

Free Anterolateral Thigh Flap for Traumatic Soft Tissue Defects of Distal Third Leg and Foot. Comparative Study between Subfascial and Suprafascial Dissection

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Received: 22 October 2019

Accepted: 24 October 2021

Abstract

Background: Lower extremity injuries requiring soft tissue coverage comprises a significant proportion of these injuries. The advantage of free tissue transfer has provided multiple options for complex defects of the lower extremities that maintain the functional and aesthetic status of the limb. Since the first report of the ALT flap in 1984, it has become one of the most commonly used flaps for the reconstruction of various soft tissue defects because it has long vascular pedicle, suitable vessel diameter with acceptable donor site morbidity. **Participants and Methods:** A prospective study was carried out on 25 patients with clinical diagnosis of complex soft tissue defects in distal third leg and foot; Patients were divided into two groups who underwent Fasciocutaneous and Cutaneous ALT, to compare between both groups in many aspects including complication rates, aesthetic and functional outcomes of donor and recipient sites. **Results:** As regard recipient site complications including congestion and partial flap necrosis were higher in group I. There were significant differences between both groups as regard donor site functional outcome including sensory disturbance and cold intolerance were higher in group I. Flap bulkiness was significantly higher in group I. **Conclusion:** In our experience, we found that the ALT free flap offers an excellent option for reconstruction of complex soft tissue defects in the lower extremities with perfect functional and aesthetic results that achieved through elevating Cutaneous ALT flap to avoid sensory disturbance of the donor site and secondary surgical debulking after Fasciocutaneous ALT flap.

Introduction

Trauma is one of the main causes of preventable death and one of the main mechanisms of complex wound formation affecting young adults and a large part of the economically active population ⁽¹⁾. The goal of lower extremity reconstruction is the coverage of defects with open wounds of the leg and foot to give patients a healed wound and to let them resume their life, ambulate, and go back to work while preventing amputation ⁽²⁾.

A soft-tissue defect of the lower extremity that exposes underlying bones, joints, tendons and neurovascular bundle pose challenge for reconstructive surgeon because of poor wound healing, unreliability of local cutaneous or myocutaneous flap as it has disadvantage of limiting mobility and local muscles may be crushed ⁽³⁾. So, these defects generally require a free tissue transfer for a successful reconstruction ⁽⁴⁾.

Reconstruction of the lower extremity with a free tissue transfer has been accepted as a standard procedure since the 1980s ⁽⁵⁾.

Free ALT flap is a sort of perforator flap that was first described in 1984, which offers a variety of tissues available from a single donor site as an excellent option for

reconstruction of large and complex soft tissue defects in the lower extremities with perfect functional and aesthetic results ⁽⁶⁾. The anatomical and logistical features of the ALT free flap make it the flap of choice or the workhorse in a wide range of soft tissue reconstructive situations "The Four Seasons Flap"⁽⁷⁾.

The unique anatomy of the thigh permits several methods of harvesting the ALT flap. The types of tissue to be included in the flap can be selected according to the defect to be reconstructed. The ALT flap can be harvested at the suprafascial level to include just skin and subcutaneous fat, which is useful when a thin flap is desired ⁽⁸⁾, but when harvested at the subfascial level, the flap can bring additional tissue bulk including the fascia lata on the deep surface. The fascia is particularly useful in several situations, such as when repairing tendon defects ⁽⁹⁾.

Patients and methods

A prospective study was carried out in the Plastic & Reconstructive Surgery Unit, General Surgery department, Faculty of Medicine, Benha University, in corporation with Plastic & Reconstructive Surgery

department, Faculty of Medicine, Al Azhar University.

This study included a total of 25 patients with a clinical diagnosis of traumatic complex soft tissue defects of distal third leg or foot and have been reconstructed with free ALT flap either Fasciocutaneous (Subfascial dissection) (group I) or Cutaneous (Suprafascial dissection) (group II). Enrollment of eligible patients began from May 2017 to May 2019. Follow up was done for 6 months.

The participants who agreed to share in this clinical study were given informed consent after being fully informed about the technique and its circumstances. The study was conducted after approval of the Committee of Ethics in Faculty of Medicine, Benha University.

The aim of this work is to compare between Subfascial & Suprafascial dissection of Free Anterolateral Thigh flap used for

reconstruction of traumatic soft tissue defects of distal third leg and foot in many aspects including patient demographics, donor site morbidities, complication rates, flap outcomes, hospitalization period, and patient satisfaction.

The ages of the studied groups varied from 13 to 49 years. There were 21 males and 4 females .There were no significant differences between both groups as regard age, gender, smoking and DM. P values were 0.531, 0.626, 1.0 and 0.543 respectively (**Table 1**).

Inclusion criteria are:

Clean wounds with healthy fractured bones or intact tibial, tarsal or metatarsal bones.

Exclusion criteria are:

Infected wounds until it become clean. Disruption of the vascular system of the lower limb (Grade IIIC). Uncontrolled chronic ill patients.

Table (1): Demographic data and Comorbidities

		Group I (n = 15)	Group II (n = 10)	P value
Age (years)	Mean \pm SD	31 \pm 11	28 \pm 10	0.531
Gender	Male n (%)	12 (80.0)	9 (90.0)	0.626
	Female n (%)	3 (20.0)	1 (10.0)	
Smoking	Yes n (%)	3 (20.0)	2 (20.0)	1.0
Diabetes mellitus	Yes n (%)	1 (6.7)	2 (20.0)	0.543

Mann Whitney U test was used for age. Fisher's exact test was used for categorical data
DM = Diabetes mellitus

Statistical Design:

Data management and statistical analysis were done using SPSS vs.25. Numerical data was summarized as means and standard deviations. Categorical data was summarized as numbers and percentages. Comparisons between two groups were done using Mann Whitney U test for numerical data. Categorical data was compared using Chi-square test or Fisher's exact test if appropriate. All P values were two sided. P values less than 0.05 were considered significant.

Results

❖ **Soft tissue defect Characteristics**

All patients (100.0%) showed post traumatic etiology. There were no significant difference between both groups as regard site and size. P values were 0.81 and 0.428 respectively (**Table 2**).

❖ **Operative data**

Operative duration was significantly higher in group II (408 min) compared to group I (348 min). P value was 0.019 (**Table 3**).

❖ **Donor site complications**

There were no significant differences between both groups as regard donor site complications including hematoma, wound infection, wound dehiscence and graft failure (**Table 4**).

❖ **Recipient site complications**

There were no significant differences between both groups as regard recipient site complications including total flap necrosis, infection and hematoma, but congestion and partial flap necrosis were higher in group I (13.3%) for each compared to group II (0%) (**Table 5**).

❖ **Donor site functional outcome**

There were significant differences between both groups as regard donor site functional outcome including sensory disturbance and cold intolerance were higher in group I than group II. But there was no significant differences in gait alteration (**Table 6**).

❖ **Donor site aesthetic outcome**

There were significant differences between both groups as regard Contour defect which was significantly higher in group I (20%) compared to group II (0%). There were no significant differences between both groups as regard donor site aesthetic outcome including hypertrophic scarring, keloid & hypo/hyper pigmentation (**Table7**).

❖ **Recipient site aesthetic outcome**

There were significant differences between both groups as regard flap bulkiness which was significantly higher in group I (40%) compared to group II (0%). There were no significant differences between both groups

as regard other recipient site aesthetic outcome including flap sagging, color mismatch and hair growth (**Table 8**).

There were no significant differences between both groups as regard wound healing and hospital stay (**Table 10**).

❖ **Duration of wound healing and hospital stay**

Patient satisfaction

There was no significant difference between both groups as regard patient satisfaction (**Table 9**).

Table (2) Characteristics of soft tissue defect

			Group I (n = 15)	Group II (n = 10)	P value
Etiology	Post traumatic	n (%)	15 (100.0)	10 (100.0)	-
Site	Distal third leg	n (%)	4 (26.7)	3 (30.0)	0.81
	Distal third leg &Foot	n (%)	1 (6.7)	0 (0.0)	
	Entire leg	n (%)	2 (13.3)	0 (0.0)	
	Foot	n (%)	8 (53.3)	7 (70.0)	
Size (cm²)	Mean ±SD		230 ;Ó124	182 (87)	0.428

Table (3) Operative data in both groups

			Group I (n = 15)	Group II (n = 10)	P value
Reconstruction time	Early	n (%)	2 (13.3)	0 (0.0)	0.5
	Late	n (%)	13 (86.7)	10 (100)	
Operative duration (min)	Mean ;ÓSD		348 ;Ó61	408 ;Ó47	0.019
Donor site closure	Direct	n (%)	6 (40.0)	6 (60.0)	0.327
	STSG	n (%)	9 (60.0)	4 (40.0)	

Table (4) Distribution of donor site complications in both groups

			Group I (n = 15)	Group II (n = 10)	P value
Hematoma	Yes	n (%)	2 (13.3)	0 (0.0)	0.5
Wound infection	Yes	n (%)	2 (13.3)	1 (10.0)	1.0
Wound dehiscence	Yes	n (%)	1 (6.7)	1 (10.0)	1.0
Graft failure	Yes	n (%)	1 (6.7)	0 (0.0)	1.0

Table (5) Distribution of recipient site complications in both groups

			Group I (n = 15)	Group II (n = 10)	P value
Total flap necrosis	Yes	n (%)	1 (6.7)	1 (10.0)	1.0
Partial flap necrosis	Yes	n (%)	2 (13.3)	0 (0.0)	0.5
Hematoma	Yes	n (%)	1 (6.7)	0 (0.0)	1.0
Congestion	Yes	n (%)	2 (13.3)	0 (0.0)	0.5
Infection	Yes	n (%)	1 (6.7)	1 (10.0)	1.0

Table (6) Donor site functional outcome in both groups

			Group I (n = 15)	Group II (n = 10)	P value
Gait alteration	Yes	n (%)	2 (13.3)	1 (10.0)	1.0
Sensory disturbance	Yes	n (%)	3 (20.0)	0 (0.0)	0.25
Cold intolerance	Yes	n (%)	4 (26.7)	1 (10.0)	0.615

Table (7) Donor site aesthetic outcome in both groups

			Group I (n = 15)	Group II (n = 10)	P value
Hypertrophic scarring	Yes	n (%)	1 (6.7)	1 (10.0)	1.0
Keloid formation	Yes	n (%)	1 (6.7)	0 (0.0)	1.0
Hypo/hyper pigmentation	Yes	n (%)	2 (13.3)	2 (20.0)	1.0
Contour defect	Yes	n (%)	3 (20.0)	0 (0.0)	0.250

Table (8) Recipient site aesthetic outcome in both groups

			Group I (n = 15)	Group II (n = 10)	P value
Flap sagging	Yes	n (%)	0 (0.0)	0 (0.0)	-
Color mismatch	Yes	n (%)	1 (6.7)	1 (10.0)	1.0
Hair growth	Yes	n (%)	1 (6.7)	1 (10.0)	1.0
Flap bulkiness	Yes	n (%)	6 (40.0)	0 (0.0)	0.051

Table (9) Patient satisfaction on both groups

			Group I (n = 15)	Group II (n = 10)	P value
Patient satisfaction	Dissatisfied	n (%)	2 (13.3)	1 (10.0)	1.0
	Satisfied	n (%)	3 (20.0)	2 (20.0)	
	Very satisfied	n (%)	10 (66.7)	7 (70.0)	

Table (10) Duration of wound healing and hospital stay in both groups

			Group I (n = 15)	Group II (n = 10)	P value
Duration of wound healing (days)			16 ±4	15 ±5	0.397
Duration of hospital stay (days)			16 ±4	15 ±5	0.397

Discussion

The characteristics of an ideal soft tissue free flap donor for distal third leg and foot reconstruction might be described as having

a large skin territory, good color and texture match with the recipient site, a long and large caliber vascular pedicle, reliability for

different flap designs, constant pedicle anatomy, acceptable donor-site morbidity, suitability for sensate reconstruction, feasibility for a two-team approach, no requirement for major artery or muscle sacrifice, applicability as a flow-through flap and suitability for usage as a thin flap ⁽¹⁰⁾.

The ALT flap provides a wealth of tissues (i.e., skin, subcutaneous tissue, fascia, muscle, nerve) that can be tailored to reconstruct a wide variety of defects. Taken as a perforator skin flap, ALT leaves the muscle essentially intact and thus minimizes donor site morbidity. If muscle is needed for the reconstruction, a smaller cuff of Vastus lateralis muscle tailored to the defect may be harvested, rather than the whole functional unit. In addition, the color and texture of the ALT is optimal for lower extremity reconstruction, compared to the use of this flap for head and neck reconstruction, and the color match of skin flaps is much better compared with muscle flaps with skin grafts ⁽¹¹⁾.

The long vascular pedicle of the ALT flap ensures flap viability in the traumatic foot by allowing for microvascular anastomosis to a healthy recipient vessel located sufficiently far away from the zone of injury ⁽¹²⁾.

In our study trauma was the main cause of complex soft tissue defects in the lower limb (25 cases, 100%), (1 cases of them) was secondary to excision of unstable ulcer post old trauma and another case after excision of Marjolin ulcer post old trauma. The same finding was reported in another study at 2017, they found that trauma "especially road traffic accident" was responsible for 94% of lower leg defects ⁽¹³⁾.

In our study the size of the flap ranged from 50cm² up to 420cm² (mean 230 cm²) in group I, while in group II ranged from 99cm² up to 390cm² (mean 182cm²). Recent study at 2017, described success with ALT free flaps of up to 35cm ×15cm (525 cm²) ⁽¹²⁾.

In our study the mean operative time was (348 minutes) in group I, while (408 minutes) in group II. Also study at 2006, reported nearby results 105-480minute (mean 270) for free flaps ⁽¹⁴⁾.

According to a study made at 2010, which included 23 patients who have made free ALT for distal leg and foot reconstruction, the rate of complete flap survival was 78.3% with four total and one partial flap loss. The cause of total failures, as identified during re-explorations, was inadvertent injury to the perforator vein during dissection in one

patient, flap infection in the early postoperative period in a patient with Gustillo grade IIIC injury, and arterial thrombosis in two old patients with long-lasting diabetes. Final reconstructions were completed with VAC therapy followed by skin grafting in these patients. Two flaps were re-explored for hematoma evacuation and salvaged. Four patients were treated non-surgically with antibiotic therapy for early postoperative infections. Three patients required systemic antibiotic therapy for osteomyelitis observed at the late postoperative period (later than 4 weeks following free tissue transfer). Wound dehiscence was observed in donor site of one patient. Overall complication rate was 56.5% (13 of 23 patients) ⁽¹¹⁾. But in our study there were 1 case (6.7%) in group I and one case (10%) in group II in which total flap failure has been occurred and another 2 cases (13.3%) in group I with partial flap loss; conservative management by dressing and NPWT was done for these cases then STSG. Regarding to the recipient site complications were hematoma in 1 case (6.7%) in group I, wound infection in 1 case (6.7%) in group I and 1 case (10%) in group II & venous congestion in 2 cases (13.3%) in group I. Regarding to the donor site complications were hematoma in 2 cases

(13.3%) in group I, wound infection in 2 cases (13.3%) in group I & in 1 case (10%) in group II, wound dehiscence in 1 case (6.7%) in group I & in 1 case (10%) in group II and total graft failure in 1 case (6.7%) in group I which treated later on by re-grafting.

Regarding recipient site aesthetic outcome a bulky appearance is still one of the major patient complaints after Fasciocutaneous ALT free flap reconstruction, especially when the pretibial area, ankle, or foot is affected. These regions are best treated using thin flaps that will not contract and fibrose, particularly if secondary procedures are required ⁽¹⁵⁾. In our study, the flap was bulky in 6 cases (40%) in group I.

A study made at 2017, reported the mean hospital stay after ALT free flap as most patients were discharged before 20th ⁽¹³⁾. Also another study at 2018, founded that average duration of hospital stay was 2-3 weeks ⁽¹⁶⁾, while in our study the mean duration of hospital stay in group I & II was approximately the same 16 & 15 days respectively.

Conclusion

In our experience, the Cutaneous ALT flap provides better donor and recipient site functional and aesthetic outcomes than Fasciocutaneous ALT flap with the

additional advantage of minimal donor site morbidity and a high level of patient satisfaction.

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To cite this article: Gamal I. El Habaa , Wael M. Ayad, Hussein G. Elgohary , Ayman M. Abdelmofeed, Mohamed H. Fahmy. Free Anterolateral Thigh flap for traumatic soft tissue defects of distal third leg and foot. Comparative study between Subfascial and Suprafascial dissection. *BMFJ* 2021; 38(3): 1009-1018. DOI: 10.21608/bmfj.2021.18550.1124