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**ORIGINAL ARTICLE**

## Using Freestyle Skin Flap in Closure of Defects in Upper Limb

Mohamed Salah Awad<sup>a</sup>, Ahmed Mohamed Aly<sup>a</sup>, Mohamed Ali Nasr<sup>a</sup>, Mohamed Atef Mohamed<sup>b\*</sup>

<sup>a</sup> Plastic Surgery Department, Faculty of Medicine, Zagazig University, Sharkiia, Egypt.

<sup>b</sup> Plastic Surgery and Burns Resident- Hehia Central Hospital - Egyptian Ministry of Health, Egypt.

### ABSTRACT

**Corresponding author:**  
Mohamed Atef Mohamed  
Email:  
aboatef20132014@gmail.com

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**Background:** Defects in upper limb may result from primary open trauma, postoperative wound infection, raw area after burns or post burn scar excision, tumor excision, radiation injury. Some defects require skin flap for proper coverage and restoration of function. One of the methods recently used for reconstruction of defects in upper limb is local freestyle skin flap. This flap is based on a perforator which provides blood supply for flap and acts as pivot point when the flap is rotated. **Objectives:** To evaluate using freestyle flap for reconstruction of defects in upper limb and assess the post-operative results for restoring function and cosmeses. **Patients and Methods:** This is a prospective study carried out in Plastic & Reconstructive Surgery Department & Emergency Unit, Zagazig University Hospitals in the period from January to July 2018 including 12 patients with soft tissue loss in upper limb managed by freestyle skin flap. **Results:** 50% of the cases had soft tissue defect after contracture scar release, while 25% were due to traumatic cause and the remaining 25% were post malignancy resection. flap dimensions ranged from 6 - 96 cm<sup>2</sup>. we had no complications in 58.3% of our cases, while minor complications like flap congestion and distal partial necrosis occurred in 33.4% which were resolved within 1 week. Unfortunately, we experienced 1 flap loss (8.3%) which managed later by debridement of necrotic tissue and skin grafting the remaining soft tissue. **Conclusion:** Freestyle skin flaps are a reliable option for coverage of small to moderate sized defects. **Keywords:** freestyle flap, propeller flap, pedicle perforator flap, upper limb reconstruction.

### INTRODUCTION

In spite of the early aversion of the plastic surgery community to accept regular use of perforator based propeller flaps in clinical practice, these flaps are gradually looked upon as a safe and reliable option in reconstructive plastic surgery [1].

A flap can be harvested on any dominant clinically relevant perforator. Free-style local island pedicled flaps are based on a combination of free-style and local flap design principles such as identification of pivot points, arcs of rotation, and assessment of tissue laxity [2].

Each perforator has a unique vascular territory and most perforators in the body are distributed within "cold spots" and "hot spots". Hot spots have high

perforator density and cold spots are relatively poor areas of perforator distribution. Most hot spots can be found adjacent to articulations and midpoint between two articulations in the extremities, whereas in the trunk, perforators are clustered parallel to the posterior and anterior midline, and midaxillary regions [3].

Another key principle in successful design of free-style flaps is familiarity of the location of dominant perforators around the body, starting with basic knowledge from traditional workhorse flaps used in reconstructive surgery [3].

Adequate repair of the soft tissue of is important to ensure restoration of the aesthetic appearance and more importantly the function. For example, soft

tissue in the hand is frequently repaired using skin grafts, cross finger flaps or thenar flaps when the surrounding soft tissue is available [4].

In some situations, soft tissue reconstruction requires thin but durable tissue to withstand with pressure, flexion and extension as in case of soft tissue loss over the elbow. Local and distal donor tissue has been used to reconstruct soft tissue defect at the elbow. For optimal soft tissue coverage at the arm; surgeons prefer thin, pliable and hairless skin flap. Several local, regional and free flaps have been reported and successfully done. One of these flaps is freestyle skin flap which offer a suitable method for reconstruction of soft tissue defect in upper limb [4].

#### **PATIENTS AND METHODS**

This prospective study was carried out in Plastic & Reconstructive Surgery Department & Emergency Unit, Zagazig University Hospitals in the period from January to July 2018 includes 12 patients with defects in upper limb managed by freestyle skin flap with this criteria; a)Age more than 5 years, b)Soft tissue loss, c)Exposed bones or tendons. We excluded patients with age less than 5 years, uncontrolled diabetes mellitus, major vascular disease and sever osteomyelitis.

Written informed consent was obtained from all participants and the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Initial assessment was carried out including history taking, thorough general and local examination. Evaluation of sensation, movement and vascularity was done.

**Surgical approach:** Size of the defect was measured, and the donor site was mapped for audible Doppler signals that were pulsatile, loud, and high pitched, and could be consistently relocated by removal and replacement of the probe. We used an 8 MHz Doppler device for perforator detection. The dominant cutaneous vessels with the most prominent Doppler signals were selected as the preferred supply for the flap and marked with large dots.

Less prominent signals were marked with smaller dots. The direction of the course of the artery can sometimes be determined by sliding the probe away from the dominant point of the signal for a few centimeters in multiple directions around it (following a hub-and-spoke pattern). Another useful technique is to remove the probe and replace it in an

angulated position, with respect to the skin surface, at several points around the dominant signal using varying pressures to indent the skin at each location; this aids one in visualizing the position of the vessel entering the chosen skin territory.

#### **Tourniquet application:**

If possible, a pneumatic tourniquet was applied to the upper arm; the limb was partially exsanguinated. Partially exsanguinated tourniquet helps identification of the perforators. The tourniquet was inflated up to 100 mmHg above the systolic blood pressure.

#### **Flap planning and designing:**

Designing of the flap may occur just before the operation starts or during the operation after preparing the recipient site. During planning and designing the flap, we put in consideration plan B which includes a backup flap and a backup vessel whenever possible or even redesigning the flap according to findings. For example, if a more reliable vessel is found during dissection and not mapped with Doppler, one can easily shift the skin island over that vessel instead. Also, one can rotate the skin island with respect to the direction of the pedicle if this may facilitate flap insertion or shift the design if a longer pedicle can be achieved by a new position.

**Flap dissection:**After designing the flap and backups, a non-committal exploratory incision is made sharing in the desired flap and the backup one. The perforators are identified, and reliable perforator is chosen. The distance of the perforator to the distal edge of the defect is measured and the width of the defect is noted and marked on either side of the perforator. The dissection is performed with scissors under loupe magnification with good hemostasis to aid visualization of small vessels and preservation of any cutaneous nerves if possible. The remaining side of the freestyle flap can be incised in any shape required once the pedicle has been dissected. The flap is then harvested and islanded on the perforator. All fibrous septa were dissected to prevent compression on the perforator after rotation. A lignocaine soaked small piece of gauze is kept over the perforator and betweenwhiles is irrigated by lignocaine solution to prevent drying and spasm of the perforator. Once the flap is islanded, the tourniquet is released, and the flap is permitted to perfuse for a while before rotation. Whenever possible, a subcutaneous vein is kept at the base of the flap. It is possible to anastomose this vein to a local vein to help venous drainage if sever venous congestion occurred. Caution is used carefully as and

when needed away from the perforator to achieve absolute hemostasis.

**Flap in-setting:**The flap is then rotated under visual inspection to determine direction of rotation to insure least degree of torsion on the perforator in case of 180-degree rotation. The initial sutures are taken along the sides of the perforator to prevent traction to it followed by remaining sutures. The donor site is then closed primarily, or skin graft may be needed. Whenever possible, one should design the flap in an area with adequate laxity for primary closure.

**Post-operative care and follow up**

Splintage and strict limb elevation is maintained for a period of 10 days. Arm sling is generally avoided for the initial couple of days. If they are applied, they are applied in a fashion that does not cause compression over the perforator. Crepe bandage is initiated on day 7. Sutures are removed on 10-12th day.

Patients were seen every 4 hours in first 48 hours for early detection of complications such as flap venous congestion and ischemia, every week in the first month and every 2 weeks during the second and third months.

In each visit patients were evaluated for wound healing, flap sensory function as pain, paresthesia or anesthesia; and range of motion of underlying joints. Early movement is advised to avoid stiffness of underlying joints and physiotherapy as and where necessary is initiated.

Patients' satisfaction towards function restoration and aesthetic appearance was measured. Regarding function restoration, total function restoration= 10, partial function restoration= from 6 to 9 and poor function restoration =5. So, 10 points for full function restoration and 5 for poor function restoration. While aesthetic appearance was evaluated for color match: from 1 to 3, texture: from 1 to 3, thickness: from 1 to 2 and donor site closure: from 1 to 2. So, 10 points for full aesthetic satisfaction, and 4 for poor satisfaction.

**Preoperative and postoperative photography had done for all patients after obtaining their consents:**

Case 1 presentation (Figures 1 & 2): A 11 years old boy presented with post traumatic

contracture scar over left cubital fossa 1 year ago, the scar was excised with contracture release and the defect was covered by freestyle skin flap from the lateral side of the same arm. Case 2 presentation (Figure 3): A 16 years old male presented with post traumatic contracture scar over dorsum of right little finger. The scar was excised with contracture release and the defect was covered by freestyle skin flap from dorsum of the same hand **Statistical analysis** Data were checked, entered and analyzed using SPSS 20, software for Windows. Data were expressed as number and percentage for qualitative variables and mean + standard deviation (SD) for quantitative one. The significance level was set at P < 0.05. T-test was used for quantitative data, and chi-square test.

**RESULTS**

In this study, we included 12 patients with upper limb defect managed by freestyle perforator flap. Table (1) shows that the age group containing the largest number of patients was age group from 46 years old to 65 years old '50%', where males and females patients represent 50% of their totals. Also, males represent the majority of the patients '8', which means 66.7% of all patients. Table (2) shows that the cause was contracture scar release in 50% of our cases, in which 2/3 of them adhesions were associated complication while 25% of our cases were because of malignancy with no deep infiltration and the remaining 25% of the cases trauma caused them. Table (3) shows the relation between flap size and closure of the donor site where total flap sizes ranged from 2cm x 3cm (about 6cm<sup>2</sup>) to 8cm x 12cm (about 96cm<sup>2</sup>) with mean size 28.6 cm<sup>2</sup>, 7 cases (58.3%) needed skin graft to close the donor site while 5 cases (41.7%) the donor site was closed primary.Regarding complications, distal partial necrosis occurred in 2 cases (16.7%) also flap congestion occurred in 2 cases (16.7%) but resolved within 1 week with limb elevation. Unfortunately, one case with traumatic soft tissue defect underwent flap loss. Bone fracture was associated, and we think that the perforator might be included in zone of trauma.Table (4) shows that patients' satisfaction to results was great in malignancy cases, less in contracture scar release, and least in traumatic cases.

**Table (1) :Age & sex distribution among studied group**

Age groups by years	Male		Female		All cases	
	No.	%	No.	%	No.	%
5-15	2	16.7%	1	8.3%	3	25%
16-30	1	8.4%	1	8.3%	2	16.7%
31-45	1	8.3%	0	0%	1	8.3%

Age groups by years	Male		Female		All cases	
	No.	%	No.	%	No.	%
46-65	4	33.3%	2	16.7%	6	50%
Total	8	66.7%	4	33.3%	12	100%

**Table (2) :**Distribution of causes, sites of the defects, associated complications.

		Causes							Total				
		Traumatic			Contracture release			scar		Malignancy			
		site	N	%	Site	N	%	site	N	%			
		-Hand	3	25%	-Hand	4	33.3%	-Dorsum of the hand	2	16.7%			
					-Cubital fossa	2	16.7%	-Palmer aspect of the thumb	1	8.3%			
							6	50%		3	25%	N=12	100%
Associated complications with the cause	Yes	Bone fractures	1	8.3%	Adhesions	4	33.3%	Deep infiltration	0	0%	N=5	41.7%	100%
	NO		2	16.7%		2	16.7%		3	25%	N=7	58.3%	

**Table (3):** Showing the relation between flap size and closure of the donor site.

Flap dimensions In cm (2 dimensions)	Donor site repair			
	Primary closure		Skin grafting	
	N	%	N	%
2 x 3	2	40%	0	0%
2 x 5	2	40%	0	0%
3 x 4	1	20%	1	14.3%
4 x 4	0	0%	1	14.3%
5 x 7	0	0%	3	42.8%
7 x 10	0	0%	1	14.3%
8 x 12	0	0%	1	14.3%
Total	5	100%	7	100%

**Table (4) :**Relation between patient satisfaction towards the outcome and the cause.

Cause	Cases	Function		aesthetic		Total Overall %
		From 10	%	From 10	%	
Traumatic	Case 1	10	80%	6	60%	70%
	Case 2	9		7		
	Case 3	5		5		
Contracture scar release	Case 1	10	86.7%	7	61.7%	74.2%
	Case 2	10		8		
	Case 3	9		6		

satisfaction Cause	Cases	Function		aesthetic		Total Overall %
		From 10	%	From 10	%	
Malignancy	Case 4	8	93.3%	6	93.3%	93.3%
	Case 5	8		5		
	Case 6	7		5		
	Case 1	10	10	93.3%	93.3%	
	Case 2	10	10			
	Case 3	8	8			

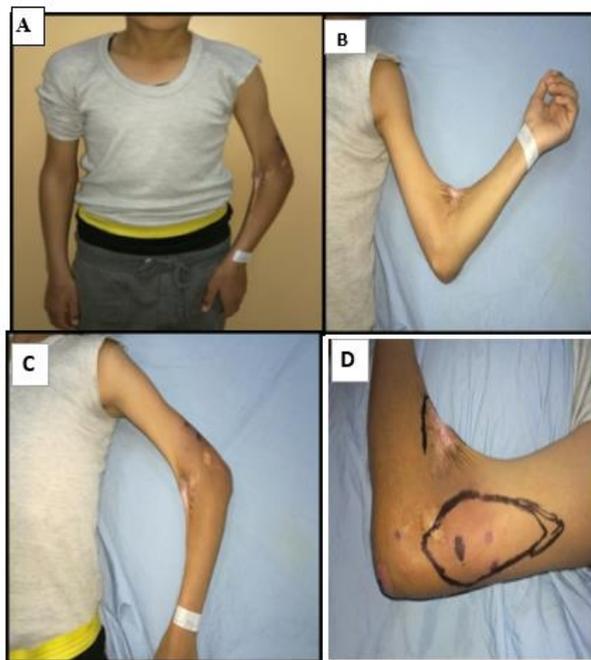


Figure 1: (A, B & C) preoperative with limitation of extension of the left elbow, (D) Marking of dominant perforator



Figure 2: (A) scar excision. (B, C & D) Flap elevation. (E) Flap inseting and coverage of donor site with skin graft



Figure 3: (A) Marking, (B) & (C) Scar excision and elevation of the flap, (D) Flap inseting, coverage of donor site by skin graft and insertion of K-wire. (E) late post operative

### DISCUSSION

Reconstruction of soft tissue defects in the upper limb is a big challenge presented to surgeons after trauma, tumor resection, contracture scar release,

burns and infection. The quality of the reconstruction has an important effect on the patient's aesthetic and functional outcome. Skin grafting, local flaps,

regional flaps and free flaps are options for soft tissue reconstruction in the upper extremity [5].

The preferred option is the simplest one which can provide the most stable coverage. The mechanism, time, location and extent of soft tissue injury, nature of the structure exposed, severity of contamination, and expected outcomes of spontaneous healing of the defect will determine options for soft tissue reconstruction used in the upper limb [5].

Advances in anatomical knowledge, progress in surgical instruments and available devices, and innovative surgical techniques have enhanced soft tissue reconstruction. Constant improvement in design and harvesting techniques has led to flap refinements resulting in considerably more appealing aesthetic results in soft tissue reconstruction [6].

In this study, 12 patients with upper limb soft tissue defects were enrolled and managed by using freestyle skin flap for reconstruction. 8 of them were males (67%). The age group varied from 6 to 65 years old with mean age of 33 years old, which get close to the age group of **Mateev and Kuokkanen** [7] and ranged from 8 to 64 years old with mean age 28 years old and the age group of **Panase and Sahasrabudhe** [8] which varied from 9 years to 51 years with the average age of 34 years.

50% of the cases had soft tissue defect after contracture scar release, while 25% were due to traumatic cause and the remaining 25% were post malignancy resection. These percentages of causes are nearly like **Mateev and Kuokkanen** [7], where 43% were traumatic, 43% were post burn contracture release and 14% were post malignancy resection, while the cause in **Gunnarsson et al.** [1] was malignancy in 72.7% of the upper limb cases.

In this study, flap dimensions ranged from 6 - 96 cm<sup>2</sup>. This figure resembles **Gunnarsson et al.**, where dimensions of upper limb flaps ranged from 12 - 122 cm<sup>2</sup> [1]. But the donor sites in our study closed directly in 41.7% of cases and the remaining needed skin graft, while with **Gunnarsson et al.**, the donor sites were closed directly [1]. This may be explained by presences of many differences between patients and defects in both studies. Elderly patients have more lax skin that may help primary closure of the donor site. Age of the patients with defects in upper limb in **Gunnarsson et al.** [1] ranged from 53 to 83 years old, which might favor more lax skin for primary closure. While in our study the age group varied from 6 to 65 years old and patients have less lax skin, so we used skin graft for coverage of the donor site in some patients.

Regarding complications, we had no complications in 58.3% of our cases, while minor complications like flap congestion and distal partial necrosis occurred in 33.4% which were resolved within 1 week. Unfortunately, we experienced 1 flap loss (8.3%) which managed later by debridement of necrotic tissue and skin grafting the remaining soft tissue. We think

This figure resembles complications occurred with **Panase and Sahasrabudhe** where failure rate was 12-13% [8]. While **Gunnarsson et al.** did not experience any total flap loss or major complications; however, minor complications occurred in 3 cases (27.2%) of the upper limb [1]. Most of our complications were in the early part of the series indicative of a learning curve associated with the use of this flap.

In general, patients' satisfaction was great in malignant cases, good in contracture scar release and fair in traumatic cases.

In view of the published data, it's can be said, that the results were within the acceptable figures.

#### CONCLUSION

Using freestyle skin flap in closure of defects in upper limb presents a simple method of complex reconstruction with less morbidity, excellent function restoration and acceptable aesthetic outcome specially when the defect is small or medium sized and donor site is closed primarily.

This flap is hardly suitable for coverage of large defects on upper limb.

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