DISTALLY BASED ADIPOFASCIAL FLAPS: A VERSATILE FLAP FOR THE RECONSTRUCTION OF LOWER LEG AND PROXIMAL FOOT DEFECTS AT THE ROYAL JORDANIAN REHABILITATION CENTER

Khaldoun J. Haddadin, MD, Samer Y. Haddad, MD*

ABSTRACT

Objective: In this study we present the use of distally based adipofascial flaps from the calf for the reconstruction of soft tissue defects of the lower third of the leg and proximal foot at the Royal Jordanian Rehabilitation Center, King Hussein Medical Center over a three-year period between 1998 and 2001.

Methods: Eleven patients were treated and were analyzed with respect to age, gender, etiology of defect, defect site, defects size, the adipofascial flap artery used and the outcome with a follow up of 1-3 years at the Royal Jordanian Rehabilitation Center, King Hussein Medical Center.

Results: There were seven adults and four children. The etiologies of the soft tissue defects were trauma in (8 patients), trophic ulcers (2 patients), and chronic osteomyelitis in (one patient). All flaps survived completely, and stable coverage of the soft tissue defects was achieved in all patients. One patient required repeat skin graft due to partial loss of the graft.

Conclusion: The simplicity of design and elevation of these flaps plus their extensive arc of rotation makes the adipofascial flaps versatile and reliable in the reconstruction of difficult defects of the lower limbs. We have found these flaps to be safe, technically easy and with minimal donor site morbidity.

Key words: Flaps, Adipofascial, Lower limb reconstruction.

JRMS June 2004; 11(1): 38-43

Introduction

In 1976 distally based vascular pedicle flaps were introduced to reconstructive surgery [(1)]. Many studies confirmed that reverse venous flow occurred in these distally based pedicles, encouraged surgeons to develop various flaps in reconstructive surgery of the limbs [(2)]. For the reconstruction of soft tissue defects of the lower leg and foot the peroneal arterial flaps [(3)], anterior tibial arterial flaps [(4)] and the posterior tibial arterial flaps [(5)] were used as adipofascial flaps.

Soft tissue defects of the lower third of the leg and foot with exposed bone present difficult reconstructive challenges for plastic surgeons. As an alternative to microvascular transfer in patients in whom local skin or muscle flaps are not suitable, the fasciocutaneous system of the leg offers a good alternative. Ponten [(6)] introduced the fasciocutaneous flaps, which proved satisfactory for small and medium-sized defects. Furthermore, the adipofascial flap, which is a fasciocutaneous flap without the overlying skin, was developed [(7)].

In this study we present the use of distally based adipofascial flaps from the calf for the reconstruction of soft tissue defects of the lower third of the leg and proximal foot. The clinical results are encouraging and the advantages are discussed.

Methods

This is a retrospective study of the distally based adipofascial flaps in the reconstruction of the lower third of the leg and proximal foot defects treated at the Royal Jordanian Rehabilitation Center, King Hussein

*From the Department of:
Plastic and Reconstructive Surgery, Royal Jordanian Rehabilitation Center, King Hussein Medical Center, Jordan
Correspondence should be addressed to Dr. K. J. Haddadin, P.O. Box 37 Amman 11831 Jordan, E-mail: kal@go.com.jo
Manuscript received April 28, 2003. Accepted October 30, 2003

Medical Center, Jordan over a three-year period between 1998 and 2001. Eleven patients were treated and were analyzed with respect to age, gender, etiology of defect, defects site, defects size, the adipofascial flap artery used and the outcome with a follow up of 1-3 years.

Surgical Anatomy

The main nutrient vessels of the leg are the anterior tibial artery, posterior tibial artery, and peroneal artery. Each artery supplies a separate territory although some of the skin areas overlap [8]. The posterior tibial artery passes inferomedially on the posterior surface of the tibialis posterior muscle and deep in the transverse facial septum, which separates the soleus and gastrocnemius from the deep muscular compartment of the posterior leg. Along its course, the posterior tibial artery gives off many branches and intermuscular perforators to the underlying fascia and skin. In its upper 2/3 the artery is deep. In the rest of its course it is superficial. In the distal third the perforators are more numerous than in the proximal third [9].

Also it is well known that the cutaneous veins have their own accompanying arteries that have branches to the skin i.e. venocutaneous perforators. Along with the neurocutaneous perforators of the cutaneous nerves the concept of adipofascial fasciocutaneous flaps was proposed [10].

Prior to performing the operation, assessment of the artery and the perforators should be carried out by palpation or Doppler. When in doubt, an arteriogram of the leg and foot should be obtained. The flap is marked on the skin with its pivot vascular pedicle 6-8 cm proximal to the malleoli (Fig. 1a and Fig. 1b). A linear or zigzag skin incision is made along the course of the artery. Then the dissection is made subcutaneously over the area of the proposed adipofascial flap (Fig. 1c). The flap is raised (Fig. 1d) and the vessels are easily identified under the thin adipofascial layer (Fig. 1e) and a cuff of subcutaneous tissue and fascia is left with the pedicle so that perforators can be preserved to maintain the blood supply of the flap. Then the flap is turned over to inset and fill the defect (Fig. 1f). The donor area is closed primarily without tension (Fig. 1g). Then a split thickness skin graft is applied over the flap (Fig. 1h and Fig. 1i).

The deep fascia is absent on the medial surface of the tibia and lower exposed surface of fibula. Immediately after piercing the deep fascia the intermuscular perforators ramify and anastomose with each other to form a rich vascular plexus at the pre-and sub fascial levels [11].

After rotation of the flap to the recipient area then the raw surface is covered with a skin graft and the donor area is closed primarily. The dermal vascular network at the donor site is sufficient to let the skin survive without its underlying subcutaneous vascular support although it is wise to trim the edges before closure to avoid minor healing problems. Occasionally we apply a skin graft over the turned over pedicle to avoid tight primary closure over the pedicle.

The anterior tibial artery has 2-3 medial perforators through the tibialis anterior along the anterior border of the tibia and 6 lateral perforators along the anterior peroneal septum. The peroneal artery has 5 perforators along the posterior peroneal septum and one perforator that pierce interosseous membrane above the ankle and a lateral malleolar branch. The posterior tibial artery has 4 perforators between the flexor digitorum longus and the soleus muscle also has malleolar and calcaneal branches.

Results

There were 9 males and 2 females, seven adults and four children ranging from 5 years to 63 years. The etiologies of the soft tissue defects were trauma in 8 patients (72%), trophic ulcer in 2 patients (18%) and chronic osteomyelitis in one patient (9%). The defect sites were divided into three areas: lower third of the leg, dorsum of the foot and heel. There were four patients in each of the first and second groups and three patients in the third group. The defect size ranged from 3x2 cm to 8x6 cm. The arterial pedicle used for these adipofascial flaps were: six peroneal artery perforators and five posterior tibial artery perforators (Table I). All the flaps were covered with split thickness skin grafts and the donor sites were closed primarily in all cases. All flaps survived completely with stable coverage of the soft tissue defects. One patient required repeat skin graft due to partial loss of the graft. All the donor sites healed completely with cosmetically accepted scars and the patients were satisfied with the scars. None of the patients needed a debulking procedure for the flaps. Examples of the results are shown in (Fig. 1j), (Fig. 1k), (Fig. 2a, b) and (Fig. 3a, b).

Discussion

In the reconstruction of lower leg defects, a problem arises which is the lack of available and reliable local flaps. Microvascular tissue transfer can provide ample tissue for reconstruction but a high incidence of free flap failure occurs in this region [12]. The flap maybe too bulky for the defect and a secondary debulking operation may be necessary. High-energy trauma results in tibial fractures as well as soft tissue and skin damage leading to skin necrosis and tibial bone or plate exposure [13]. Defects occurring in the proximal or middle third of the leg may be covered by regional flaps such as soleus [14] or gastrocnemius muscle flaps, musculocutaneous flaps and proximally based fasciocutaneous flaps [6], however, scanty soft tissue and poor blood supply renders reconstruction difficult when these defects occur in the lower leg,

The fasciocutaneous flaps introduced by Ponten have no definite vascular pedicle and thus need a wide base. In their experience Ponten [6] and Barclay *et al* [15] found

that the fascial layer could survive a longer length of tissue than that of the overlying cutaneous tissue after transplantation. Dickson *et al* [16] found that in 14 out of 15 cases in which partial necrosis occurred, the necrosis was limited to the skin, and the fascia was viable. Many studies revealed that the deep fascia of the leg is a highly vascularized and reliable tissue. A main artery of the leg can be dissected to support a large axial flap. These island flaps have a large axis of rotation. In order not to sacrifice a major artery, a distally based fasciocutaneous flap nourished by lower perforators originating from the posterior tibial artery can be used [5]. If the direction of the vascular pedicle is not changed the blood flow in the flap is not retrograde in spite of the fact that its base was distal, therefore no problem of venous congestion is encountered as can occur in a reversed vascular pedicle flap. These flaps could be designed as island flaps and could be transposed 90 or 180 degrees since their vascular pedicle can supply a large skin territory and can provide a durable and thin coverage of the Achilles tendon [17, 18].

Each adipofascial flap was nourished by lower perforators originating from the posterior tibial artery and these perforators were identified in five cases in this series. Gumener *et al* [19] reported a reverse fasciocutaneous flap in the calf area that was nourished by both the lower perforators of the posterior tibial artery and peroneal arteries. El-Khatib used the perforators of the dorsalis pedis artery for the resurfacing of the forefoot defects [20]. Also these flaps were based on the saphenous artery to cover the soft tissue defects around the knee and superior third of the leg [21]. A large flap could be used as a cross leg fasciocutaneous flap to cover the whole leg defect [22] and a large base to accommodate the two perforators but extensive dissection is needed for a successful transplantation, which sometimes causes transit edema in the leg. In our series the width of the flaps did not exceed 10 cm and the maximum length was up to 10 cm below the level of the knee. The donor site scar was satisfactory to our patients but a new technique to harvest these flaps using the endoscopic assistance was done to decrease the donor site morbidity [23].

The requisites for adipofascial flap survival are: Pre-operative Doppler assessment of perforators at proposed pivot point, good flap design, adequate flap to base area and length to width ratio, dissection of vessels at pivot point avoids kinks and noncompressive dressing. In our series the patients were immobilized for one week and a light dressing was used especially over the area of the pedicle. We had one case of partial loss of the graft that needed repeat skin graft but we had no cases of a discharging sinus as reported by others [24].

These flaps are gaining popularity in soft tissue coverage of the extremities thus creating a new concept in reconstructive surgery within the last decade [25, 26].

Conclusion

The simplicity of design and elevation plus their extensive arc of rotation make the adipofascial flaps versatile and reliable in the reconstruction of difficult defects of the lower limbs. We have found several advantages of these flaps. They include (1) safety; (2) reliability, longitudinally oriented axial- pattern flap; (3) technically easy and quick dissection; (4) availability in either the fatty tissue side or the fascial side; (5) single stage without microsurgery; (6) no sacrifice of skin or major arteries or nerves at donor site; (7) potential for reinnervation with minimal donor site morbidity; (8) softness and conformability, and the ability to obliterate the dead space completely.

The addition of this technique to the armamentarium of reconstructive surgeon has proved useful in repairing soft tissue defects.

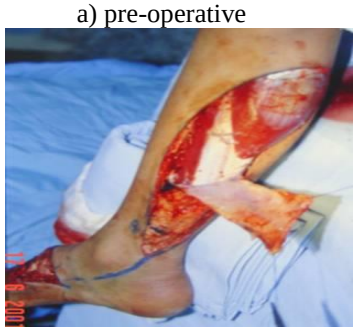
Table I. Demographic characteristics, etiology and defect site, size and the involved artery among the study group.

Patient No.	Age years	Gender	Etiology	Defect site	Defect size	Artery	
1	28	Male	Trauma	Lower 1/3 leg	5x3 cm	Peroneal	
2	6	Male	Trauma	Dorsum foot	5x4 cm	Peroneal	Fig 2
3	5	Male	Trauma	Lower 1/3 leg	4x2 cm	Post. tibial	
4	11	Female	Trauma	Dorsum foot	8x6 cm	Peroneal	
5	35	Male	Trauma	Dorsum foot	6x4 cm	Peroneal	
6	19	Female	Trauma	Heel	3x3 cm	Post. tibial	
7	63	Male	Chronic Osteomyelitis	Lower 1/3 leg	3x2 cm	Post. tibial	
8	27	Male	Trophic ulcer	Heel	3x2 cm	Peroneal	
9	32	Male	Trophic ulcer	Heel	4x3 cm	Peroneal	
10	12	Male	Trauma	Dorsum foot	8x4 cm	Post. tibial	Fig 1
11	45	Male	Trauma (Bullet injury)	Lower 1/3 leg	5x3 cm	Post. tibial	Fig 3

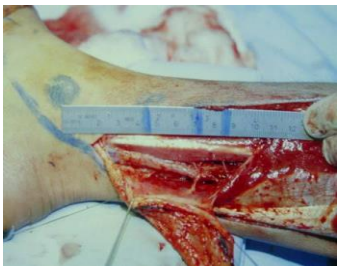
a) pre-operative

b)

c)



d)



e)

f)

g)

h)

i)

j)

k)

Fig. 1: A 12-year-old male with trauma over the dorsum of the right foot that resulted in a defect of 8x4 cm in size. The defect was closed using a posterior tibial artery adipofascial flap. a) Pre operative. b) Marking of skin incision and the perforator. c) Dissection of the proposed adipofascial flap. d) Elevation of the flap. e) Identification of the perforators. f) Inset of the flap. g) Donor area closed primarily. h) Split thickness skin graft applied over the flap. i) Immediate post operative. j) After 3 weeks. k) After 6 weeks.

a) Pre-operative

b) Post-operative after one year

Fig. 2. A 6-year-old male with trauma to the dorsum of the left foot, which resulted in a defect of 5x4 cm requiring flap coverage. The defect was closed using a peroneal artery adipofascial flap.

a) Pre-operative

b) Post-operative after 6 weeks.

Fig. 3. A 45-year-old male with a bullet injury to the lower third of the right leg that resulted in fracture of the tibia and a defect of 5x3 cm. The fracture was fixed with external fixation. The defect was closed using a posterior tibial artery adipofascial flap.

References

1. **Bostwick J, Briedis J, Jurkiewicz, MJ.** The reverse flow temporal artery island flap. *Clinics in Plastic Surgery 1976*; 3: 441-445.
2. **Timmons MJ.** William Harvey revisited: Reverse flow through the valves of forearm veins. *Lancet* 1984; 2: 394-397.
3. **Yoshimura M, Imura S, Shimamura K, *et al*.** Peroneal flaps for reconstruction in the extremity: Preliminary report. *Plast Reconstr Surg* 1984; 74: 402-407.
4. **Rocha JFR, Gibert A, Masquelet A, *et al*.** The anterior tibial artery flap: Anatomy study and clinical application. *Plast Reconstr Surg* 1987; 79: 396-401.
5. **Amarante J, Costa H, Reis J, Soares R.** A new distally based fasciocutaneous flap of the leg. *Br J Plast Surg* 1986; 39: 338-342.
6. **Ponten B.** The fasciocutaneous flap: its use in soft tissue defects of the lower leg. *Br J Plast Surg* 1981; 34: 215-220.
7. **Lin SD, Lai CS, Chou CK, Tsai CW.** The distally based posterior tibial arterial adipofascial flap. *Br J Plast Surg* 1992; 45: 284-287.
8. **Nakajima H, Minabe T, Imanishi N.** Three dimensional analysis and classification of arteries in the skin and subcutaneous adipofascial tissue by computer graphics imaging. *Plast Reconstr Surg* 1998; 102(3): 748-760.
9. **Carriquiry C, Costa MA, Vasconez LO.** An anatomic study of the septocutaneous vessels of the leg. *Plast Reconstr Surg* 1985; 76: 354-358.
10. **Nakajima H, Imanishi N, Fukuzumi S, *et al*.** Accompanying arteries of the cutaneous veins and cutaneous nerves in the extremities: Anatomical study and a concept of the venoadipofascial and/ or neuroadipofascial pedicled fasciocutaneous flap. *Plast Reconstr Surg* 1998; 102(3): 779-791.
11. **Cormack GC, Lamberty BGH.** A classification of fasciocutaneous flaps according to their patterns of vascularisation. *Br J Plast Surg* 1984; 37: 80-85.
12. **Khouri RK, Shaw WW.** Reconstruction of the lower extremity with microvascular free flaps: A 10- year experience with 304 consecutive cases. *J Trauma* 1989; 29: 1086-1090.
13. **Byrd HS, Spicer RE, Cierny G.** Management of open tibial fractures. *Plast Reconstr Surg* 1985; 76: 719-728.
14. **Tobin GR.** Hemisoleus and reversed hemisoleus flaps. *Plast Reconstr Surg* 1985; 76: 87-96.
15. **Barclay TL, Cardoso E, Sharp DT, Crockett DL.** Repair of lower leg injuries with fasciocutaneous flaps. *Br J Plast Surg* 1982; 35: 127-132.
16. **Dickson WA, Dickson MG, Robert AHN.** The complications of fasciocutaneous flaps. *Ann Plast Surg* 1987; 19: 234-238.
17. **El-Khatib H.** Island adipofascial flap for resurfacing of the Achilles tendon. *Plast Reconstr Surg* 1996; 98(6): 1034-1038.
18. **Lin SD, Lai CS, Chou CK, Tsai CW.** The distally based posterior tibial arterial adipofascial flap. *Br J Plast Surg* 1992; 45: 284-287.
19. **Gumener R, Zbrodowski A, Montandon D.** The reversed fasciocutaneous flap in the leg. *Plast Reconstr Surg* 1991; 88: 1034-1041.
20. **El-Khatib H.** Adipofascial turn over flap based on perforators of the dorsalis pedis for resurfacing forefoot defects. An anatomic and clinical approach. *Plast Reconstr Surg* 1998; 102(2): 393-397.

21. **Lin SD, Lai CS, Chiu YT, *et al*.** Adipofascial flap of the lower leg based on the saphenous artery. *Br J Plast Surg* 1996; 49: 390-395.
22. **Kohli JS, Pande S, Bajaj SP.** Large transverse fasciocutaneous leg flap: Whole leg flap. *Br J Plast Surg* 2000; 53: 495-498.
23. **Hallock GG.** Adipofascial flap harvest using endoscopic assistance. *Ann Plast Surg* 1997; 38(6): 649-652.
24. **Lin SD, Lai CS, Tsai CC, *et al.*** Clinical application of the distally based medial adipofascial flap for soft tissue defects on the lower half of the leg. *J Trauma* 1995; 38(4): 623-629.
25. **Lin SD, Lai CS, Chou CK, Tsai CC.** Reconstruction of the soft tissue defects of the lower leg with a distally based medial adipofascial flap. *Br J Plast Surg* 1994; 47: 132-137.
26. **Sarhadi NS, Quaba AA.** Experience with the adipofascial turn over flap. *Br J Plast Surg* 1993; 46: 307-313.