

## Thin Anterolateral Thigh Perforator Flap in Upper Limb Reconstruction

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### ABSTRACT

**Background:** Upper extremity soft tissue defects require a single-stage surgery that enables prompt, well-vascularized covering in order to get the best functional outcome.

**Aim of the study:** To assess the functional and aesthetic outcomes of the thin anterolateral thigh perforator flap in upper extremity soft defects and to evaluate them by follow up.

**Patients and Methods:** This follow-up study, which included 20 patients (15 male and 5 female), was conducted at Al-Azhar University Hospitals' Plastic and Reconstructive Surgery Department between July 2018 and October 2021. All patients were evaluated for their aesthetic and functional outcomes at 6 months post-operatively. In 16 cases, the defect was caused by acute trauma, while post-traumatic scarring was the cause in four cases. In 17 cases, the donor site was mostly closed, while three others were covered by split skin grafts.

**Results:** We studied the results of reconstruction of the upper extremity soft tissue defects utilising thinned anterolateral thigh flaps. The study included 20 patients; the mean age of the patients was 30.1±12.5 years. The flap's mean thickness before thinning was 21 (15-32) mm and 5 (4-9) mm after thinning. Two cases suffered partial tip necrosis, which were managed by conservative treatment, and three patients had hematomas as a result of primary flap thinning. Six hours postoperatively, one patient had flap ischemia. A team of 4 plastic surgeons as well as the patients themselves performed the functional and aesthetic assessment by a 5-point scale, Quick Disabilities of Arm, Shoulder and Hand score (QuickDASH score). The aesthetic assessment by the surgeons (mean score: 20.9) and patient (mean score: 19.2) was good. The mean score of the QuickDASH score was 23.

**Conclusion:** The thin anterolateral thigh flap is flexible and reliable in upper extremity reconstruction, giving satisfactory functional and aesthetic outcomes.

**Keywords:** Thin Anterolateral Thigh Flap; Soft Tissue Reconstruction; Upper Limb.

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### INTRODUCTION

To achieve a satisfactory functional and aesthetic outcome, upper extremity soft-tissue covering necessitates the use of a thin and flexible flap.<sup>1</sup> The knowledge of the flaps' vascular anatomy enables the surgeons to harvest thin flaps at the superficial fascial level and super-thin flaps at the level of the thin subcutaneous fatty layer.<sup>2</sup> Pure skin perforator flaps to the level of the dermis depending on a branch of the superficial circumflex iliac artery and the superficial inferior epigastric artery also harvested by Narushima et al.<sup>3,4</sup>

The anterolateral thigh perforator (ALT) flap was first described by Song et al,<sup>5</sup> depends on the perforators of the descending branch of the lateral

circumflex femoral artery. There are several advantages to the ALT flap, including its ease of harvesting, little donor site morbidity, and satisfactory outcomes<sup>5,6</sup>, the vascularized fascia lata that can serve as a gliding surface for tendons, and it is also utilised in the restoration of difficult upper extremity wounds with vascular deficit by using venous grafts.<sup>7</sup>

The primary defatting of the anterolateral thigh flap results in a malleable flap that can replace the upper extremity thin skin and contour. It also eliminates the need for a second procedure to thin the flap and remove extra flap bulkiness, which can limit range of motion if not addressed. As a result, this primary thinning enhances function and quality of life while reducing total hospitalizations and expenditures.<sup>8,9,10</sup>

The aim of this study was to assess the functional and aesthetic outcomes of complicated upper extremity injuries by utilizing a thinned ALT flap.

## MATERIALS AND METHODS

This study was conducted at the Plastic and Reconstructive Surgery Department, Al-Azhar University Hospitals from July 2018 to October 2021 and included 20 patients with complex defects over the upper extremity. The defects were due to post-traumatic deformities and postburn scars. Exclusion criteria included patients with peripheral vascular diseases and severe chronic illnesses. Functional and aesthetic outcomes were also assessed and reported on.

### Ethical approval

The Ethical Research Board (ERB) of Al-Azhar University's Faculty of Medicine in Cairo, Egypt, approved the study. Before the study proceeds, all patients are assigned informed consent after the obvious explanation of the possible adverse events.

### Aesthetic evaluation

The aesthetic results were assessed by four plastic surgeons, patients, or patient relatives in the case of a child, using a five-point likert scale.<sup>11</sup> The points on the scale are colour matching, contouring, texture, distribution of the hair, and satisfaction. Each item has points from one to five, with one being the worst and five being the best. The overall score (min, 5 & max, 25) was categorized as follows: 5 to 9, poor; 9 to 13, bad; 13 to 17, fair; 17 to 21, good; and 21 to 25, very good. The panel's plus patients' total scores were added together to produce the final score.

### Functional evaluation

The Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) score has been used for subjective self-assessment. 11-15 indicate no difficulty, 16-40 indicate "problem, but working," while >40 indicates "unable to work."

### Surgical technique

In patients with acute damage, the wound was properly irrigated first, then serially debrided till the flap became ready for reconstruction. If there was

any associated structural injury, it was repaired first, as soon as the wound was suitable. A vertical line was marked from the anterior superior iliac spine to the lateral superior aspect of the patella while the patient was in a supine position. Draw a circle with a radius of 3 cm at the midway of this straight line. The perforators were detected inside and adjacent to the drawn circle using a handheld 8 MHz Doppler.<sup>11</sup> The flap's dimensions had been determined based on the defect size, with an additional 1–2 cm added to the defect's measurements. A subfascial or suprafascial technique was used to harvest a thin ALT flap. In the case of the subfascial technique (Figure 1), the standard ALT flap was harvested initially. A medial incision was performed down to and through the thigh fascia to expose the rectus femoris muscle. The vastus lateralis muscle was then split from the rectus femoris muscle by retracting it medially, exposing the septum. Retrograde dissection was performed to skeletonize the septocutaneous perforator. Intramuscular dissection was continued till it reached the descending branch of the lateral circumflex femoral artery. The lateral cutaneous nerve of the thigh was carefully dissected away from the pedicle, then lateral incision was performed. The primary thinning then started from periphery, almost above the superficial fascia, between the superficial small rounded and the deep, big, diagonally fat lobules, by using scissors or electrocautery.<sup>12</sup> In the suprafascial plane (figure 2), the flap can also be harvested by detecting and identifying the perforators that pierce the fascia and protect them with a cuff of adjacent tissue.<sup>13</sup> In most circumstances, the donor area could be closed with direct closure, but in patients where a wide flap is desired, a skin graft or a locally flap may be required to close the donor area.

### Statistic evaluation

Data were analyzed using IBM® SPSS® Statistics version 26 (IBM® Corp., Armonk, NY) and MedCalc® Statistical Software version 20 (MedCalc Software Ltd, Ostend, Belgium; <https://www.medcalc.org>; 2021). Paired numerical data is compared with the paired-samples t-test. Correlations between numerical variables are examined using the Pearson correlation (Pearson r). Correlations of numerical variables with binary or ordinal variables are examined using point-biserial (rpb) or rank-biserial (rrb) correlation.

## RESULTS

### Patients

The demographics of the patients, their comorbidities, and the characteristics of the injury was collected (Table 1). The mean length of the flap was 18.5 cm (range 9–32), the mean width of the was 9.1 cm (range 6–15), and the surface area was 185 cm<sup>2</sup> (range 55-434). The initial flap had a mean thickness of 21 mm (range 15-32), while the flap after thinning had a mean thickness of 5 mm (range 4-9). The donor site was directly closed in 17 cases, with three cases requiring skin graft.

Variable	Value
Age (years), mean ± SD (range)	30.1 ± 12.5 (11.0 to 53.0)
Sex, M/F	5/15
Smokers, n (%)	8 (40.0%)

Chronic illness, n (%)	2 (10.0%)	
Type of injury		
Acute	16 (80.0%)	
MCA	9 (45.0%)	
Machine injury	4 (20.0%)	
Fall from height	1 (5.0%)	
Fire work	1 (5.0%)	
Flame burn	1(5.0%)	
Chronic	4 (20.0%)	
Post burn contracture	3(15.0%)	
Fall from height	1(5.0%)	
Technique of flap elevation		
Subfascial	16(80.0%)	
Suprafacial	4(20.0%)	
Anatomy of flap perforator		
Septocutaneous	3(15.0%)	
Musculocutaneous	5(25.0%)	
Septo&musculocutaneous	2(60.0%)	
Original thickness of the flap (mm), mean ± SD (range)	21 ± 5(15-32)	
Thickness of flap after thinning (mm), mean ± SD (range)	5 ± 1 (4 to 9)	
Donor site closure, n (%)		
Primary closure	17(35.0%)	3(25.0%)
Skin graft		

**Table 1:** Patient's demographics, chronic illness, cause of injury and details of the flap.

Post operative complications (table 2)

Three patients suffered hematomas from initial thinning, resulting in total flap loss. Flap ischemia had occurred in one patient; during re-exploration, thrombosis of the artery was detected, removed and re-anastomosis was done with complete salvage of the flap. Partial necrosis of the tip has occurred in two patients, with one having a flap surface area of 258 cm<sup>2</sup> and thickness was 7 mm. The other patient had a flap surface area of 220 cm<sup>2</sup> with a thickness of about 6 mm. Both flaps were treated in 3 weeks by secondary intention. Three flaps developed infections that required only antibiotic therapy. Re-operations were done three weeks following surgery, with STTG performed in three patients who experienced total flap loss. Tenolysis was done on one patient. Two patients needed tendon spacer and a tendon graft. Flap thinning and defatting was performed for one patient, while two others had flap division and re-fashioning to create new web spaces.

Variable	Value
<b>Complication / Adverse outcome, n (%)</b>	
Hematoma & total loss	3 (15.0%)
Infection	3 (15.0%)
Partial Tip necrosis	2 (10.0%)
Arterial thrombosis	1 (5.0%)
Reoperation to flap:	9 (45.0%)
<b>Type of reoperation, n/N (%)</b>	
Graft	3/9 (33.3%)
Defatting	1/9 (11.1%)
Tendon spacer with graft	2/9 (22.2%)
Refashioning of flap	2/9 (22.2%)
Tenolysis, n/N (%)	1/9 (11.1%)

**Table 2:** Incidence of complications and adverse outcomes in the study population

## Functional and aesthetic results

The panel mean total aesthetic score for the five items was good (Table 3) 20.9 (STD 2.9, ranging 13.5–24), that was greater than the patients' mean total score of 19.2 (STD 3.6, ranging 13–24) (good). The patients' total aesthetic scores were significantly related to the panel scores. (Paired-sample t-test, P- Value 0.018). The mean Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) score was  $23 \pm 10$  (3 to 41). Eight cases scored the highest score that 'had no difficulty', eleven cases scored 'had a difficulty but work' and only one case recorded 'unable to move'. The correlation between the thickness of the flap and QuickDASH score before and after thinning was insignificant. (p- value 0.848, 0.988).

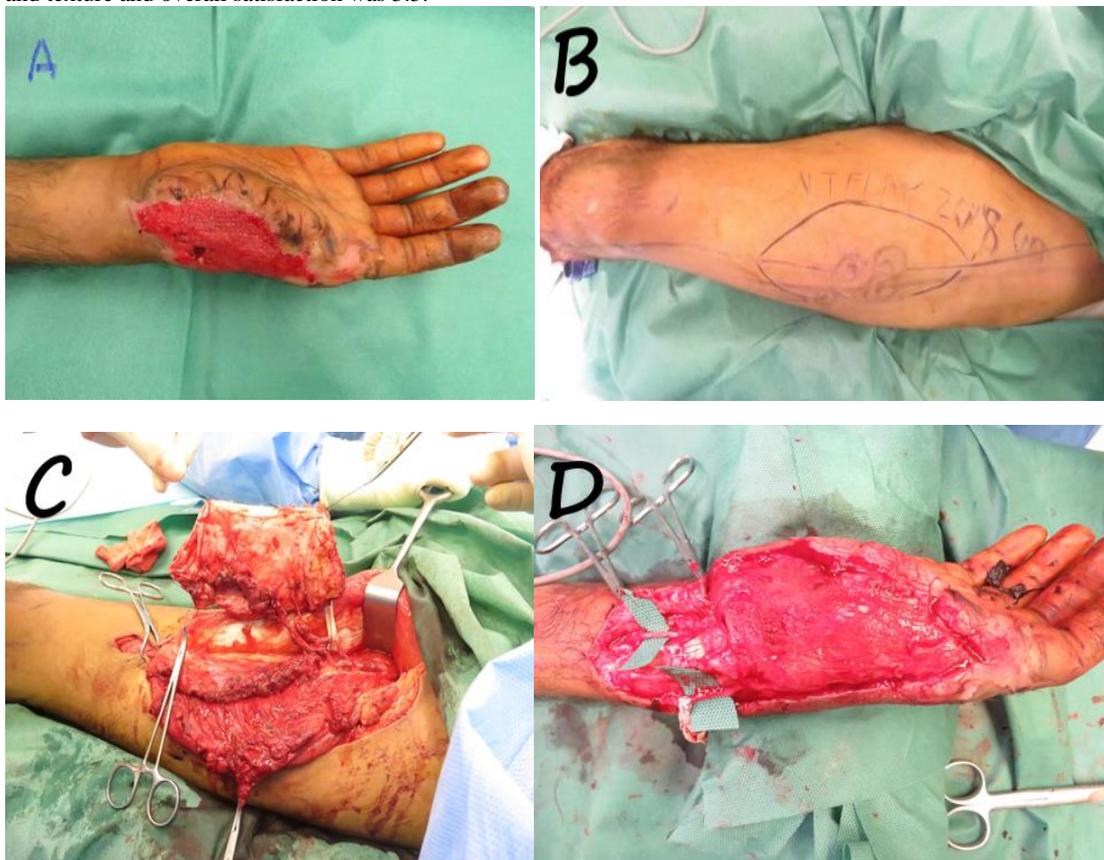
Variable	Paired difference						
	Physician-rated score	Patient-rated score	Mean	SE	Lower 95% CI	Upper 95% CI	P-value†
<b>Aesthetic score</b>							
Color, mean $\pm$ SD	4.4 $\pm$ 0.8	4.0 $\pm$ 0.8	0.5	0.2	0.0	1.0	0.056
Hair, mean $\pm$ SD	4.0 $\pm$ 1.1	4.1 $\pm$ 1.1	-0.1	0.3	-0.7	0.5	0.793
Contour, mean $\pm$ SD	3.8 $\pm$ 0.8	3.6 $\pm$ 1.3	0.2	0.3	-0.4	0.8	0.498
Texture, mean $\pm$ SD	4.4 $\pm$ 0.7	4.0 $\pm$ 0.6	0.4	0.2	0.0	0.8	<b>0.039</b>
Satisfaction, mean $\pm$ SD	4.3 $\pm$ 0.6	3.6 $\pm$ 0.6	0.7	0.1	0.4	1.0	<b>&lt;0.001</b>
Total aesthetic score, mean $\pm$ SD	20.9 $\pm$ 2.9	19.2 $\pm$ 3.6	1.7	0.7	0.3	3.1	<b>0.018</b>
<b>Functional score</b>	<b>mean</b>	<b><math>\pm</math>SD</b>	<b>(range)</b>				
DASH score	23	10	3-4				

**Table 3:** Comparison of aesthetic scores as rated by physicians or patients

## Case presentation

## Case 1

A male patient 24 years old with post traumatic amputation of rt thumb, no history of systemic diseases or previous surgery. Subfascial harvesting technique for elevation of ALT followed by primary defatting as showed in (figure 1). Quick DASH score of the patient was 21 which means that the patient had "a difficulty but work". The panel score was 4 as regard color, 3.5 as regard contour, 4 as regard texture, 3 as regard hair and the overall satisfaction was 4. The patient 5 point- likert scale was 4.5 as regard color, 3 as regard contour, 3.5 as regard hair and texture and overall satisfaction was 3.5.

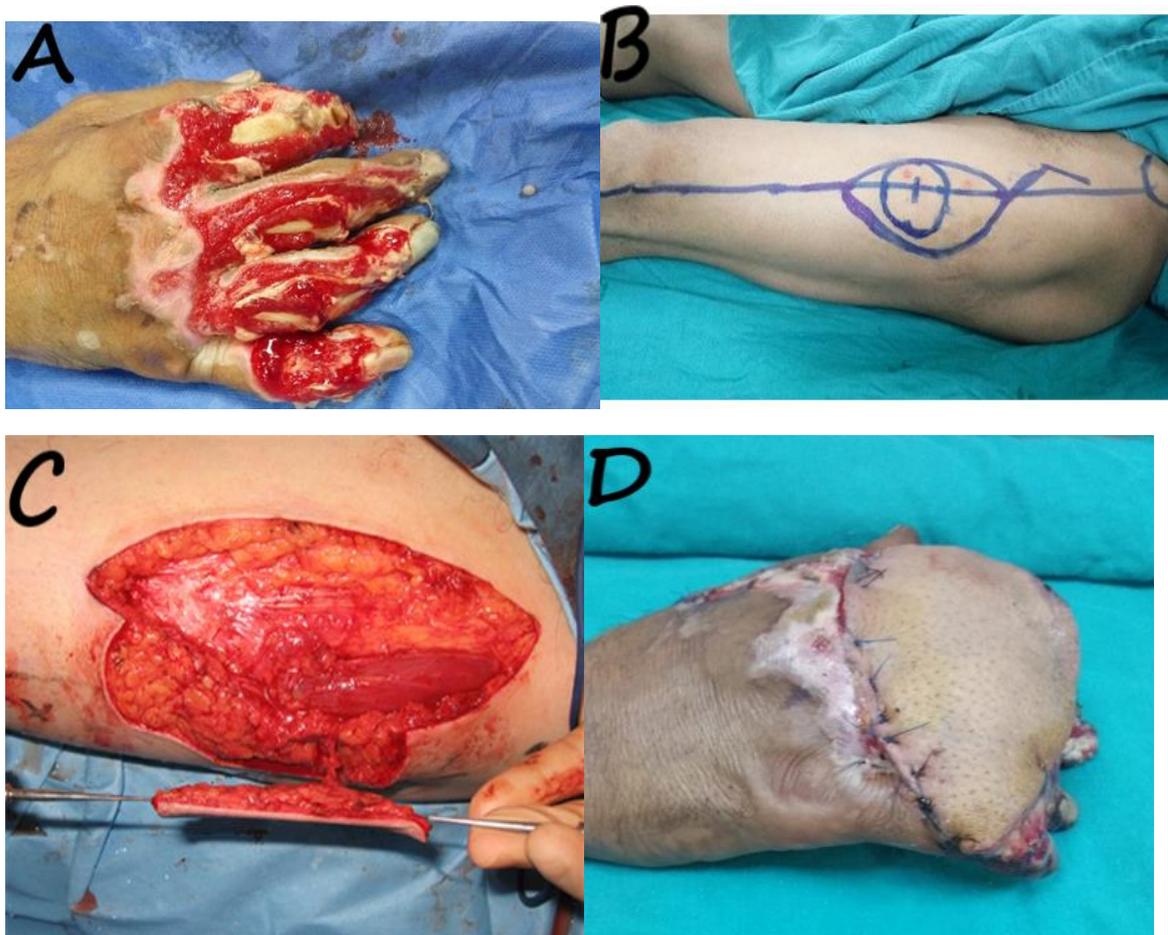




**Fig. 1:** A: male patient 24 years old with post traumatic amputation of rt thumb. B: ALT flap marking. C sub fascial harvesting and primary thinning of contralateral ALT flap. D: Preparation of recipient vessels. E: post operative view after coverage of the raw area.

#### Case 2

A male patient was 45 years old, with post traumatic soft tissue defects at the dorsum of the medial 4 fingers, patient was hypertensive with no history of drug intake or previous operation, suprafascial harvesting technique for elevation of ALT followed by primary defatting as showed in (figure 2), 3 weeks later separation of the flap to reconstruct the medial four fingers. Quick DASH score of the patient was 23 which means that the patient had “a difficulty but work”. The panel score was 3 as regard color, 4 as regard contour, 4 as regard texture, 3 as regard hair and the overall satisfaction was 3.5. The patient 5 point- likert scale was 4 as regard color, 4 as regard contour, 3 as regard hair and 3.5 texture and overall satisfaction was 3.5.





**Fig.2:** A: male patient 45 years old with post traumatic soft tissue defects at the dorsum of medial 4 fingers. B: ALT flap marking at the contralateral thigh. C: suprafascial harvesting and primary thinning of contralateral ALT flap. D: in setting of the flap over the defect. E: 3 weeks later post operative view after separation of the flap to reconstruct the finger.

### DISCUSSION

Bulky flaps provide unfavorable aesthetic results and lead to functional disabilities especially in regions like the hands. Primary anterolateral thigh flap thinning was utilized to reconstruct various areas of the body, such as the upper extremity.<sup>14</sup> Kimura et al. published 6-year study of an ultrathin ALT flap, which included 31 patients. There were variances in width and length, but the average was 7.7 14.7 cm to sustain flap vascularity. Its research documented that:

two patients suffered partial loss and they found that the safe zone for thin ALT flap which has a thickness of 3 to 4 mm must not exceed a circle with 9cm diameter.<sup>15</sup> Later on, they reported additional ten cases study with wide thinned ALT flaps. The average diameter ranged from 105 to 450 cm<sup>2</sup>, with a thickness of 4–5 mm on average. Only two flaps were larger than 240 cm<sup>2</sup>, one of which was outside the safe zone and was worsened by partial necrosis.<sup>16</sup> According to our findings, two patients had partial necrosis with flap surface areas of 258, 220 cm<sup>2</sup>.

There is no generally accepted technique for evaluating the aesthetic results of the flaps. Aesthetic results of the upper extremity reconstruction could be assessed personally by matching different parameters to the adjacent area and the unaffected opposite extremity. For assessing various flaps, A four-point Likert scale is widely utilized.<sup>11</sup>

Five observers were utilized by Askouni to objectively evaluate the optimal covering for distal third of upper limb as regard the aesthetic result (color match, contouring, texture match and overall aesthetic outcome).<sup>14</sup> They also found that the fasciocutaneous flaps, such as ALT flap, had the lowest ratings in all aesthetic items. This could be due to the bulky flap with poor contouring and color matching. However, they didn't report anything on the extent of flap thinning despite the initial thinning of the majority of the flaps prior to inset. Following that, the same Likert scale to perform aesthetic

assessment on seven patients of thinned ALT flap for reconstruction of different areas of the upper extremity was used.<sup>11</sup> They observed that color and texture were the best-rated items, with a mean score of 3.9, while general appearance was the worst-rated item, with a score of 3.6. Their overall appearance and contour scores were higher than those reported by another study (3.6 versus 2.2 and 3.8 versus 2, respectively)<sup>17</sup>, also there were improvements in color when compared to the muscle, fascial, and fasciocutaneous flaps (3.9 versus 3.6, 3.8, and 2.5, respectively), and improvements in texture (3.9 versus 3.3, 3.5 and 3.1).

Hair distribution was included to the Likert - type scale in our study since it was identified as a significant factor in aesthetic evaluation by Rehim et al.<sup>10</sup> We used the 5-point Likert scale to compare the panel evaluation to patient's self-evaluation after adding hair distribution. Our results revealed higher panel ratings than the previously noted research, with texture and color got the highest score of 4.4 and contour got the least score of 3.8. The panel scores were significantly higher, and there was a significant relation between the total panel and patient ratings.

The functional assessment in upper limb reconstruction, has been done by the QuickDASH score.<sup>11</sup> This means that most upper extremity functions, such as trying to grasp, trying to take a pen or a glass of water, can be performed, which is better than those assessed by Kovacs et al<sup>18</sup> who concluded that the average DASH scale rating before 3 years after the injury is 28.7 percent and 20.2 percent after 3 years.

To summarize, the thin ALT flap is a flexible, dependable, and safe approach for reconstructing complicated upper limb wounds. The technique of elevation and thinning was simple if you know the territory of the area properly. However, many research are needed to provide us with advance tools to evaluate this flap mainly and other flaps for upper extremity reconstruction

## CONCLUSION

Thin anterolateral thigh free flap is a reliable tool in dealing with various defects in the upper limb. With proper pre operative planning, meticulous operative handling single stage reconstruction can be achieved together with early functional restoration and accepted aesthetic appearance .

Minor secondary surgical procedures are usually requested specially in the hand for either finger separation or debulking. The high rate of the flap success and the low rate of complications make it a good option in the upper limb reconstruction.

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