Evaluation of Free Tissue Transfer in The Reconstruction of Soft Tissue Defect in The Leg

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Background: There are many possible reconstructive options for reconstruction of defects in the lower limb. These include: skin grafts, local flaps, distant flaps and free flaps.
Patients and Methods: We present four cases with soft tissue defects in the legs who were admitted to the Plastic and Reconstructive Surgery Division, Cipto Mangunkusumo Hospital, Jakarta, between February 2009 and February 2010.
Result: In all four cases, the free anterolateral thigh (ALT) flaps have been performed for reconstruction of soft tissue defect in the upper third of the leg (3 patients) and lower third of the leg (1 patient). The cause of soft tissue defect was trauma in 3 patients and malignancy in 1 patient. All of the donor sites have similar size with the defect tissue with 15 to 20 cm in length and 10 to 15 cm in width. End-to-end microvascular anastomosis was performed in 2 cases while end-to-side anastomosis was done in the other 2 cases. Arterial thrombosis and infection were complications found in early post-operative period. Arterial thrombosis caused failure in 1 case of free ALT flap which were reconstructed further with free radial forearm flap.
Summary: Free ALT flap is relatively easy to harvest once the technique of perforator flap dissection has been learnt. It has a reliable blood supply despite some anatomic variability, it is pliable and can be thinned to a significant degree without compromising blood supply, and can provide a long pedicle with large-diameter vessels.
Keywords: *Free ALT flap, Soft tissue defect, Free radial forearm flap*
Latar belakang: Ada beberapa pilihan teknik rekonstruksi untuk memperbaiki defek yang berada di bagian kaki. Pilihan tersebut termasuk *skin graft, local flaps, distant flap*, dan *free flaps.*
Pasien dan Metode: Kami menyajikan empat kasus dengan tumor jaringan lunak di kaki yang dirawar di Divisi Bedah Plastik dan Rekonstruksi, Rumah Sakit Ciptomangunkusumo, Jakarta antara bulan Februari 2009 sampai Februari 2010.
Hasil: Pada semua kasus, free anterolateral thigh (ALT) telah dilakukan untuk rekonstruksi defek jaringan lunak di sepertiga atas kaki (3 pasien) dan sepertiga bawah kaki (1 pasien). Penyebab defek jaringan lunak yaitu adanya trauma pada 3 pasien dan keganasan pada 1 pasien. Semua lokasi donor mempunyai ukuran yang sama dengan defek jaringan lunak dengan panjang 15 - 20 cm dan lebar 10 - 15 cm. Anastomosis mikrovaskular tipe *end-to-end* dilakukan pada 2 kasus dan anastomosis tipe *end-to-side* dilakukan pada 2 kasus lannya. Komplikasi berupa trombosis arterial dan infeksi ditemukan pada periode awal postoperatif. Trombosis arterial menyebabkan kegagalan dalam 1 kasus dari *free ALT flap* yang direkonstruksi lebih jauh dengan *free radial forearm flap.*
Ringkasan: *Free ALT flap* adalah flap yang relatif mudah untuk dilakukan begitu teknik diseksi flap perforator dikuasai. Flap tersebut memiliki suplai pembuluh darah yang cukup disamping adanya beberapa variabilitas anatomi. *Free ALT flap* sangat mudah beradaptasi, dan dapat di rampingkan ke ukuran tertentu tanpa menggangu suplai darah, dan dapat menyediakan *pedicle* yang panjang dengan pembuluh darah berdiameter besar.
Kata Kunci*: Free ALT flap, Soft tissue defect, Free radial forearm flap*

There are many possible reconstructive options which are developed or modified for reconstruction of defects in the lower limb. These include: skin grafts, local flaps, distant flaps and free flaps [1,2]. For the most part, the simplest and least technically-demanding method likely to be successful should be chosen. Plastic surgeons find certain flaps particularly useful for specific lower extremity defects. If the leg is divided

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topographically into thirds, these common alternatives are upper third, middle third and lower third of the leg. [3]

Local fasciocutaneous or muscle flaps are useful to cover small to moderate defects of bone or to cover exposed vessels or tendons. It is generally accepted that local flaps can cover defects of the proximal or middle third of the leg [4], under some circumstances free tissue transfer may be indicated when treating patients with lower extremity wounds. The numerous advantages include stable wound coverage, improve aesthetic and functional outcomes, and minimal donor site morbidity.

PATIENT AND METHODS

We present 4 cases with soft tissue defects in the legs. All patients were admitted to our division during February 2009 to February 2010. All patients were subjected to thorough clinical examination and appropriate laboratory and radiological investigations.

The flap design, elevation and operative techniques are described as follows. The line between the anterior superior iliac spine and the lateral border of the patella is drawn on the donor thigh and the mid point of this line is marked. Two centimeters above this point is usually the exit point of the cutaneous perforator. The transparent pattern of the recipient defect is placed on the donor site with the site of donor perforator in the center of the flap. The medial margin of the flap is incised first down to the deep fascia and epimysium of the rectus femoris muscle. The edges of the deep fascia and epimysium are secured to the subdermal tissue. The flap is then undermined and raised laterally towards the intermuscular septum between the rectus femoris and the vastus lateralis muscles. The descending branch of the lateral circumflex femoral artery (LCFA) and its septocutaneous perforator, or the beginning of the musculocutaneous perforator may be seen in the intermuscular space. After locating and mobilizing the vascular pedicle and the cutaneous perforator, the other three margins of the flap were incised. Superiorly, care is taken not to injure the lateral cutaneous nerve of the thigh, which lies above the deep fascia and emerges anterior to the anterior superior iliac spine, this nerve can be later anastomosed with a cutaneous nerve at the recipient site, if neurosensory flap is required.

Preoperatively, the Allen's test was performed to ascertain that the whole hand could be nourished by one ulnar artery, and thus the radial artery would be expendable. The required size and shape of the flap, measured from the pattern of the defect, were mapped out on the flexor or radiodorsal surface of the forearm such that all proposed flap amply overlay these vessels with proper orientation to simplify any microvascular anastomoses at the recipient site.

Distal flap had an advantage of being thinner than proximal flap, particularly noticeable in female patients. The disadvantage of distal flap had been the difficulty of retaining a donor defect with intact paratenon suitable for skin grafting procedure. The upper arm tourniquet was properly inflated following incomplete exsanguination. Thus, capillary bleeding of the remaining blood seen during dissection could be completely and atraumatically coagulated by a bipolar diathermy to prevent post-operative hematoma. The flap elevation began on the ulnar side where the thicker deep forearm fascia was more easily identifiable. The plane of dissection was kept just deep to the fascia and a fasciocutaneous flap carefully developed to preserve the lateral intermuscular septum and its perforators from the radial vessels, and also to isolate and preserve the superficial veins as required. The cephalic vein and the superficial nerve were dissected into the deltoid and upper arm respectively to obtain greater length. Elevation of the flap subfascially exposed muscle proximally and tendons with paratenon intact distally for skin graft. The palmaris longus (PL) tendon which lay within a condensation of the deep fascia was freed or included as required; if it was freed, taking care to preserve its paratendon.

RESULT

The free ALT flaps have been performed in 4 patients for reconstruction of soft tissue defect in the upper third of the leg (3 patients) and the lower third of the leg (1 patient). The cause of soft tissue defect was trauma in 3 patients and malignancy in 1 patient with varied size from 13 to 20 cm in length and 8 to 15 cm in width (Table 1). Each defect has bone as wound base . In these cases the type of flaps were fasciocutaneous (M2,M3,F1) and musculocutaneous (M1). In the musculocutaneous type; fasciocutaneous tissue was ultimately used because of arterial thrombosis. All of donor sites have similar size with the defect tissue ranging from 15 to 20 cm in length and 10 to 15 cm in width. Closure of donor sites were performed primarily (M2) with skin graft (M1,M3,F1) (Table 2). The diameter of arteries in the flaps varied from 1.5 to 2 mm and length of the vascular pedicle was 13-15 cm. The pedicle arteries were always accompanied by two veins; the diameter of the veins varied from 1 to 1.2 mm. Microvascular anastomosis was performed in end-to-end fashion in 2 cases (M2 and M3) while end-to-side anastomosis was done in 2 cases (M1 and F1) (Table 3). Early postoperative complication was arterial thrombosis (M1 and M3) which required reexploration. The early complication of arterial thrombosis caused failure of the flap in M3 which was further reconstructed with free radial forearm flap (fasciocutaneous type) and the donor site has length of 16 cm and width of 11 cm. We used radial artery as vascular pedicle with 10 cm in length and diameter of 2 mm. It was accompanied by 1 commitant vein. The recipient vessels were descending genicular artery and popliteal vein. Microvascular anastomosis was performed end-to-end. Klebsiella infection was found in this case but overall the final result of the flap was vital. The M1, M2, and M3 patients are described in Figures 1-3.

Table 1. Soft tissue defect

Patient	Site	Etiology	Size (cm)	Wound base
M/1	Upper third of the leg	Malignant tumour	18 x 13	Bone & Plate
M/2	Upper third of the leg	Trauma	13 x 8	Bone & Plate
M/3	Upper third of the leg	Trauma	20 x 15	Bone
F/1	Lower third of the leg	Trauma	16 x 13	Bone

Table 2. Donor site of Free Antero Lateral Thigh Flap

Patient	Type	Size (cm)	Treatment of Donor Site
M/1	Musculocutaneous	20 x 10	Skin graft
M/2	Fasciocutaneous	15 x 10	Close Primerly
M/3	Fasciocutaneus	20 x 15	Skin graft
F/1	Fasciocutaneus	19 x 16	Skin graft

Table 3. Types of Microvascular Anastomosis

Patient	Donor vessel			Recipient Vessel	Type of Microanastomosis	Ischaemic Time (minute)
	Vessel	Length (cm)	Diameter (mm)			
M/1	LCFA descending branch	15	2	a. poplitea	ETS	60
	v.comitantes	15	1	v.comitantes	ETE	
	v.comitantes	15	1	v.comitantes	ETE	
M/2	LCFA descending branch	15	1,5	a.descending genicular	ETE	75
	v.comitantes	15	1,2	v.comitantes	ETE	
	v.comitantes	15	1,2	v.comitantes	ETE	
M/3	LCFA descending branch	13	1,5	LCFA descending branch	ETE	60
	v.comitantes	13	1	v.comitantes	ETE	
	v.comitantes	13	1	v.comitantes	ETE	
F/1	LCFA descending branch	10	1,5	a.dorsalis pedis	ETS	45
	v.comitantes	10	1	v.comitantes	ETE	

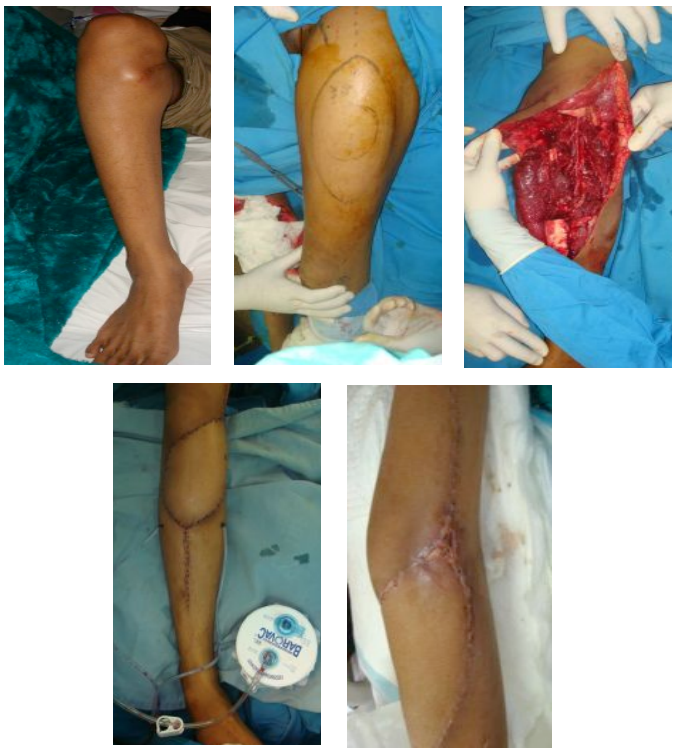

Figure 1.. Male 19 years old with malignant tumor in upper third of the leg (M1). (*Above, left*) Preoperative malignant tumor upper third of the leg. (*Above, centre*) Intra operative of the soft tissue defect. (*Above, right*) Diagram illustrating the design of the ALT flap. (*Below, left*) Recipient site with free ALT flap. (*Below, right*) Post operative defect upper third of the leg after reconstruction with free ALT flap.

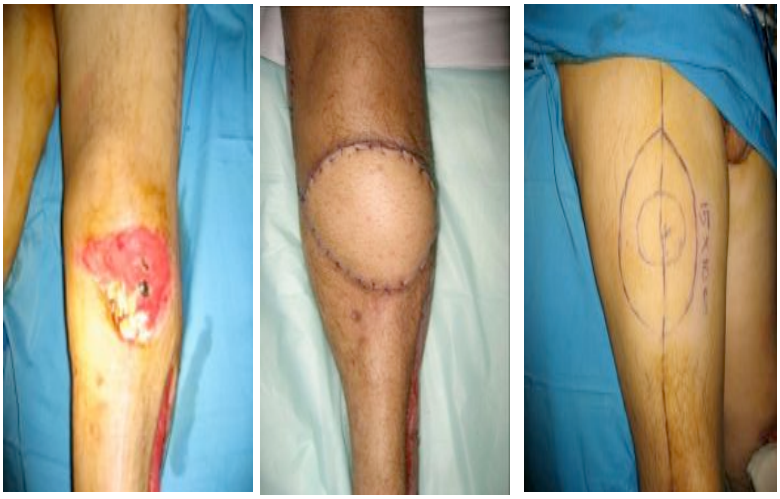

Figure 2. Male 28 years old with defect in upper third of the leg (M2). (*left*) Post traumatic soft tissue defect of upper third of the leg. (*center*) Post operative defect upper third of the leg after reconstruction. (*right*) Diagram illustrating the design of the ALT flap.

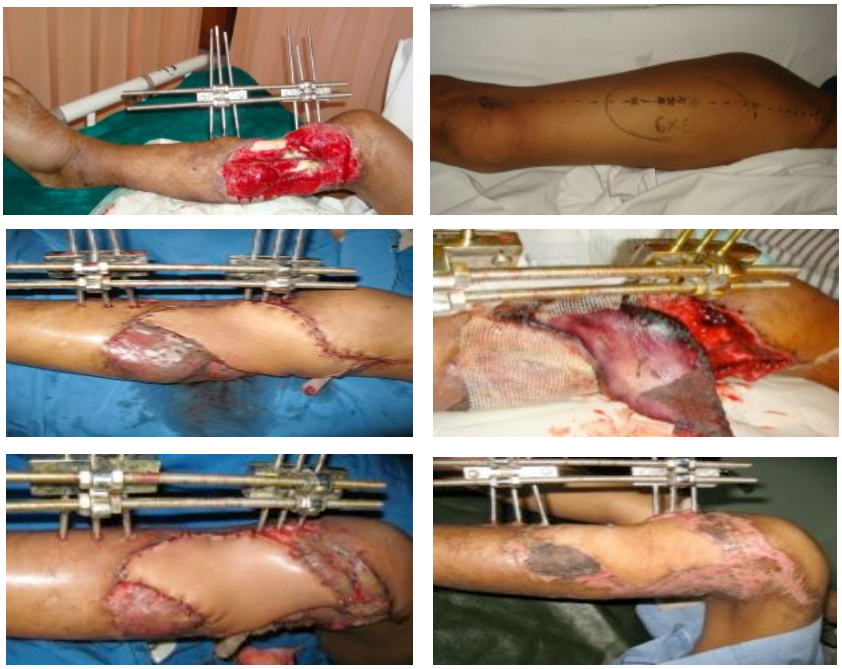

Figure 3. Male 19 years old with defect in upper third of the leg (M3). (*Above, left*) Soft tissue defect upper third of the leg. (*Above, right*) Diagram illustrating the design of the ALT flap. (*Centre, left*) Recipient site with Free ALT Flap. (*Centre, right*) failed free ALT flap. (*Below, left*) Recipient site with free radial forearm flap. (*Below, right*) Post operative defect upper third of the leg after reconstruction with free radial forearm flap.

DISCUSSION

In this serial cases leg defect was caused by trauma (3 cases) and malignancy (1 case). Reconstruction of soft tissue defect was performed using free ALT flap. The smallest defect was 13 x 18 cm while the largest one was 20 x 15 cm in diameter. In this case the largest flap was 20 x 15 cm. Zhou et al [13]. had transferred 32 Free ALT Flap for reconstruction of multiple soft tissue defects and the largest flap was 15 x 10 cm, whereas the largest flap in Koshima et al [14]. series was 25 x 18 cm. In 1991, Zhou et al evaluated their results of utilizing this flap for the reconstruction of defects in various regions of the body. In 1993, Koshima and colleagues reported on 22 cases of head and neck reconstruction utilizing this flap. This flap has been extensively reported in the literature and has become a workhorse flap for reconstruction of small or large defects, both simple and complex, with excellent results and minimal morbidity at the donor site. In three cases descending branch of lateral circumflex femoral artery was used for free ALT flap. The anterolateral thigh flap is supplied by either septocutaneous vessels or musculocutaneous perforators that usually arise from the descending branch of the LCFA. Earlier anatomic studies suggested that flap harvest was based predominantly on direct septocutaneous vessels but more recent large series indicate that the flap is primarily based on musculocutaneous perforators (87% vs 13%). Less commonly, the perforators may originate from other sources such as the transverse branch of the LCFA. Song et al [15]. Koshima et al. [16] Kimata et al [17] had reported that the descending branch of the lateral circumflex femoral vessels are the vascular pedicle of the ALT Flap in all cases. The descending branch of LCFA has diameter 1,5 mm to 2 mm with long vascular pedicle ranged 10 to 15 cm. We found that the descending branch of LCFA has an external diameter more than 2 mm with long vascular pedicle ranged 8-12 cm in length. The two venae comitants accompanying the descending branch of the LCFA has always an external diameter larger than that of the artery with an average diameter of 2.5 mm. Chuan et al [18]. stated that the length of descending branch of LCFA may reach 8-12 cm and its average diameter was 2.1 mm and its two vena comitants was 2.3 mm. Zhou et al [13]. found that the diameter of the artery in 32 free ALTF varied from 1.5 to 2.5 mm and the length of the vascular pedicle was 5 to 12 cm. In one of our cases, there was failure of the ALT flap caused by arterial thrombosis. Radial forearm free flap (RFFF) was performed to reconstruct the failed ALT flap. RFFF has become the workhorse because of its large size with thin and pliable skin of the flap. Furthermore, the RFFF is easy to dissect with a constant anatomy. Long vascular pedicle and large veins of 2-3 mm in diameter of both superficial and deep veins make it safe for microvascular anastomoses without interpositioning vein graft and more than one venous anastomosis can be achieved to solve problem of post-operative venous congestion.

Choosing the appropriate reconstructive technique for a particular wound in a specific patient is the essence of good clinical judgment. For the most part, the simplest and least technically demanding method likely to be successful should be chosen. In this case we used Free ALT flap as donor site. The anterolateral thigh flap is relatively easy to harvest once the technique of perforator flap dissection has been learned. It has a reliable blood supply despite some anatomic variability, it is pliable and can be thinned to a significant degree without compromising blood supply, and can provide a long pedicle with large-diameter vessels. It can also be used as a flow-through flap, and, because of its unique position, allows for a two team approach to the reconstruction of most defects in the body. The flap can also provide different tissue components such as muscle, fascia, and skin in a variety of combinations.

SUMMARY

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