

Local fasciocutaneous flaps: Reliable answer for skin coverage over annoying ankle defects and relief from microsurgery: Series of 62 cases

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Abstract

The management of soft-tissue defects in the lower limbs due to an increase of high energy trauma currently has become a very frequent procedure. Defects over ankle region are problematic because of the limited mobility and availability of the overlying skin and on the other hand, there is relatively poor vascularity of the skin of lower leg area. Various reconstructive options available are local, distant and free flaps. With the advancement of microsurgical techniques, free tissue transfer has provided an elegant method of soft tissue cover for ankle defects. Major disadvantage for free tissue transfer is in availability of microsurgical set up at remotely based trauma centers managed single handedly by orthopedic and trauma surgeons. This makes local flaps an inevitable option for ankle soft tissue defects. This report is based on our study of different type of local fascio-cutaneous flaps used in 62 patients for soft tissue coverage for defects in lower leg especially over tendo-achillis region.

Level of clinical evidence- 2

Keywords: Fasciocutaneous flaps, Foot and ankle defect, Reverse-flow sural flap.

Introduction

The management of soft-tissue defects in the lower limbs due to an increase of high energy trauma currently has become a very frequent procedure. The orthopedic surgeon should be capable of carrying out an integral treatment of these lesions, including not only open reduction and internal or external fixation of the fracture fragments, but also the management of possible complications such as local skin loss. Such defects over ankle are problematic because of the limited mobility and availability of the overlying skin and on the other hand, there is relatively poor vascularity of the skin of lower leg area. Various reconstructive options available are local, distant and free flaps. The flap chosen should be easy to execute, with minimal discomfort to the patient and should provide durable coverage of the defect. With the advancement of microsurgical techniques, free tissue transfer has provided an elegant method of soft tissue cover for posterior ankle defects. Major disadvantage for free tissue transfer is inavailability of microsurgical set up at remotely based trauma centers managed single handedly by orthopedic and trauma surgeons. This makes local flaps an inevitable option for tendo-Achillis region soft tissue defects.

We were interested in assessment of various local fascio-cutaneous flaps for reconstruction of soft-tissue defects around ankle and especially tendo-achillis region. Our aim was to study success rate of various flaps at different defects and secondary aim was to assess long term outcome regarding rehabilitation of patient. We undertook a retrospective cohort study to assess outcomes in patients who had undergone reconstruction of ankle and foot defects with various local fascio-cutaneous flaps.

Patient and Methods

This study is a retrospective review of the local

fasciocutaneous and neurocutaneous flaps for skin coverage of defects over ankle carried out between august 2013 to july 2015 in 62 patients (Table 1): 42 men and 20 women with an average age of 43 years (ages 17–68 years) and a postoperative follow-up of average 14 months. Eight patients were diabetic and eleven patients were smokers. Fifty two cases were post traumatic etiology, 8 were post cellulitis, and 2 were post-surgical wound dehiscence. Average size of defect was 8x5 cm with largest defect of size 12x7 cm. Forty two patients were managed with reverse-flow sural flap cover out of which 8 were island reverse sural flaps, 10 cases with reverse saphenous flap cover, while 4 cases were managed with lateral supramalleolar flap cover, 4 with propellar flap and 2 cases with V-Y advancement.

Table 1

Sex	No of patients
Male	42
Female	20
Etiology	
Post-traumatic	52
Post cellulitis	8
Post surgical	2
Management	
Reverse-flow sural flap	42
Standard	34
Island	8
Reverse saphenous flap	10
Lateral supramalleolar	4
Propellar flap	4
V-Y advancement	2

Surgical technique

Reverse-flow sural flap: The sural fasciocutaneous flap relies on the vascular axis of the sural nerve which consists of the median superficial sural artery and the lesser saphenous vein. This axis courses between the heads of gastrocnemius muscle to a region just proximal to the lateral malleolus at which several cutaneous branches anastomose with approximately 3–5 septocutaneous perforators from the peroneal artery. These anastomoses ultimately form the reverse flow arterial supply of the reverse sural flap. They are located in the posterior crural septum beginning 5 cm proximal to the lateral malleolus and extending proximally. The lesser saphenous vein provides the principal venous drainage of the flap. Its identification and distal preservation is vital to the success of this flap. The patient was put in prone position and the distal aspect of gastrocnemius muscle marked. A line was marked beginning at a point midway between the lateral malleolus and the Achilles tendon and extended superiorly to the midline at approximately the junction of the proximal one third and distal two thirds of the leg corresponding to the two heads of gastrocnemius. The peroneal perforators were marked at 5–13 cm proximal to the tip of lateral malleolus. On the posterior calf, several cm distal to the popliteal fossa and according to the size demands of the defect, a skin paddle was designed. The skin island was incised down to the level of the dermis. In the proximal portion, sural neurovascular bundle and lesser saphenous vein were identified and ligated. The flap was raised to a point at least 5 cm proximal to the lateral malleolus to preserve the most distal peroneal perforator. a cuff of gastrocnemius muscle was included with the upper part of the flap. The flap was carefully mobilised and inset into the defect. The procedure was done under spinal anaesthesia. The recipient wound was prepared by refreshing its edges, removal of granulations and thorough washes with normal saline. In cases where chronic exposure of the bone had resulted in drying and desiccation of the bone it was debrided until healthy bleeding from the bone started. Donor area was grafted with a split thickness skin graft harvested from the medial surface of the same or the contralateral thigh and a slab given for 5 days to ensure graft take.

Reverse saphenous flap: The flap was elevated proximal to distal in supine position. Anterior margin of flap was kept just medial to medial margin of tibia and posterior margin did not cross midline. Dissection proceeded in a plane deep to deep fascia. Care was taken to include both great saphenous vein and saphenous nerve in the flap. Distally pivot point was kept 5-6 cm proximal to medial malleolus, thus preserving most distal perforator of posterior tibial artery (present 5-6 cm proximal to medial malleolus). Doppler should be used to locate the perforator

preoperatively and to plan the flap more accurately. The flap was turned and insetted in the defect taking care not to twist the pedicle. Donor site was closed with split thickness skin graft. Limb was immobilised for 3 weeks avoiding pressure on flap and pedicle.

Lateral supramalleolar flap: The patient is placed supine with a roll or a pillow placed under the ipsilateral hip. Assessment of the defect is carried out and the size of the flap marked within the vascular territory. A hand-held Doppler probe can be used to locate the perforating branch, and its position is marked. A tourniquet is used during the dissection. The ulcer is excised and the defect thoroughly irrigated. The margins of the flap are then incised down to the deep fascia. The deep fascia is incised and the flap raised proximally to distally in the sub-fascial plane to locate the perforator. Once the perforator is located and preserved, the remainder of the flap is raised. The flap is then rotated into the defect based on its vascular pedicle. The donor can be closed with split-thickness skin graft.

Propellar perforator flap: The preoperative detection of the perforators in the distal lower leg is useful. For the beginning, only one edge of the future flap is incised, and this incision must be not only in the limit of the planned flap, but also of a possible alternative flap, if a suitable perforator isn't found. The incision should be made up to or deep to the deep fascia, and is followed by subfascial dissection under magnification and all the identified perforators are preserved. Once the best perforator(s) is chosen, according with its location, size, suitability to sustain the flap, number of venae comitantes, course and orientation, the definitive design of the flap is accomplished. The chosen perforator is cleared retrograde of all muscular branches and fascial strands for at least 2 cm, but no longer than needed for optimal flap's rotation. Now, the incision around the flap and the harvesting can be completed, but it's not yet rotated into the defect. The flap can be rotated in a clockwise or counter-clockwise direction, function of the angle between the proximal long axis of the flap and the defect, and attention should be paid to choose the right rotational direction to avoid kinking of the vessels. The donor-site can be partially directly sutured, and the remaining defect skin grafted.

Result

All patients were managed with local fasciocutaneous and neuro-fasciocutaneous flaps. All the flaps healed well except for one reverse saphenous flap loss in diabetic and smoker patient, managed with VAC dressing followed by SSG. 3 patients out of 42 reverse sural flap, 2 out of 10 reverse saphenous flaps and 2 out of 4 lateral supramalleolar flaps showed marginal flap necrosis. 2 of these were managed with debridement and flap advancement while rest 6 patients required no active intervention and healed well with regular dressings. 4 cases of propellar flaps and 2 V-Y

advancement flaps survived well without any complication. Donor site in all patients healed well without any morbidity except 4 patients with minimal graft loss, managed with regular dressings and secondary healing. (Table 2)

All patients had a normal gait, were able to stand on tip toes, had active plantar flexion and had returned to their original occupation 3 months after reconstruction. They had full range of movement at the ankle.

Table 2

	Total flap loss	Marginal necrosis	Donor-site morbidity
Reverse-flow sural flaps	0	3	3
Reverse saphenous flaps	1	2	0
Lateral supramalleolar flap	0	2	1
Propellar flap	0	0	0
V-Y advancement	0	0	0

Discussion

Defects over the posterior heel have been difficult to cover especially in case of combined injuries involving the weight bearing part of the heel and require a well vascularised reconstruction having a good durability and sensation because of its location and repeated friction by footwear. There are many possible reconstructive options for this region, including local flaps, distant flaps and free flaps. The aims of the reconstructive exercise in such cases are:

1. To provide vascularised soft tissue cover
2. To address the contour defect,
3. Protect the tendo achilles
4. Allow smooth gliding of the tendon; and
5. To provide durable skin cover to allow wearing of shoes.

With the advancement of microsurgical techniques, free tissue transfer has provided an elegant method of soft tissue cover for posterior ankle defects. The advantage of free flap reconstruction is that the Achilles tendon is covered with a healthy layer of viable tissue that decreases the risk of tethering and subsequent ulceration.¹ Even single stage coverage plus functional reconstruction is reported with free tissue transfer.² Major disadvantage for free tissue transfer is in availability of microsurgical set up at remotely based trauma centers managed single handedly by orthopedic and trauma surgeons. In addition, there is the donor-site morbidity to consider and a prolonged hospital stay that usually requires one night in the intensive care unit for flap monitoring. This makes local flaps an inevitable option for ankle defects.

Distally based superficial sural artery flap originally described by Masquelet in 1992 is a skin island flap that has reliable blood supply, easy and quick to elevate and major arteries are not sacrificed.³ This flap is useful in moderate sized Posterior heel defects with exposed Tendoachilles or Calcaneum . Sacrifice of the sural nerve causes sensory loss over the lateral part of the foot. Except the inferior aesthetic appearance of donor site, loss of sensations over the

lateral aspect of foot, flap does not affect the function of the limb.^{4,6} (Fig. 1, 2)

Reverse saphenous flap is a neuro-veno-fasciocutaneous flap on medial aspect of leg. The vascular axis of the flap is based on arterial plexus around great saphenous vein and saphenous nerve. This plexus is in communication with perforators from posterior tibial artery 5-6 cm above medial malleolus. A study by Mao H et al on reverse saphenous flap showed detailed anatomy and vascular basis of the flap reconfirming th reliability of the flap.⁷

The lateral supramalleolar flap is a fasciocutaneous flap raised on the distal perforating branch of the peroneal artery as its vascular pedicle. Masquelet et al., showed that the perforating branch of the posterior peroneal artery consistently emerges from a groove between the tibia and the fibula, just proximal to the distal tibiofibular ligament and can be found 5cm above the lateral malleolus. It divides into a superficial (ascending) cutaneous and a deep descending branch shortly after perforating the interosseous membrane. The superficial cutaneous branch supplies a skin territory approximately 12.0-18.0cm in length and 9.0cm in width, corresponding to an area on the lower half of the leg from the tibial crest to the posterior margin of the fibula.⁸ The lateral supramalleolar flap can be used for a very distal foot defect coverage involving both surfaces. Since its description by Masquelet et al., supramalleolar fascio-utaneous flap has become an alternative to sural flap. Some consider it even better and also as a substitute for free flaps in the distal leg, ankle, and foot soft tissue defects.⁹

In their series of 17 reverse-flow sural flaps, Yilmaz et al¹⁰ showed, there was marginal necrosis in one patient and partial flap necrosis in another patient as compared to marginal flap loss in 3 out of 42 patients of our series.

V-Y plasty technique is common in plastic surgical practice. This technique is probably described by Blasius.¹¹ In this technique, an incision is made as V pattern and the V patterned skin is approached to cover the defected area as Y shape. Most authors offered the technique as a reliable method for reconstruction of

relatively small defects.^{12,13} Although V-Y plasty is a common procedure to cover the defect it has limited usage in covering of lower extremity defect. V-Y plasty has one session operation, short operation time and a reliable method.

The concept of propeller flap belongs to Hyakusoku et al.,¹⁴ which described in 1991 an adipocutaneous flap designed as a propeller, blood supplied through a random subcutaneous pedicle and rotated 90 degrees. The term was used for the first time to define a perforator flap based on a skeletonized perforator vessel and rotated 180 degrees by Hallock in 2006.¹⁵ The ultimate definition and terminology of propeller perforator flaps was reached by an Advisory Panel of the First Tokyo Meeting on Perforator and Propeller Flaps in 2009.¹⁶ According with this consensus, a propeller perforator flap is designed as a skin island with two paddles which can be of the same dimensions or with a larger and a smaller one, the demarcation limit between them being the perforator vessel. To be a propeller flap, it has to rotate around the perforator vessel for at least 90 to 180 degrees.

A study by Kansal et al on 96 cases of reverse saphenous flaps showed 2 cases of flap necrosis and 3 cases of total flap loss.¹⁷ While our series had total flap loss in 1 patient and marginal loss in 2 cases out of 14 cases. In case of lateral supramalleolar flap we had 2 cases of marginal flap necrosis. This was slightly more as compared to Magdy Abd Al Moktader et al, who had 2 cases of marginal flap loss out of 16 cases.¹⁸ Both the V-Y advancement flaps survived well without any complication in our study. Some other studies mention this method for leg defect reconstruction. Reconstruction of lower extremity defects, especially weight bearing areas, needs special attention by Yaremchuk MJ, 1989 and Maruyama Y et al, 1990.^{19,20} In our study all 4 propellar flaps survived well without any complication. Koshima et al. used a posterior tibial artery propeller perforator flap of 19×13 cm, and Quaba and Quaba extended the length of the same flap to within 10 cm of the popliteal skin crease.^{21,22}

To conclude the goal of reconstruction for ankle soft tissue defect is to provide sensate and stable coverage with minimal donor site morbidity. Basic principles of wound management with debridement, prevention of infection, and early soft tissue reconstruction are important. These defects especially involving the weight-bearing heel are difficult to cover and require a sensate flap and glabrous skin. Thin and pliable skin cover is essential over ankle region for comfortable usage of footwear and avoid friction damage with recurrent ulcerations due to footwear. The simplest appropriate technique for the reconstruction of the injured foot is likely to produce the best outcome. Simple locally available fascio-cutaneous flaps are handy and should be rehearsed well by all orthopedic and plastic surgeons.

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