	5 C	4 HN, 1 A	8×22 max	0/5	NR
Tamimy et al (31), 2010	29	29 FC	LE	NR	24/29	NR
Tiguemounine et al (32), 2005	13	3 FC, 10 MC	3 HN, 2 UE, 6 LE 2 A	NR	1/13	NR
Tsai et al (33), 2002	12	12 MC	C	NR	0/12	NR
Tsuji et al (34), 2008	12	9 FC, 3 MC	HN	4×7 – 8×8	0/12	0/12
Uygur et al (35), 2008	5	5 FC	UE	10×6 – 13×9	1/5	NR
Valentini et al (36), 2008	10	3 FC, 7 MC	HN	5–8 × 8–15	0/10	NR
Wang et al (37), 2005	15	12 FC, 3 MC	UE	64–250 cm <sup>2</sup>	7/15	Yes
Wei et al (38), 2002	672	350 FC, 154 C, 95 MC, 73 other	484 HN, 58 UE, 121 LE, 9 T	NR	NR	NR
Wei et al (39), 2002	22	13 C/FC, 5 MC, 4 other	HN	6×6 – 14×16	12/22	NR
Wen et al (40), 2009	427	NR	NR	7×16 – 13×30	23/427	NR
Wolff et al (41), 2006	191	87 MC, 44 FC, 29 C, 31 other	HN	3×5 – 21×10	0/191	NR
Yildirim et al (42), 2003	28	16 FC, 12 other	6 HN, 4 UE, 18 LE	9×11 – 20×26	18/28	NR
Yu et al (43), 2010	114	NR	HN	NR	11/114	NR

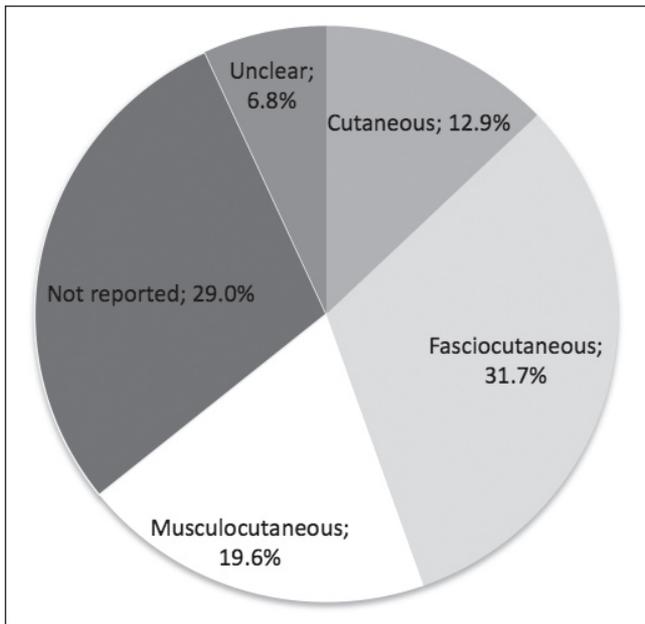
A Abdomen; B Back; C (Indications) Chest; C (Types of flap) Cutaneous; FC Fasciocutaneous; GU Genitourinary; HN Head and neck; LE Lower extremity; max Maximum; MC Musculocutaneous; NR Not reported; P Pelvis/perineum; T Trunk; UE Upper extremity

recipient site in terms of the outcome and the patient's postoperative quality of life. In the multitude of studies reporting recipient site outcomes with the use of this flap, donor site complications are occasionally mentioned (2-43). However, because the sample sizes of most of these studies was relatively small, and the incidence of most of the reported complications was low, exact figures of specific complication occurrences have not been objectively documented. By collecting and analyzing reported data systematically, the sample size is increased and the true frequency of a complication can be more accurately determined (48). Factors that may influence or lead to these complications can also be more clearly delineated. As a result, improvement in techniques can be focused on specific targets, and a more factual informed consent conversation can occur with the patient regarding

donor site complications. Herein, the authors summarize the types of complications and their incidence regarding the donor site of the ALT flap, with a discussion of factors that influence these complications and recommendations to avoid them.

## METHODS

A computerized search was conducted in the MEDLINE, EMBASE and CINAHL electronic databases as well as the Cochrane Central Register of Controlled Trials from 1984 to 2010 using the following terms: "anterolateral thigh flap", "donor site" and "complications". The 1984 starting date was chosen because this was the year that the ALT flap was first introduced. To be included, a study was required to meet the following predetermined criteria: the study population had to

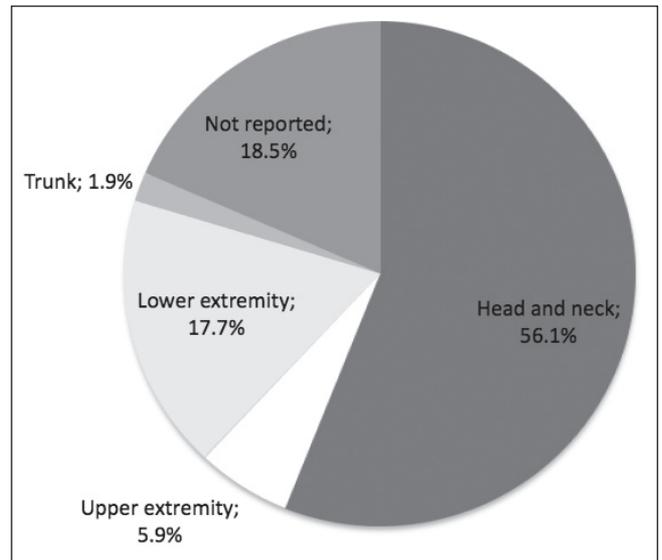


**Figure 1** Tissue composition of anterolateral thigh flaps: Percentage of flaps elevated as cutaneous, fasciocutaneous, or musculocutaneous flaps and the number of cases in which the type of flap was not reported or unclear

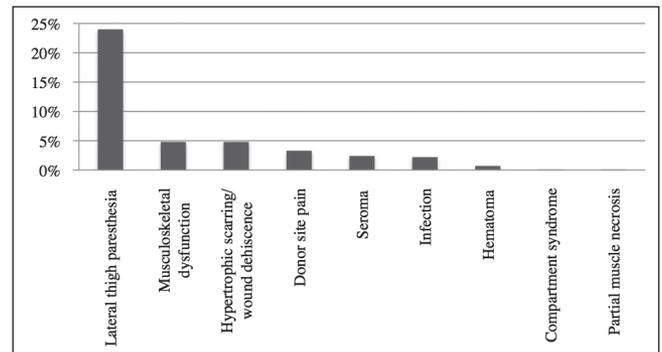
consist of human patients who had undergone reconstruction with an ALT flap; and the results, including complications, were published in English. Studies that only listed nondonor site complications were excluded. Disagreements on potential relevance were discussed. If a consensus could not be reached a decision on inclusion was made by the senior author (AT). Two of the authors (JC and OA) independently scanned the titles and abstracts for potential relevance. The degree of nonrandom agreement between the reviewers was determined with the kappa statistic. Donor site complications, including lateral thigh paresthesia, musculoskeletal dysfunction, pain, wound breakdown, hypertrophic scarring, infection, hematoma, seroma, compartment syndrome and muscle necrosis, were extracted. The number of reported complications was pooled across all studies and divided by the total number of flaps where the complication was reported to arrive at an incidence rate.

**RESULTS**

One hundred fifty-two citations were initially identified, of which 42 articles were independently selected by each reviewer for inclusion in the final analysis (Table 1). The two reviewers agreed on all selected articles, with a resulting calculated kappa coefficient of 1.00, indicating that bias was avoided in the selection of relevant articles. In total, 2324 patients underwent reconstruction with an ALT flap. All of the studies were either retrospective case series or prospective cohorts. Because validated scales for such study designs do not currently exist, the quality of these articles was unable to be qualified. However, differences in study designs did not discernibly influence the type or incidence of complications being reported. Of the 2324 flaps, 737 (31.7%) were fasciocutaneous, 456 (19.6%) were musculocutaneous and 299 (12.9%) were cutaneous; 673 (29.0%) were not reported and 159 (6.8%) were unclear (Figure 1). Indications for the flaps included 1303 (56.1%) for head and neck reconstruction, 411 (17.7%) for defects of the lower extremity, 138 (5.9%) for the upper extremity, 43 (1.9%) for trunk defects (15 chest, 10 thorax, nine abdomen, seven perineum, one back and one genitourinary) and 429 (18.5%) not reported (Figure 2). The size of flap harvested was recorded differently across the studies, with some studies recording the maximum size of flap, some listing all the flap dimensions and some reporting the flap surface area. No correlation was made between the size of defect and incidence of



**Figure 2** Indications for anterolateral thigh flap reconstruction: Percentages of flaps used to reconstruct defects of the head and neck, upper extremity, lower extremity and trunk (including chest, thorax abdomen, back, perineum, genitourinary) regions, as well as the cases in which the indication was not reported



**Figure 3** Per cent incidence of patients (y-axis) with complications associated with the anterolateral thigh flap donor site (x-axis)

complications or need for skin grafts. Of the 1558 studies that reported whether a skin graft was required to close the donor site, 230 (14.8%) used skin grafts.

Not all studies reported the same complications (Table 2). Of the studies that reported complications, 4.8% (49 of 1012) of patients encountered musculoskeletal dysfunction. Postoperative lateral thigh paresthesia was reported in 12 studies and it occurred in 24.0% (75 of 313) of patients. Donor site pain occurred in 3.3% of patients (seven of 213). Problems with the donor site scar including hypertrophic scarring or wound breakdown occurred in 4.8% of cases (56 of 1174). The infection rate was 2.2% (41 of 1889) and hematomas occurred in 0.7% of cases (nine of 1305), while seromas occurred in 2.4% of cases (11 of 452). In all of the studies, there were only two cases of compartment syndrome (0.09%) and two cases of partial muscle necrosis (0.09%) (Figure 3).

**DISCUSSION**

The ALT flap is widely used in the reconstruction of the head and neck, upper extremities, lower extremities, trunk and perineum. Both recipient site function and donor site morbidity impact a patient's postoperative quality of life. Reported donor site morbidity by these studies was low; however, a lack of large sample sizes has precluded the availability of precise numbers for the frequencies of these complications. The results of the present systematic review have shown the

**TABLE 2**  
**Complications associated with the anterolateral thigh flap donor site**

Reference, year	Musculoskeletal			Wound breakdown/scar		Infection	Hematoma	Seroma	Other
	Paresthesia	dysfunction	Pain	hypertrophy					
Addison et al (2), 2008	NR	2/2	0/2	2/2	NR	NR	NR	NR	2 cases of compartment syndrome
Amin et al (3), 2006	NR	0/18	NR	2/18	1/18	NR	NR	NR	
Bianchi et al (4), 2009	NR	0/8	NR	NR	NR	NR	NR	NR	
Camaioni et al (5), 2008	NR	4/31	NR	0/31	0/31	0/31	0/31	0/31	
Chang et al (6), 2010	NR	NR	NR	NR	0/9	NR	NR	NR	
Chen et al (7), 2005	NR	0/20	NR	0/20	0/20	0/20	NR	NR	
Demirtas et al (8), 2010	NR	2/5	NR	2/5	0/5	0/5	NR	NR	
de Vicente et al (9), 2008	NR	NR	NR	0/10	0/10	0/10	0/10	0/10	
Farace et al (10), 2007	NR	NR	NR	0/10	0/10	0/10	0/10	0/10	
Felici et al (11), 2006	NR	NR	NR	NR	NR	NR	NR	NR	
Genden et al (12), 2005	NR	0/12	0/12	NR	NR	NR	NR	NR	
Huang et al (13), 2004	NR	0/21	NR	NR	NR	NR	NR	NR	
Kimata et al (14), 2000	28/35	4/35	NR	NR	1/35	NR	NR	NR	
Koshima et al (15), 2003	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	
Kuo et al (16), 2002	21/140	NR	NR	1/140	1/140	0/140	NR	NR	
Kuo et al (17), 2001	NR	0/20	NR	NR	NR	NR	NR	NR	
Lee et al (18), 2010	NR	NR	0/127	0/127	0/127	0/127	0/127	0/127	
Lipa et al (19), 2005	9/21	13/21 M; 5/21 S	NR	10/21	2/21	NR	NR	1/21	
Loreti et al (20), 2008	0/25	1/25	NR	1/25	NR	NR	NR	NR	
Lueg et al (21), 2004	NR	NR	NR	1/34	1/34	1/34	2/34	NR	
Mosahebi et al (22), 2008	NR	0/15	0/15	10/15	NR	NR	2/15	NR	
Novak et al (23), 2007	2/18	NR	3/18	NR	NR	NR	NR	NR	
Özkan et al (24), 2004	NR	NR	NR	NR	0/31	0/31	NR	NR	
Özkan et al (25), 2005	NR	NR	NR	0/11	0/11	0/11	NR	NR	
Pribaz et al (26), 1995	NR	0/44	NR	2/44	0/44	1/44	1/44	NR	
Ross et al (27), 2003	NR	NR	NR	0/18	0/18	0/18	0/18	0/18	
Sagar et al (28), 2010	–	–	4/7	–	–	–	–	–	
Shieh et al (29), 2000	8/37	NR	NR	1/37	6/37	NR	NR	NR	
Spyriounis et al (30), 2006	2/5	0/5	NR	NR	NR	NR	NR	NR	
Tamimy et al (31), 2010	NR	2/29	NR	NR	NR	NR	NR	NR	
Tiguemounine et al (32), 2005	NR	0/13	NR	0/13	0/13	0/13	0/13	0/13	
Tsai et al (33), 2002	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	
Tsuji et al (34), 2008	4/12	0/12	0/12	NR	NR	NR	NR	NR	
Uygur et al (35), 2008	1/5	0/5	0/5						
Valentini et al (36), 2008	NR	0/10	NR	NR	0/10	0/10	NR	NR	
Wang et al (37), 2005	NR	NR	NR	1/15	0/15	NR	NR	NR	
Wei et al (38), 2002	NR	NR	NR	NR	10/672	4/672	NR	NR	
Wei et al (39), 2002	NR	NR	NR	0/22	1/22	NR	NR	NR	
Wen et al (40), 2009	NR	16/427	NR	21/427	17/427	NR	NR	NR	2 partial muscle necrosis
Wolff et al (41), 2006	Barely perceptible	0/191	NR	NR	NR	NR	NR	NR	
Yildirim et al (42), 2003	NR	0/28	NR	NR	NR	NR	NR	NR	
Yu et al (43), 2010	NR	NR	NR	2/114	1/114	3/114	5/114	NR	
Total	75/313 (24.0%)	49/1012 (4.8%)	7/213 (3.3%)	56/1174 (4.8%)	41/1889 (2.2%)	9/1305 (0.7%)	11/452 (2.4%)		

Data presented as n/N unless otherwise indicated. M Minor; NR Not reported; S Significant.

following complications, listed in order of decreasing frequency: lateral thigh paresthesia (24.0%), musculoskeletal dysfunction (4.8%), hypertrophic scarring or wound dehiscence (4.8%), donor site pain (3.3%), seroma (2.4%), infection (2.2%), hematoma (0.7%), compartment syndrome (0.09%) and partial muscle necrosis (0.09%). Therefore, severe complications such as compartment syndrome and partial muscle necrosis can occur, but are rare.

Unfortunately, most studies did not draw connections between complications and specific flap characteristics. However, certain operative factors that may influence these outcomes have been described for lateral thigh paresthesia, musculoskeletal dysfunction, compartment syndrome and the need for skin graft closure of the donor site.

Due to its anatomical location, the medial branch of the lateral cutaneous nerve of the thigh can be injured or sacrificed during ALT

flap elevation, or may be included to make the flap sensate, leading to lateral thigh paresthesia (14,16,30). Therefore, depending on the setting, paresthesia may not be considered a complication as much as an anticipated consequence of surgery.

With regard to musculoskeletal dysfunction, four factors have been discussed: the amount of vastus lateralis muscle elevated or damaged; the amount of fascia elevated or damaged; the close course of the ALT's vascular pedicle to the femoral motor nerve branch innervating the vastus lateralis; and closure with skin grafts (14,17,19,23,34). These factors are discussed in detail below.

### Vastus lateralis muscle

The quadriceps femoris muscle unit is composed of four muscles: the rectus femoris, the vastus medialis, the vastus intermedius and the vastus lateralis, which attach to the patella and play a role in its stability, as well as being primary knee extensors. The vastus lateralis is the biggest of these muscles and, if damaged, could result in patella and knee instability, as well as decreased knee extension (17,49). Perforator vessels to the ALT flap are septocutaneous (between rectus femoris and vastus lateralis) or musculocutaneous, the latter running through the vastus lateralis, and require intramuscular dissection with potential damage to the muscle (19,26,34). Some authors have subjectively concluded that the degree of donor site dysfunction was related to the degree of vastus lateralis damage (14,19); however, others found no such differences (30). Two studies carried out quantitative functional assessments comparing thighs from which an ALT flap was harvested with normal thighs, and found no statistically significant differences in function (17,34).

### Fascia elevation

With respect to the role of fascia elevation during ALT flap harvest in musculoskeletal dysfunction, several authors have concluded that persistent lower extremity weakness was more significantly related to the degree of deep fascia damage or elevation with the flap, rather than variations in vascular pedicle anatomy and subsequent type of dissection (intramuscular or not) (19,50). Lipa et al (19) found that persistent weakness was associated with extensive elevation of fascia with the flap compared with very limited fascia elevation near the pedicle ( $P=0.0374$ ).

### Proximity to femoral motor nerve

The close course of the vascular pedicle of the ALT flap with the femoral motor nerve branch innervating the vastus lateralis could lead to nerve damage during flap elevation, subsequently resulting in knee extension weakness (7,19,44). Anatomical variations include the nerve passing through the pedicle of the ALT flap, or passing between perforators supplying the flap, seen in 28% of a 36-human cadaveric thigh dissection study (51).

### Skin grafts

Closure with the use of skin grafts has been reported to result in adhesions between the graft and underlying fascia, significantly limiting range of motion at the hip and knee compared with patients whose thighs had been closed primarily (60% versus 3.1% of patients, respectively) (14).

Addison et al (2) discussed two cases of compartment syndrome in the thigh after elevation and closure of an ALT flap. In both cases, the diagnosis of compartment syndrome was delayed due to epidural analgesia, bed rest, and the subsequent absence of pain or specific symptoms or signs. The first case had flap dimensions of 30 cm × 10 cm, and the donor site wound margins were noted to be blistering, tense and moist on postoperative day 3. The second case had flap dimensions of 25 cm × 12 cm, and blistering with marginal necrosis of the wound edges was noted on postoperative day 5. The authors mentioned that the maximum flap width that enables direct closure is not absolutely defined and that judgment based on the overall circumference of the thigh, as well as skin and subcutaneous tissue laxity, was required in flap planning. They also noted that tight donor site closures are relatively

well-tolerated secondary to tissue creep and stress relaxation, which eventually minimize tension and scar stretching. However, they cautioned that excessive wound tension also increases the risk of wound dehiscence or delayed healing, unsightly scarring and distal deep venous thrombosis. They categorized risk factors as being extrinsic (flap width to thigh circumference, skin laxity, thickness of subcutaneous fat, circumferential dressings) and intrinsic (swelling, hematoma, muscle ischemia).

Most authors quote a maximum width for a primary closure of the donor site of 8 cm to 10 cm (3,7,25,35-37,39,42); however, wider defects have been closed, such as a reported 12 cm defect in a patient with a relatively large thigh circumference secondary to a high body mass index (3). A primarily closed donor site may result in a long scar, but it is usually more aesthetically pleasing than when closed with a skin graft, which is commonly done if a donor site defect is too wide to safely close without significant tension (32,39). This aesthetic issue may preclude the use of this flap in the female population, and this issue must thoroughly be discussed during informed consent (16). Other options to close large ALT flap donor sites have been discussed in the literature. These options include closure of the ALT flap donor site using an ipsilateral groin flap, which was attempted for ALT flap donor sites up to 20 cm × 15 cm with acceptable results, while the groin flap donor site is closed primarily (52); the use of tissue expansion of the thigh before ALT flap elevation in elective cases (53); or original closure of the donor site with a split-thickness skin graft, followed by a delay of three to six months to allow for contraction of the skin graft and increased laxity of the remaining thigh skin, followed by either serial excision of the graft or excision of the graft after expansion of neighboring thigh skin followed by primary closure (7,54). All of the points discussed above should be kept in mind during the preoperative counselling of patients, when discussing the expected consequences and complications of ALT flap surgery.

### CONCLUSION

The ALT flap has become a widespread option for the reconstruction of defects affecting multiple anatomical regions. Free flap donor site morbidity is often as important as recipient site outcomes with regard to a patient's quality of life. Lateral thigh paresthesia is the most common complication associated with the ALT flap harvest. Severe complications such as compartment syndrome, muscle necrosis and permanent musculoskeletal dysfunction can occur, but are rare. Meticulous dissection and preservation of the lateral cutaneous nerve of the thigh and the femoral motor nerve branch to the vastus lateralis, leaving as much deep fascia intact as possible and closing primarily, all decrease the risk of complications. However, skin graft closure should be used if primary closure would lead to excessive tension, and possibly delayed healing or compartment syndrome. Damage to or inclusion of part of the vastus lateralis into the ALT flap did not show a statistically significant impact on musculoskeletal function in objective studies. Awareness of this data can lead to the diminishment or avoidance of complications and can help surgeons discuss these occurrences more objectively with their patients.

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