Distally Based Fasciocutaneous Flaps In the Management of Soft Tissue War Injuries of the Lower Half of the Leg

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ABSTRACT:

BACKGROUND :

Soft tissue war injuries affecting the lower half of the leg are a major challenge facing plastic surgeons .Distally based fasciocutaneous flaps have an important role in the management of these defects.

OBJECTIVE :

To demonstrate the role of distally based fasciocutaneous flaps as an alternative to free tissue transfer in the management of lower leg soft tissue defects.

METHODS :

Thirty seven war injury patients with soft tissue loss in the lower half of the leg were managed by distally based septocutaneous flaps (19 cases),and distally based superficial sural artery flap (18 cases) , donor areas were closed by partial thickness skin grafts in all of the cases.

RESULTS :

All of the 37 flaps survived and healed uneventfully except in 4 cases in whom partial necrosis of the flap occurred at the tip. Two cases of distally based superficial sural artery island flaps developed venous congestion and edema .

CONCLUSION :

Distally based fasciocutaneous flaps are an important alternative to microvascular tissue transfer in treating lower leg war injuries. The versatility and arc of rotation of the distally based superficial sural artery flap were better than in distally based septocutaneous flaps.

KEYWORDS:

INTRODUCTION:

Lower extremity war injuries are usually extensive causing wide spread soft tissue and bone loss. Usually other areas of the body are also involved and the patient is in a critical situation if it is not fatal. After stabilization of the patient general condition and management of any life threatening injury, plastic surgeons face the challenge of soft tissue reconstruction . Starting from the simplest surgical techniques in the ladder of reconstruction ,namely direct suturing or skin grafting, till reaching the most sophisticated techniques like microvascular tissue transfer. Coverage of soft tissue defects in distal areas of the leg and foot is always a difficult yet common problem because of the tightness, poor circulation , and the limited local tissue available for reconstruction [1-5].

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Various methods of reconstruction to cover such defects with exposure of underlying bones and tendons include local cutaneous ,fascial or fasciocutaneous flaps based either proximally or distally, cross-leg flaps, distally based muscle flaps, and free flaps and each has its merits and drawbacks [6,7,8,9,10]. Generally , microvascular techniques have revolutionized the treatment modalities ,free flaps are superior to other methods because they allow reconstruction of large defects with well vascularized tissues that have exact physical properties needed [9,11,12]. In a busy surgical ward with a remarkable shortage of equipment and facilities ,microsurgical tissue transfers are impossible as they require time and facilities in addition of being technically demanding necessitating the availability of a trained microsurgical team . In these situations ,surgeons usually try to find suitable alternatives to free transfers. Fasciocutaneous flaps of the lower extremity are a relatively a new concept largely attributable to the clinical work of Ponten who described 23 of these flaps in 1981 [3,13] .

The early designs extending along the vertical axis

of the leg with a proximal pedicle have been modified by the use of the transverse flaps with a lateral or medial pedicles , and lastly, with distal pedicle [12] . Distally based Fasciocutaneous flaps are commonly vascularized by the medial septocutaneous perforators arising from the tibial artery, the lateral septocutaneous perforators arising from the peroneal artery, or can be based on both [1,3] .Over the past 13 years some authors have focused on the concept of neorocutaneous flaps [14] . Arteries that are accompanying superficial sensory nerves give nutrient vessels to the skin ,and some flaps can be designed over these areas [10,14] .

In 1992, Masquelet and colleagues first described the distally based superficial sural artery island flap based on the vascular axis of the sural nerve and its anastomosis with the lowermost septocutaneous perforator from the peroneal artery [4,10] .

Many surgeons demonstrated the versatility of the flap and its advantages in the reconstruction of the lower leg [1, 4, 10,15,16] .

In this study we managed 37 war injury patients with soft tissue loss in the lower half of the leg by distally based fasciocutaneous flaps .

PATIENTS AND METHODS:

Thirty seven patients with soft tissue loss and exposure of tendons ,joints or bones in the lower half of the leg and foot were treated with distally based fasciocutaneous flaps over a period of 26 months from April 2003 to June 2005.

All of the wounds were war injuries resulting from either shell or bullet injuries. Their ages range from 10 to 73 years.Fourteen of them were females and 23 were males. Life saving surgeries were done for 5 of them (Lapratomy and thoracotomy) and the patients were admitted to the plastic surgery unit when the general condition of the patient is stable ,and any bony injury was fixed externally and necrotic soft tissues excised .

In 18 patients there was a bone gap necessitating bone grafting after 6 to 12 weeks. The soft tissue defects were closed by the following distally based fasciocutaneous flaps :

1. Distally based superficial sural artery island flap (9 cases).
2. Distally based superficial sural artery interpolation flap (9 cases).
3. Distally based septocutaneous flap based on the medial septal perforators (6 transposition flaps and 3 island flaps).
4. Distally based septocutaneous flap based on the medial and lateral septal perforators (8 transposition flaps and 2 island flaps).

The selection of the type of the flap depends on the site of trauma and the presence of intact donor area. All the flaps were done secondarily after wound excision ,under general anesthesia ,and with the aid of a tourniquet .

Distally based superficial sural artery flap:

The flap is based on the median superficial sural artery which originates from the popliteal artery and accompanies the sural nerve and descends between the two heads of the gastrocnemeous muscle . In 65% of cases this artery descends to the lateral maleollus ,in 35% of cases the artery fades distally to a vascular net at the distal third of the leg, in both cases the artery has a constant distal anastomosis with septocutaneous perforators from the peroneal artery which will supply a reverse – flow flap [9,10,17] . The axis of the flap is along the course of the sural nerve which is over a line joining the midpoint of the popliteal fossa and a point approximately 1 cm behind the lateral maleollus. The center of the flap is placed on the midline in the posterior surface of the leg and outlined according to the dimensions of the defect .The standard flap described is the island flap, we also made 9 interpolation flaps. The upper border of the flap is incised and the and the lesser saphenous vein ,medial sural nerve and accompanying arteries are divided and ligated.

The flap is then elevated with deep fascia making sure that the vessels and the nerve are included in the flap. In cases of island flaps, a longitudinal strip of fascia containing the sural nerve and lesser saphenous vein is taken with the pedicle.

And the skin island was tunneled subcutaneously to reach the defect . In all of the cases the dissection stops 5-7 cm proximal to the lateral maleollus and the donor areas were closed by a split thickness skin grafts.(Figure)

Distally based septocutaneous perforator flaps:

These flaps are fasciocutaneous flaps based on septocutaneous perforators passing in the medial intermuscular septum with or without septocutaneous perforators passing in the lateral intermuscular septum. The flap is either centered over the medial intermuscular septum to include the septocutaneous branches of the posterior tibial artery ,or based over the entire posterior area to include the septocutaneous perforators of the peroneal artery in the lateral septum also. They were elevated in the subfascial plane till reach 1 cm proximal to the lowest septocutaneous perforator if a Doppler ultrasound device is available. Unfortunately in most of the cases Doppler exams were unavailable, in these cases the dissection

stops 8 cm proximal to the medial maleollus, although most of the surgeons advocated the use of Dopller preoperatively ,some authors did not believe that its use is helpful [2]. Donor sites were closed by split thickness skin grafts.

Flap delay for one week was done in 3 cases when the planned flap was very long reaching few centimeters from the knee joint flexion crease and intraoperative bleeding points from the tip of the flap were scanty. The patients were followed up for a period of 5-23 months , donor and recipient sites were evaluated and early and late complications were recorded.

RESULTS:

All of the 37 flaps survived and healed uneventfully except in 4 cases in whom partial necrosis of the flap occurred at the tip. Two of them were flaps based on the medial septocutaneous perforators ,one was based on both medial and lateral septocutaneous perforators and one flap was distally based superficial sural artery flap. The necrotic tissue was either excised or sloughed spontaneously and a split thickness skin grafts were applied to close the resulted wound in one case, the other 3 wounds healed by secondary contraction. The sural nerve and the short saphenous vein were included in all of the reverse superficial sural artery flaps .The nerve was included in only 5 septocutaneous flaps and the short saphenous vein was included in 10 septocutaneous flaps. The largest dimensions of the flap were 11 cm in width and 19 cm in length and the donor areas extended to the middle or proximal thirds of the posterior leg . Donor areas were closed by partial thickness skin grafts in all of the cases. During the follow up period 11 patients developed complications .All of them showed improvement in a period of 1-5 months and became ambulatory after the completion of wound healing if the bones were not involved. The complications were:

- Partial flap loss (4 cases).
- Venous congestion or prolonged edema (2 cases).
- Infection (One case).
- Donor site complications (3 cases).

Donor site complications included scar hypertrophy (one case),partial skin graft loss(one case), and painful neuroma (one case). Parasthesia in the foot after nerve division is considered a sequel rather than a complication.

The distally based superficial sural artery island flap showed excellent versatility and its reach was better than the septocutaneous flaps . The flap can cover defects on the medial ,posterior or anterior aspects of the leg and foot.

DISCUSSION :

Distally based fasciocutaneous flaps in the leg were described as a safe, easy , and time saving option for soft tissue reconstruction in the distal half of the leg .In Iraq were plastic surgeons face a large number of war injuries among civilians of different ages , and were there is a great shortage of medical supplies and lack of facilities , the use of conventional pedicled flaps remains a good alternative for microvascular free tissue transfer and reduces the number of amputations. The blood supply of the septocutaneous flaps is via the septocutaneous perforators arising from the tibial artery (medially) or the peroneal artery (laterally) .The flap should be based on the lower perforators to make the flap pedicle as long as possible , the exact location of the perforators is variable.

Peroneal artery perforators travel in the septum between the peroneus longus and the flexor halusis longus muscles in the proximal two thirds of the leg and between the peroneus longus and the soleus muscles in the distal one third of the leg . the average number of perforators is 4.8 per leg with a range of 1 to 7.They are concentrated at the seventh and eighth tenths the lateral longitudinal distance (7.4 cm above the lateral maleollus) .In the distal leg perforators may course medially to connect to the posterior tibial system [13] . El Khatib showed that these lateral septocutaneous perforators are located 7-10 cm from the tip of the lateral maleollus [16] ,other studies demonstrated that they are 5 perforators with a 3-5 cm intervals between them and the lowest one is 5-10 cm above the maleollus [3] . The posterior tibial artery perforators pass in the septum between the soleus and the flexor digitorum longus muscles .The average number of perforators is 3.1 ,with a range of 0 to 6 [13] .They are located 3.5-7 cm from the tip of the medial maleollus [16] . Other studies showed that the lowest perforators are located 9-12 cm from the medial maleollus. It is obvious that there is some variation in the exact locations of the lowest septocutaneous perforators of both systems .That makes preoperative Doppler ultrasound identification of the perforators sites is of great importance since surgical dissection of the perforators and intraoperative identification are risky .In most of our cases Doppler identification was unavailable .we made the pivot point for the reverse superficial sural artery flap rotation 7 cm from the lateral maleollus for safety. The site ranges in the literatures from 3 cm to 7 cm [2,4,5,6,7,9,10,16] . For the same reason , we made the pivot point for the septocutaneous flaps based on the medial septocutaneous perforators 8 cm above the medial maleollus .

The distally based sural artery flap was used to cover large defects in the anterior ,posterior and medial aspects of the distal half of the leg ,the flap was elevated from the middle third of the posterior leg ,this coincides with other studies done previously [2,7,9] , in 4 of our cases the flaps were elongated to include skin from the proximal third of the leg ,in one of them the bleeding points from the tip of the flap was scanty ,we did a delay of 7 days to increase the vascularity of the flap and it healed later uneventfully .Husamettin and co workers elevated the flap from the proximal third leaving just 1-2 cm of skin from the popliteal crease and used the term (super sural neurofasciocutaneous) to identify these flaps [6] . Partial skin necrosis occurred in 4 cases , all of them affected the distal 1-3.5 cm of the flaps , in 3 cases the wounds healed by wound contraction and in one case split thickness skin graft was used to cover the wound. Partial necrosis secondary to venous congestion is one of the disadvantages of the distally based sural artery island flap. Unfortunately ,the distal tip is usually the portion that fails which is commonly the part of the flap that one needs the most [18] .

Two cases developed prolonged congestion and edema both of them are distally based sural artery island flaps .the edema decreased with time but it did not disappear .

A tight subcutaneous tunnel through which the flap pedicle is passed leading to vascular compression (especially the venous drainage) may explain this edema. Venous drainage of the flap occurs via superficial venous network, which is formed by small concomitant veins ,lesser saphenous vein and septocutaneous veins of the peroneal venous system [5,6].After flap elevation ,direct reflux through the valves does not occur, small concomitant veins were present along both sides of the lesser saphenous vein and were considered to be venae comitantes of accompanying arteries of the vein .These small veins receive blood from the lesser saphenous vein and play a role in bypassing the valves [6]. Many surgeons reported the possibility of pedicle compression in the tight subcutaneous tunnel affecting the venous drainage system when using the standard distally based sural island flap .Technical modifications have been described to overcome this problem.

The flap can be planned in a tear drop configuration so that there is cutaneous extension over the neurovascular axis [6,10] ,other workers considered the tear drop configuration inadequate in decreasing tunnel tightness and prefer division of the skin bridge of the tunnel and skin grafting over the pedicle [5,19].

Ogun et al did not experience any circulatory impairment and considered the reported tightness as a result of improper tunneling [2] . In this study when the distally based sural island flap was used 5 cases developed venous congestion early after the operation, they showed improvement with time and the edema disappeared later except in 2 cases one of them developed partial skin loss later .

In both cases the skin over the subcutaneous tunnel was either edematous or scarred. When we used the distally based superficial sural artery flap as a peninsular interpolation flap, we did not encounter any venous congestion postoperatively, but this type of flaps necessitate the need of a second operation for flap separation .The same approach is described by Maffi and his co workers [18] .

Although flap edema was seen in a number of septocutaneous island flaps ,we did not find congestion leading to tissue loss or long lasting edema for more than 3 months even when tunneled under adjacent skin. The full width fascial pedicle may have better venous drainage ,in addition to that, the small angle of pedicle rotation and the vicinity of the recipient site made the possibility of pedicle compression inside the tunnel less .

The sural nerve should be included in the distally based superficial sural artery flap making numbness at the lateral aspect of the foot unavoidable , trials of preserving the nerve have led to partial flap loss [2,9,10] .On the other hand, the nerve can be preserved when distally based septocutaneous flaps are pedicled on the medial septocutaneous perforators making it an advantage when using these flaps. Most of our patients showed slow improvement and a decrease in the level of numbness one year after the operation, but the symptoms did not disappear during the period of follow up, Ogun showed that these sensory changes improves with time and does not constitute a major problem [2] . A similar result was reported by Singh and Naasan [7], and by Costa Ferreira et al [9]. Despite the risk of flap congestion in the subcutaneous tunnel and donor site numbness ,we found that the distally based sural artery flap is more versatile and reliable than the distally based septocutaneous flaps based on the medial septocutaneous perforators (or perforators of both sides) .It provides a large skin island which can be mobilized to cover soft tissue defects in different locations in the lower half of the leg and foot. This coincides with the results of other studies which showed that the flap meets almost all criteria for an ideal flap,

making it an excellent choice for covering soft tissue defects of the lower leg [2] .

CONCLUSION:

The technique of the distally based fasciocutaneous flaps in general was simple and safe .The operation can be done in a short time without interfering with the blood flow of one of the major vessels of the leg . In this study ,most of the patients were multiply injured ,lapratomies and thoracotomies were done for some of them prior to their referral to the plastic surgery ward. The facilities ,time, personnel, and the expertise for microvascular surgery were unavailable. The flaps were performed in busy general hospitals under suboptimal environment and shortage of medical supplies ,which are expected during wars. They obviated the need for microvascular tissue transfers in most of the cases saving the limb from amputation ,except when the degree of soft tissue loss and bone exposure are very extensive. The distally based superficial sural artery flap is an excellent option when the tissue loss involves the distal part of the leg and foot. Its versatility and (reach) made it superior to other distally based fasciocutaneous flaps . Careful technique and awareness about the possible complications that may arise can save the lower limbs of many war victims.

REFERENCES:

1. Fraccalvieri M ,Verna G, Dolcet M, Fava R, Rivarossa A, Robotti E, Bruschi S . The distally based superficial sural flap: our experience in reconstructing the lower leg and foot. Ann Plast Surg 2000;45(2):132-9.

2. Ogun Tunc Cevat, Arazi Mehmet, Kutlu Abdurrahman . An easy and versatile method of coverage for distal tibial soft tissue defects. J Trauma 2001;50(1):53-59.

3. Arajy ZY, Najjar UA . Evaluation of the inferiorly based fasciocutaneous flap in leg reconstruction .The Iraqi Postgraduate Medical Journal 2003;2(4): 429-436.

4. Yang Daping, Morris SF. Reversed sural island flap supplied by the lower septocutaneous perforator of the peroneal artery. Ann Plast Surg 2002; 49(4):375-378.

5. Touam C, Rostoucher P, Bhatia A, Oberlin C. Comparative study of two series of distally based fasciocutaneous flaps for coverage of the lower one – fourth of the leg ,the ankle and the foot. Plast reconstr Surg 2001; 107(2): 383-392.

6. Top Husamettin , Benlier Erol , Aygit AC, Kiyak M. Distally based sural flap in treatment of Chronic venous ulcers . Ann Plast Surg 2005; 55(2):160-165.

7. Singh S, Naasan A . Use of distally based superficial sural island artery flaps in acute open fractures of the lower leg . Ann Plast Surg 2001;47(5):505-510.

8. Bashir AH. Iferiorly based gastrocneius muscle flap in the treatment of war wounds of the middle and lower third of the leg. Br J Plast Surg 1983;36:307-309.

9. Costa-Ferreira A, Reis J, Pinho C, Martins A, Amarante J. The distally based island superficial sural artery flap : clinical experience with 36 flaps. Ann Plast Surg 2001; 46(3):308-313.

10. Yilmaz M , Karatas O, Barutcu A. The distally based superficial sural artery island flap: clinical experience and modifications. Plast Reconstr Surg 1998;102(7):2358- 2367.

11. Hsieh CH, Liang CC, Kueh NS, Tsai HH, Jeng SF. Distally based sural island flap for the reconstruction of a large soft tissue defect in an open tibial fracture with occluded anterior and posterior tibial arteries –A case report. Br J Plast Surg 2005; 58(1):112-115.

12. Quarmby C, Skoll PJ. The distally based , cross-leg ,sural artery island flap. Plasr Reconstr Surg 2001;108(3):800.

13. Whetzel T, Barnard M, Stokes RB. Arterial fasciocutaneous vascular territories of the lower leg. Plast Reconstr Surg 1997; 100(5): 1172-1183.

14. Cavadas PC. Reversed saphenous neurocutaneous island flap: clinical experience .Plast Reconstr Surg 1997; 99(7):1940-1946.

15. Rajacic N, Darweesh M, Jayakrishnan K, Gang RK, Jojic S. The distally based sural flap for reconstruction of the lower leg and foot. Br J Plast Surg 1997; 49(6):383-9.

16. El Khatib H. Reversed skin island fascial pedicle flap of the posterior calf for distal defects of the leg and foot: An alternative for free flap transfer. Ann Plast Surg 2001;46(2):193-194

17. Yang DP, Fang DY, Guo TF, Han XF. Vascular anatomy and clinical applications of the distally based superficial sural artery island flap. Zhonghua Zheng Xing Wai Ke Za Hi 2004;20(1):24-6.

18. Maffi TR, Knoetgen J, Turner NS, Moran SL. Enhanced survival using the distally based sural artery interpolation flap. Ann Plast Surg 2005;54(3):302-305.

19. Jeng SF, Hsieh CH, Kuo YR, Lin TS, Wei FC. Distally based sural artery flap.Plast Reconsrt Surg 2003; 111(2): 840-841.
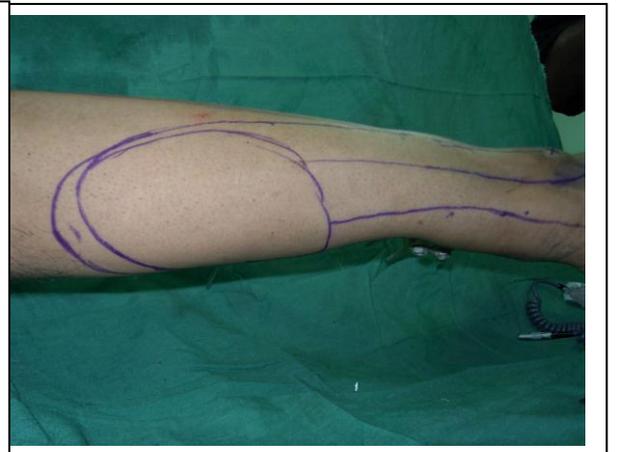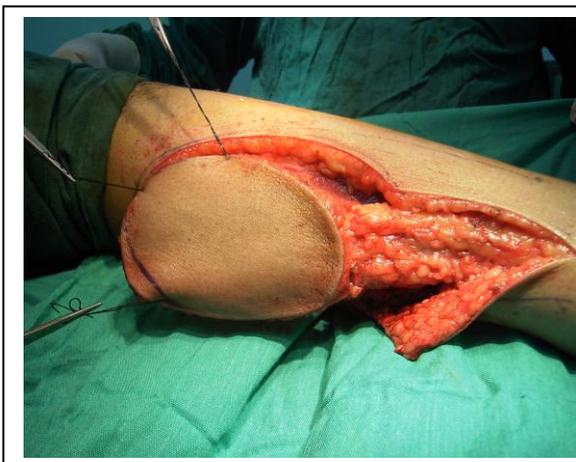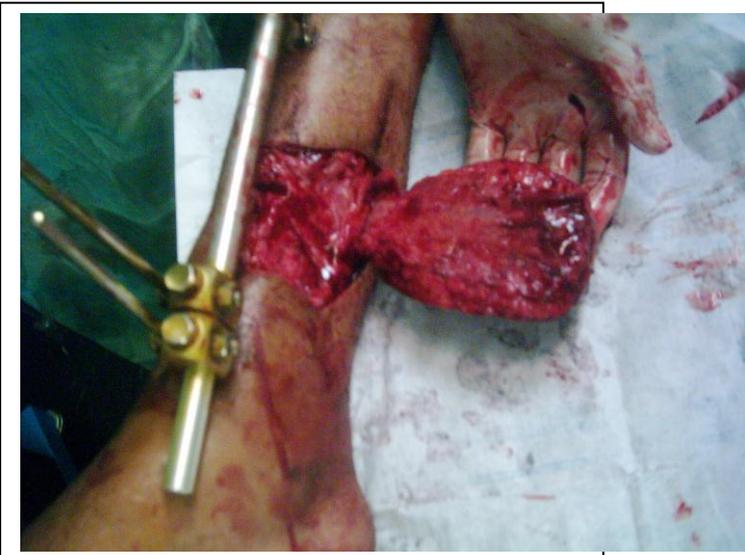
Figure : Distally based superficial sural artery flap for reconstruction of 8 cm by 6 cm post traumatic defect in the lower third of the leg.