

# Indications, Postoperative Outcomes, and Complications of the Lateral Arm Free Flap: A Systematic Review and Meta-analysis

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**Background:** The lateral arm free flap (LA-FF) has become an increasingly popular choice in the reconstruction of soft tissue defect in many anatomical regions. However, there is a paucity of literature regarding its safety and efficacy. The aim of this study is to analyze its different applications along with their surgical outcomes.

**Methods:** A systematic review including all studies assessing the surgical outcomes of the LA-FF and proportional meta-analysis using a random-effect DerSimonian–Laird model was performed to assess the postsurgical complications and flap failures.

**Results:** Twenty-five articles were included in the final analysis, representing a total of 1272 flaps in 1256 patients. Indications were mainly defects following tumoral resection and trauma. Across the different studies, the reported flap size range varied from 2 × 4 cm to 12 × 16 cm. The overall pooled flap failure rate across all indications was 3% [95% confidence interval (CI), 0.01–0.04], with a pooled failure rate of 2% (95% CI, 0.01–0.04) in the head and neck region, 3% (95% CI, 0.01–0.06) in the upper limb region, and 3% (95% CI, 0.01–0.06) in studies evaluating its use in different anatomical locations. The overall donor site complication rate was 11% (95% CI, 0.03–0.21), with no major complications described.

**Conclusions:** This meta-analysis demonstrates safety and efficacy of the LA-FF in reconstructing moderate to large soft tissue defects. It is mainly used for head and neck posttumoral resection and upper and lower limb posttraumatic reconstruction. (*Plast Reconstr Surg Glob Open* 2024; 12:e6247; doi: [10.1097/GOX.0000000000006247](https://doi.org/10.1097/GOX.0000000000006247); Published online 11 October 2024.)

## INTRODUCTION

Originally depicted by Song et al,<sup>1</sup> the lateral arm free flap (LA-FF) is harvested from the distal third of the lateral aspect of the arm, and its perfusion is assured by the septocutaneous perforator of the posterior branch of radial collateral artery (PRCA).<sup>2</sup> The PRCA is the most suitable pedicle when designing the basis of the flap,<sup>3–6</sup> due to its twin branch, the anterior branch of the radial collateral artery and its proximity to the radial nerve. Indeed, the current literature already advocates for the versatility of

the LA-FF.<sup>3–8</sup> Its potential uses have been demonstrated in many regions of the body, whether be it in the head and neck region or in the upper and lower limb.<sup>1–29</sup> Although an increase in the practice of upper limb flaps has been observed,<sup>20</sup> there is a paucity of literature comprehensively assessing the safety and efficacy of the LA-FF. The aim of this study is to perform a systematic review and meta-analysis of the surgical outcomes and complications associated with LA-FF flaps in various settings of reconstruction.

## METHODS

The study protocol was preemptively registered on PROSPERO (CRD42024527387), and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Guidelines were followed to perform the analysis.

### Search Strategy

PubMed/MEDLINE were searched on March 21, 2024, using a combination of keywords synonym of “lateral arm free flap” and “arm flap morbidity” along with Boolean operators and MeSH Terms. The search queries’ details can be found in Table 1. No publication date restrictions were applied (Table 1).

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**Article Selection**

Population, intervention, comparison, outcomes and study (PICOS) principles were used when defining the selection criteria before the systematic review. All retrospective and prospective studies were selected, if the number of cases was equal, or greater than 5 LA-FF. All recipient sites were included to provide an overview of the flap applications. Reconstructive failure, defined as a complete free flap loss, was the primary outcome. Donor site complications were defined as the secondary outcome (Table 2). The articles obtained from the search query underwent processing by two authors (E.D. and J.M.) through the Rayyan web-app (<https://www.rayyan.ai/>; accessed March 27, 2024). In the prescreening phase, articles were selected by title and abstract, and duplicates were removed. All remaining articles were then screened by title and abstract. In the event of diverging opinions, a discussion with the senior author (C.M.O.) assured the accuracy of article inclusion. The articles remaining were then fully read by the two authors, provided they matched the selection criteria, and results were integrated into a standardized spreadsheet file (Fig. 1).

**Data Extraction**

Study characteristics and primary and secondary outcomes were then incorporated into an Excel spreadsheet (version 16.83, Microsoft Corp., Redmond, Wash.) by one author (E.D.) under the supervision of the senior author (C.M.O.). Donor site complications, recipient site complications, and flap failure rate were reported on a per-patient basis. All donor site complications reported were added to compute the overall donor site complication rate. Flap failure rate was then stratified by recipient site (multiple sites, lower limb; upper limb; trunk-abdomen; and head and neck), and the complications analyzed and computed.

**Statistical Analysis**

Using the R software version 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria) along with its meta-package, a proportional meta-analysis of the primary and secondary outcomes was conducted. A random-effect DerSimonian–Laird model was used to obtain pooled complication rates.

The  $I^2$  statistic along with the  $Q$ -statistic  $P$  value was used to evaluate heterogeneity between studies, with  $I^2$

**Takeaways**

**Question:** What are the applications of the lateral arm free flap? Is the procedure safe?

**Findings:** A systematic review and meta-analysis including 1272 flaps in 1256 patients was performed. Indications were mainly defects after tumoral resection and trauma. The overall pooled flap failure rate was 3% across all indications, 2% in the head and neck region, and 3% in the upper limb region. The overall donor site complication rate was 11%, with no major complications described.

**Meaning:** We offer an overview of major indications and complications after lateral arm free flap reconstruction.

more than 70% being considered as significant heterogeneity and  $I^2$  with values below 30% considered as low heterogeneity.<sup>30</sup> Results are presented as forest plots with proportions and their 95% confidence intervals (CIs).

**RESULTS**

Twenty-five articles representing a total of 1272 flaps in 1256 patients were selected.<sup>3,5–8,10–13,15–22,24–29,31,32</sup> Eleven studies evaluated the LA-FF reconstruction in the head and neck, six in the upper limb, and one in the lower limb regions.

The mean flap surface was reported in seven studies and ranged from 30 to 94.6 cm<sup>2</sup>.<sup>3,5,6,19,26,29,32</sup> Across the different studies, the reported flap size ranged from 2×4 cm to 12×16 cm,<sup>3,5–7,11,12,18–22,24,25,28,29,32</sup> and the mean pedicle length was between 4.6 and 9.5 cm.<sup>5,6,8,20,32</sup> The mean dissection time reported in two studies ranged from 26 to 67 minutes.<sup>6,11</sup>

The overall flap failure rate was 3% (95% CI, 0.01–0.04), with low heterogeneity ( $I^2 = 11%$ ), with a total of 53 flap failures reported. Among the 12 cases of pedicle revision recorded across the 1272 interventions, only one flap was not salvaged.<sup>8,10,11,16,21,22,26,32</sup>

The principal indications in the head and neck region were lingual, buccal mucosa, inner cheek, pharyngeal, palatal, and scapular defects, mostly after carcinoma resections.<sup>5–8,11,12,15,17,19,20,22</sup> Mandibular, lip, temporal region, and facial skin defects covered with an LA-FF were also described, albeit representing a lower proportion. A

**Table 1. Research Strategy**

Database	Date	Search Query	N Articles
PubMed, MEDLINE	March 21, 2024	(Lateral arm free flap) AND (Lateral arm free flap morbidity) AND (Lateral free flap complications)	505

**Table 2. Selection Criteria According to PICOS**

	Inclusion	Exclusion
Population	All patients	Cadaveric studies, animal studies
Intervention	Lateral arm free flap	Pedicled flap
Comparator	None	
Outcomes	Primary: reconstructive failure Secondary: donor site and recipient site postoperative complications	Studies not reporting the primary outcome
Study design	Prospective, retrospective, comparative	Case reports, case series (<5 cases), reviews

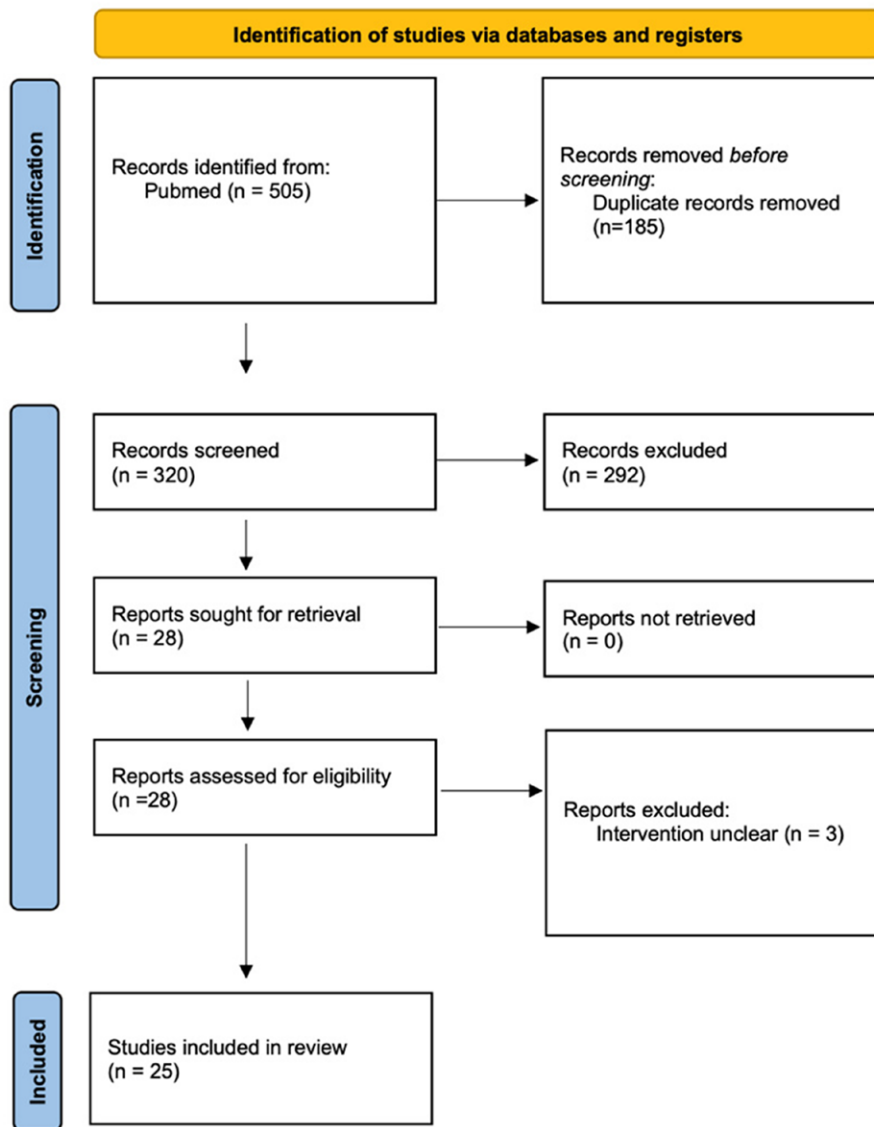


Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart.

total of 539 procedures in 532 patients (347 men and 185 women) in this region were recorded, with a mean patient age ranging from 46.5 to 62.8 years. The pooled flap failure rate for head and neck LA-FF reconstruction was of 2% (95% CI, 0.01–0.04).

In the upper limb region, the main indications were closure of posttraumatic defects in the forearm and dorsal and palmar hand regions. Tissue defects of the wrists, fingers and cubital fossa were less frequently described.<sup>3,16,24–26,32</sup> A total of 296 reconstructive procedures of the upper limb using the LA-FF in 244 male and 51 female patients were recorded. The mean patient age ranged from 24.9 to 74 years. The pooled flap failure rate of LA-FF for upper limb reconstruction was 3% (95% CI, 0.01–0.06).

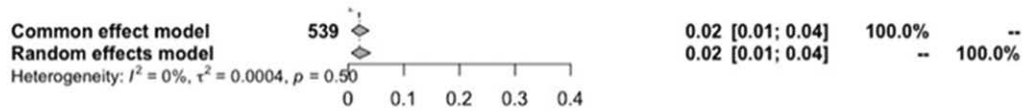
In the lower limb region, the only included article presented LA-FF as a solution to defects overlying the Achilles tendon.<sup>21</sup> A total of 16 procedures were performed in four

female and 12 male patients, with a mean age of 47 years. The flap failure rate was 6.25%.

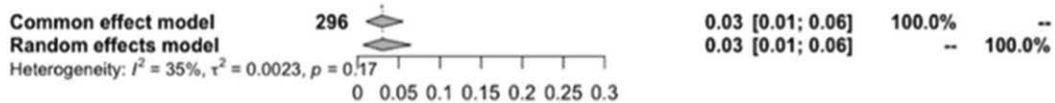
Six studies evaluated LA-FF reconstruction in multiple recipient sites within the same cohort, not allowing us to include them individually in one of the three anatomical regions categories.<sup>10,13,27–29,31</sup> The affected locations were the temporal region, neck, lower leg, heel, wrist, finger, scalp, heel, palm of hand, tibial, mandible, metacarpus, radius, metatarsus, and elbow. In total, 421 LA-FF were performed in 413 patients (358 men and 55 women), with a mean age ranging from 34.5 to 54 years. The pooled flap failure rate was 3% (95% CI, 0.01–0.06), and heterogeneity across studies was medium ( $I^2 = 35\%$ ). Two patients who underwent pedicled flaps were excluded from the study by Haas et al<sup>18</sup> as they did not correspond to the inclusion criteria (Fig. 2).

Donor site morbidity was reported in 15 studies.<sup>3,5,7,11,12,16,18–20,22,27–29,31,32</sup> The most frequently to the

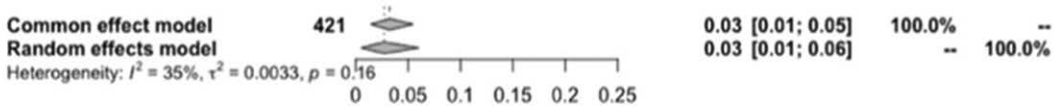
## Head & Neck failure rate



## Upper limb failure rate



## Multiple recipient site failure rate



## Overall failure rate

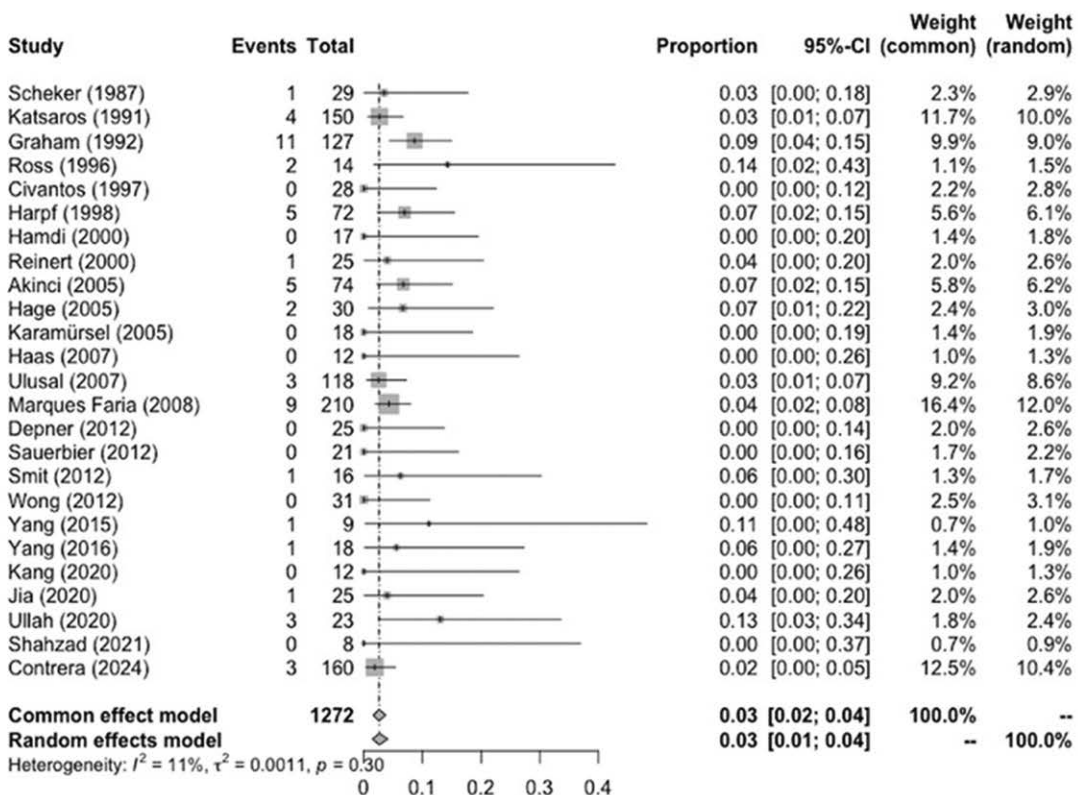


Fig. 2. Pooled flap failure rates, according to anatomical region and overall pooled flap failure rate.

least frequently reported complications were, respectively, paraesthesia and numbness (n = 10); wound dehiscence (n = 6); elbow pain (n = 5) and hypersensitivity (n = 5); transient or persisting range of motion loss (n = 4) and

hypertrophic scarring (n = 4); hematoma (n = 3); paresis (n = 2), superficial infection (n = 2), and seroma (n = 2); contracture (n = 1); and dog ear (n = 1). Accounts of cosmetic dissatisfaction were also reported in three studies,

## Donor site complication rate

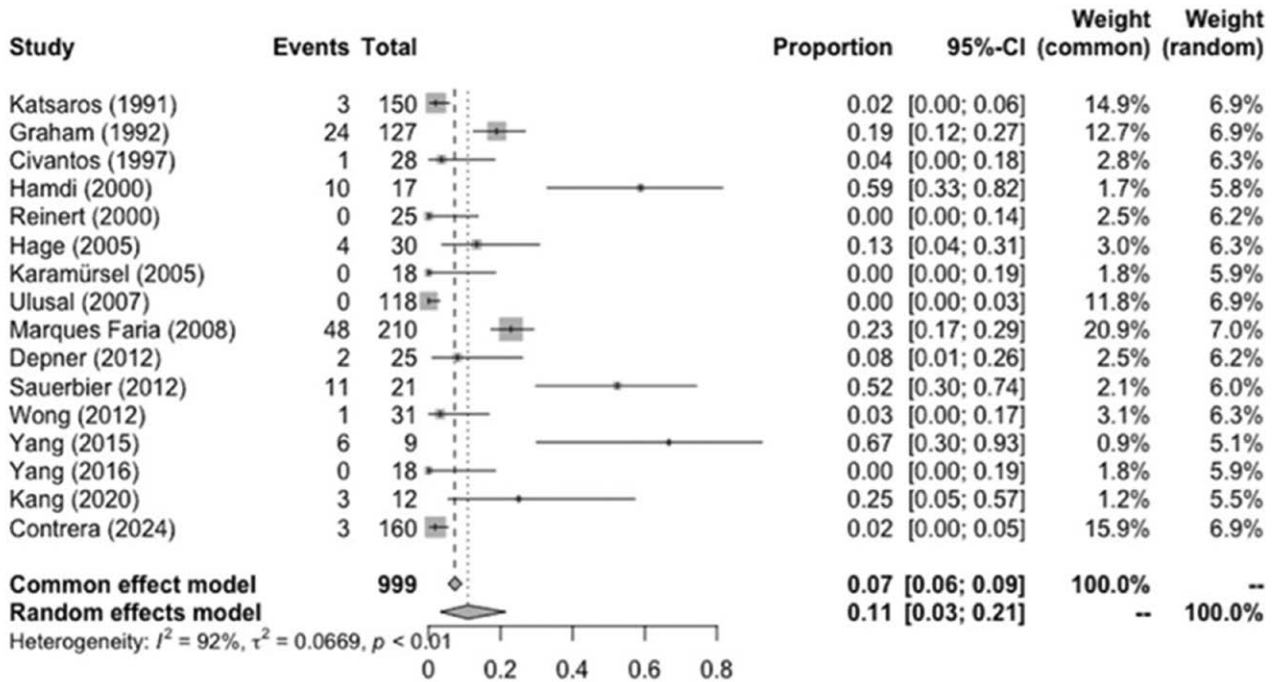


Fig. 3. Pooled donor site complication rate.

namely Hamdi and Coessens,<sup>27</sup> Graham et al,<sup>29</sup> and Akinci et al.<sup>32</sup> The donor site complications were all considered minor complications. With a high heterogeneity with an  $I^2$  of 92%, the pooled overall donor site complication rate was of 11% (95% CI, 0.03–0.21) (Fig. 3).

### DISCUSSION

To the extent of our knowledge, this systematic review and proportional meta-analysis represents the first comprehensive meta-analysis of surgical outcomes following LA-FF-based reconstruction. The two main indications were closure of traumatic defect (caused by industrial accidents, burn injuries, among others) and reconstruction after tumoral resection. Ninety percent of the studies of the LA-FF in the head and neck region reported its use in the reconstruction after carcinoma resection,<sup>5,11,12,15,17,19,20,22</sup> and all the studies investigating LA-FF reconstruction in the upper and lower limbs region were in the context of a defect after trauma and burns.<sup>3,16,24–26,32</sup> With an overall pooled flap failure rate of 3% (95% CI, 0.01–0.04), and pooled donor site complication rate of 11% (95% CI, 0.03–0.21), the overall success rate is high and remained consistent across various indications and anatomical regions.

A notable advantage of the LA-FF resides in its versatility due to its consistent vascular anatomy.<sup>29</sup> As previously mentioned, this flap is nourished by the continuation of the profunda brachii artery, which lies in the intermuscular septum and runs with the radial nerve. The profunda

brachii artery splits into the anterior and posterior radial collateral artery, which supplies the fasciocutaneous flap.<sup>3–6</sup> Being a nonessential terminal branch, which has only small ramifications to the triceps, brachialis, humerus, and lateral skin of the arm, its harvest results in very low morbidity. Additionally, the tissue from the LA-FF is pliable and thin,<sup>3,5,7,10,12</sup> which enables it to be applied to a variety of locations and organs, from the scalp and tongue to the fingers. With an undersurface compatible with tendon gliding, it can also be used in lower limb defect coverage such as in the Achilles heel region.<sup>10,18,21,33</sup> Moreover, the LA-FF flap composition also results in important versatility.<sup>3,31</sup>

However, a recurrent drawback noted by authors was the shortness of the LA-FF pedicle,<sup>10,19,32</sup> which can lead to challenges in the inseting of the flap and may restrict its applications. Some authors describe the detachment of the lateral head of the triceps muscle and harvesting of the deep brachial artery in the spinal groove to address this limitation.<sup>18,28</sup> This explains the variations in the mean pedicle lengths across the included studies, as not all authors described the use of the detachment.<sup>5,6,8,20,32</sup> The skin paddle can be as long as the distance from the insertion of the deltoid muscle to the lateral epicondyle and even go beyond in the proximal forearm.<sup>17</sup> Not only does this extended LA-FF enable the harvest of a more thin and pliable skin paddle, if the width is not greater than 6 cm, donor site closure may be performed primarily, without the necessity of a skin graft.<sup>3,24</sup> As the subcutaneous tissue from the insertion of the deltoid to the lateral epicondyle

gets progressively thinner, the thickness of the flap can also be adjusted depending on the indication. However, this is a little more nuanced in female patients because they have a thicker subcutaneous tissue in the lateral arm.<sup>11</sup>

Moreover, the dissection time of the LA-FF is short, ranging from 25 to 67 minutes, and can be performed in a bloodless field when a tourniquet is applied, which is especially important when operating on polymorbid and older patients.<sup>12,16,18</sup>

Another popular flap often employed in the context of reconstruction following tumoral resection, especially in the head and neck region is the radial forearm free flap (RF-FF). Considered by many as a workhorse flap, the RF-FF is a thin and pliable flap located in the anterior forearm.<sup>34</sup> Composed of the anterior forearm skin and subcutaneous tissue, the current literature strongly advocates for its versatility.<sup>35</sup> With a capacity to provide a long and large pedicle, this flap perforator is the radial artery, which proves to be a disadvantage in terms of morbidity.<sup>4,12,17,25</sup> Indeed, when harvesting the RF-FF, this major artery of the hand must be sacrificed. Additionally, it can also lead to decreased grip strength, arm swelling, and bone segment fracture.<sup>36–38</sup> A review of the RF-FF by Ranganath et al<sup>39</sup> including over 700 patients reports a flap failure rate of 2.7%. Another review by Bruin et al reports a donor site mean pain incidence of 23% and mean hypesthesia incidence of 34% following RF-FF reconstruction.<sup>40</sup> Studies comparing donor site sensitivity after RF-FF reconstruction note significantly decreased sensitivity compared with the LA-FF and note worse aesthetic donor site outcomes.<sup>19,41</sup>

Ten studies reported the presence of paresthesia or numbness in the donor site region postoperatively.<sup>5,7,8,11,16,18,19,27,29,32</sup> This recurrent symptom could be explained by damage caused to the lower lateral brachial cutaneous nerve as well as the posterior antebrachial cutaneous nerve when raising the flap. However, some authors note that by virtue of the ingrowth of neighboring cutaneous nerves, numbness and paresthesia often spontaneously disappear after 6 months.<sup>2,27,29</sup> These sensory disturbances either resolved on their own or remained but in diminished intensity and were not considered an impairment by patients.<sup>5–8,11,16,18,19,27,29,32</sup>

Regarding aesthetic outcomes, most of the authors report high patient satisfaction.<sup>5–8,16–19,21,26–29,31,32</sup> In cases where the flap is greater than or equal to 6 cm in width, a skin graft is not necessary and the donor site can be primarily closed with a well-accepted resulting scar, whereas in cases of larger width, a skin graft is often needed and patient satisfaction with their scar is lower.<sup>2,24,25</sup> Surgical intervention such as flap thinning, debulking and liposuction can be performed to address bulkiness and scar hypertrophy.<sup>16,26,31</sup>

Another issue described was hair transfer to the recipient site, especially in male patients.<sup>25,29,32</sup> However, unlike the RF-FF, the donor site scar in the LA-FF can easily be covered.<sup>6,7</sup> Interestingly, Graham et al<sup>29</sup> further recorded that dissatisfaction in female patients was twice as high compared with male patients, leading their team to recommend against the use of LA-FF in women. More

recent studies argue that there is no significant difference between the two genders, and that cosmesis was rather well accepted by the patients.<sup>28</sup>

The choice to include studies which documented five or more patients could constitute a filter that discards case reports depicting experimental applications of the LA-FF. The paucity of literature documenting the use of LA-FF in the lower limb region is another limitation to the interpretation of the specific reconstructive success in this region. Moreover, the lack of standardized reporting for donor site complications as well as recipient site complications may explain the high heterogeneity in the donor site overall complication rate. No publication bias assessment method was used, given the homogenous results and the overall flap failure rate that was in line with what is described.

## CONCLUSIONS

The LA-FF stands out by its versatility demonstrated by its various applications in the head and neck, upper and lower limb reconstructions. This systematic review and meta-analysis demonstrate its safety and efficacy and highlight the potential of the LA-FF in becoming a workhorse flap for traumatic and postcarcinoma tissue defect reconstruction.

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## DISCLOSURE

*The authors have no financial interest to declare in relation to the content of this article.*

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