DISTALLY BASED SURAL FASCIOCUTANEOUS FLAP FOR SOFT TISSUE RECONSTRUCTION OF THE DISTAL LEG, ANKLE AND FOOT DEFECTS

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Background: Soft tissue management around the lower third of the leg and foot presents a considerable challenge to the reconstructive plastic surgeon. The options in this region are limited. A durable flap is the preferred option for coverage of such defects. This descriptive study was conducted at Hayatabad Medical Complex and Said Anwar Medical Centre Peshawar over a period of 4 years to evaluate the efficacy of distally based Sural flap in coverage of the lower third of leg, ankle and foot defects, in 25 patients. **Methods:** A descriptive study was conducted at the department of Plastic and Reconstructive Surgery at Hayatabad Medical Complex and Said Anwar Medical centre Peshawar. 25 patients with soft tissue defects over the distal leg and foot were included in this study. Distally based sural fasciocutaneous flap was used for coverage in all cases and its survival, successful coverage of the defect and donor site morbidity studied. **Results:** Out of 25 flaps, 20 showed complete survival (80%). Partial flap loss was found in 2 patients (8%), marginal flap necrosis in 2 patients (8%) and complete loss in 1 patient (4%). **Conclusions:** The distally based sural flap is a versatile and reliable flap for the coverage of soft tissue defects of the distal lower extremity. The procedure is done as a single stage; the dissection is easy with short operating time and minimal morbidity.

Key Words: Distally based Sural flap; distal leg, heel and foot defects; reconstruction of foot

INTRODUCTION

Soft tissue management around the lower third of the leg and foot poses a considerable challenge to the reconstructive surgeon because of the composite tissue defects, inadequate and tight local tissues and poor circulation.[1] Tendons, bone or hardware are frequently exposed because of the thinness of subcutaneous tissues, making skin grafting a poor option.[2] A durable flap with good skin texture, reliable vascularity, good arc of rotation, ease of dissection and minimum donor site morbidity is the most desired option for coverage of such defects.[3,4]

The different local flaps for hind foot defects including dorsalis pedis artery flap, abductor hallucis and abductor digiti minimi muscle flaps, have inadequate tissue and a limited arc of rotation thereby limiting their frequent use. Medial planter artery flap is an ideal option for the weight bearing heel but its involvement in trauma frequently precludes its use.[5]

Locoregional flaps for lower leg and ankle defects such as peroneal artery flap, anterior and posterior tibial artery flaps have the disadvantage of sacrificing a major artery in an already traumatized leg.[6] Supramalleolar flap is another option but its reliability is questionable in case of vascular compromise.[7] Free tissue transfer is ideal option in most circumstances but the need for microsurgical expertise and prolonged operating time remain its disadvantages.[8]

The distally based sural flap, first described by Masquelet *et al*[9] in 1992 as a neurocutaneous island flap, is another option for coverage of lower 1/3 of leg, ankle and foot defects.

The objective of this study was to evaluate the efficacy of distally based sural flap.

MATERIALS AND METHODS

We carried out this descriptive study at the Department of Plastic and Reconstructive Surgery, Hayatabad Medical Complex, and Plastic and Reconstructive Surgery Unit at Said Anwar Medical Centre, Peshawar over a period of 4 years from January 2005 to December 2008. It included 25 patients having soft tissue defects of lower third leg, Achilles tendon, heel, malleoli and dorsum of foot. Patients with scarring or wounds on the posterior calf or the pedicle site were excluded from the study.

Preoperatively the age and sex of each patient, cause, size and site of the defect, time since injury, exposure of bone or tendons, presence of chronic osteomyelitis, and any co-morbid conditions were noted. All patients with exposed bones or fractures were radiographed. Per operatively dimensions of the flap, level of proximal flap margin when designed on the leg (which would be the distal flap end when mobilised over the defect), island or paddled, tunnelling or exteriorising of the pedicle, capillary refill or any congestion at the end of the procedure were recorded. In the immediate postoperative period the flap was monitored for any venous congestion or pallor. Functional and aesthetic outcome was noted in terms of complete or partial flap survival, successful coverage of the recipient defect, healing of any underlying fracture proved radiographically, ease or difficulty in walking or wearing shoes, ambulatory status of the injured limb after six months and any concerns of the patient regarding the

aesthetic appearance of the flap. Donor site healing or any complication was also recorded. The patients were questioned about any botheration due to the loss of sensibility in the sural distribution area, i.e., the lateral side of the foot, any painful neuromas, or any concerns about the aesthetic disfigurement at the donor site. Pre- and postoperative photographs of each patient were taken and the surgical procedure was performed by one surgeon. Patients were discharged on the 3rd postoperative day in case of uneventful recovery and called back on the 5th postoperative day to remove the graft dressing. They were followed for at least 6 months.

The technical details of the procedure:

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 septocuataneous 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. Reverse venous drainage occurs clinically and angiographically. Reverse flow is said to occur due to the presence of bridging vena commitants that by pass the venous valves.[10] In addition, the dennervation of the veins during flap elevation is also a contributory factor towards valvular incompetence.

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 island or paddle was designed in a tear drop shape with a distal taper in order to facilitate closure distally (Figure-1). The skin island was incised circumferentially down to the level of the dermis. In the proximal portion, sural neurovascular bundle and lesser saphenous vein were identified and ligated (Figure-2). The flap was raised to a point at least 5 cm proximal to the lateral malleolus to preserve the most distal peroneal perforator (Figure-3). The skin island was designed higher in the proximal third of the leg when either the most distal perforator was compromised in trauma or coverage of a very distal defect on the foot was needed. In these cases a cuff of gastrocnemius muscle was included with the upper part of the flap. About 4–5 cm of fat and subcutaneous tissue was raised along with the pedicle to ensure the safety of the neourovascular bundle. The flap was carefully mobilised and inset into the defect, by either tunnelling or dividing the skin bridge thus exteriorising the pedicle to avoid pressure on it (Figure-4).

The procedure was done under general 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 (Figure-5, 6, 7). Donor area was grafted with a split thickness skin graft harvested from the medial surface of the same or the contralateral thigh and a back slab given for 5 days to ensure graft take.

RESULTS

Over the period of 4 years, a total of 25 distally based sural fasciocutaneous flaps were performed on 25 patients. Twenty (80%) patients were male while 5 (20%) were female. Their age ranged from 2 to 60 years, with a mean age of 25 years. The patients included 9 children below the age of 12 years.

Road traffic accident was the cause of soft tissue defect in 19 (76%) patients; other trauma (including earthquake and falls) in 4 (16%), and electric and bomb blast injury in 1 (4%) patient each.

The site of the defect was distal third of the leg in 9 (36%) patients, heel in 9 (36%), lateral malleolus in 3 (12%), and 2 (8%) each for exposed achilles tendon and dorsum of foot. Of the heel defects 5 were on the posterior non weight bearing area, 4 on the anterior weight bearing area and 1 involved the complete sole of the foot (Figure-8, 9). The ones on the anterior weight bearing heel area had extensive sole injury with involvement of medial plantar flap area in the injury zone.

Most of the defects (68%) were chronic and in cases of bone exposure showed dry and desiccated outer cortices. The defects on the distal third of the leg included exposed fracture of tibia in all patients. Of the distal leg and heel defects 7 each were more than three weeks post injury while the rest were within 2 weeks of injury.

Of the 3 malleoli defects, one as a result of electric injury was present for one and a half years, while 6 weeks had passed in another. Amongst the defects on the Achilles tendon 1 presented as a non-healing ulcer in a 60 years old man with varicose veins of the long and short saphenous system, for the last 20 years (Figure-10, 11). Rest of the defects on the Achilles tendon area, malleolus and dorsum of foot were within two weeks of injury.

Figure-1

Figure-2:

Figure-3:

Figure-4

Figure-5

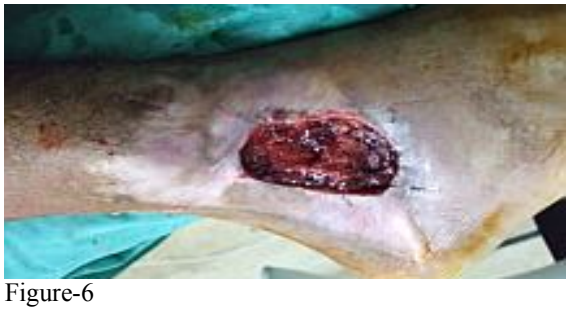

Figure-6

Figure-7

Figure-8

Figure-9

Figure-10

Figure-11

The dimensions of the flap ranged from 6–12 cm in length and from 4–8 cm in width. The mean length was 8.4 cm and mean width 5.7 cm. Twenty-two (88%) flaps were islanded while 3 (12%) flaps were harvested with skin paddle. The flaps for defects on the distal leg, Achilles tendon, malleolus and posterior non weight bearing, were designed lower in the leg in its middle third and the flaps proximal limit did not encroach the upper third of the leg. The remaining flaps were designed higher in the proximal third of the leg

and a gastrocnemius cuff was included in the upper part of the flap. The pivot point was kept 6–7 cm proximal to the lateral malleolus in all cases.

Out of 25 flaps, 20 showed complete survival (80%). Partial flap loss (up to one third but less than half of the flap) was found in 2 patients (8%) with anterior weight bearing heel and dorsum of foot defects; marginal flap necrosis in 2 patients (8%) with anterior tibial and anterior heel defect and complete loss in 1 patient (4%) with extensive heel injury. In all patients with complete survival of the flap and those with marginal necrosis (88%) (the necrosed area was debrided, flap advanced and resutured to the defect margins) successful coverage of the defect was achieved. Healing of tibial fractures was noted in all but one patient where later chronic osteomyelitis required raising of the flap and debriding the infected bone. Out of the heel flaps one needed debulking later, for easy fit in the shoes. Rest did not have any problem with wearing shoes. The patients did not experience any difficulty in walking after coverage of the anterior weight bearing heel defects. Most of the patients especially where chronic exposure was a problem, found a relief in the coverage of the defect. Two patients (8%) with the flaps for lateral malleolus and Achilles tendon coverage were concerned about the appearance of the flap. They were later serially debulked.

In all cases the donor site showed uneventful recovery and good graft take. None complained of any painful neuromas or showed any concern about the sensory loss over the lateral aspect of the foot. Esthetically 8 (32%) found the donor site appearance of concern while the rest (68%) were not bothered.

DISCUSSION

Reconstruction of the lower leg and foot continues to be one of the most challenging tasks for the reconstructive plastic surgeon. An unreliable lower limb subdermal plexus translates to notoriously poor wound healing using cutaneous flaps[11]. Following the developments in flap surgery, pedicled fasciocutanous flaps and free flaps have been used. The introduction of distally based sural fasciocutaneous flap provides reliable and effective method to cover skin defects of distal leg, foot and ankle.[9,13]

The defects reported in the literature that needed repair, include those resulting from road traffic accidents, non healing skin wounds, chronic venous ulcers, chronic osteomyelitis in diabetics, contractures, gangrene, unstable scars, cancer resections, and electrical burns.[6,12] The major cause of defects in our patients included trauma due to road traffic accidents, similar to some other studies.[2,7] Our study included 9 children with complete flap survival showing that sural flap is equally applicable in paediatric population. The lower leg and heel were the most frequently involved sites in our study.

The flap can be used to cover exposed vessels, bones, tendons, and internal fixation hardware. It has been shown to be more reliable and a better choice than the lateral supramalleolar flap (another distally based fasciocutaneous flap used in the distal lower extremity). The flap has been shown to be successful in diabetic and medically compromised patient.[15] Anterior and posterior tibial vessels occlusion and varicose leg veins are not considered an absolute contraindication to the use of a distally based sural flap.[8,14] An occluded peroneal artery is however considered a contraindication. One of our patients had varicose veins of short and long saphenous systems. His flap showed no congestion in the postoperative period and survived completely. Similarly another patient was a non insulin dependant diabetic for the last 10 years. His flap used for anterior tibial coverage also survived completely with an uneventful recovery.

We noted complete flap survival in 80% of our patients, partial flap loss in 8%, marginal necrosis in 8% and complete loss in 4%, being comparable to other studies. Successful coverage of the defect was achieved in our study in (88%) of patients: complete survival 80% and marginal necrosis 8% (the necrosed area was debrided, flap advanced and resutured to the defect). A meta-analysis of 50 articles that report the use of 720 distally based sural flaps, suggested 82% success rate of the flap. Complete flap necrosis was reported in 3.3%, and partial or marginal flap necrosis in 11%.[16] Similarly, a detailed retrospective analysis of sural flap complication rate was recently performed on a series of 70 consecutive flaps. The complication rate reported was 59% (41 of 70 flaps), partial necrosis was noted in 17% and complete necrosis in 19% flaps.[17] Akhtar[2] in his study of 84 patients observed flap survival in 78.5%, partial necrosis in 16.5% and complete necrosis in 9.5%. The flaps that showed marginal or partial necrosis showed postoperative congestion. One of these was used for anterior tibial defect while others were for heel and dorsum of foot defects.

Various techniques have been adopted to increase the blood flow and hence the survival of the flap. These are: keeping the pedicle at least 4 cm wide, including a gastrocnemius muscle cuff especially when the flap is designed higher in the leg and sural flap delay procedures especially when large flaps are planned or if very distal foot defects need coverage.[18–21] Al-Qattan has also used the muscle cuff as a plug for small lower limb defects following debridement of infected/necrotic bone.[22,23] We included gastrocnemius muscle cuff when the flap was raised from higher in the leg, delayed one flap and kept the pedicle width to a minimum of 4 cm in all cases. The complete survival observed in our flaps

used over the anterior heel or dorsum of foot defects could be due to these modifications.

The only flap that showed complete loss in our study was in a patient with extensive heel defect due to a road traffic accident. We suspect that due to the shearing and avulsion of surrounding tissues the perforator 5 cm proximal to the lateral malleolus, which was the point where we pivoted the flaps, might have been injured. Many studies have shown the usefulness of doppler in such cases.[16] It is therefore recommended that in cases with extensive trauma, doppler identification of the perforators be done before deciding on the pivot point.

Many studies have suggested that venous congestion, and not lack of arterial supply, is the most significant reason for flap necrosis.[17] The fundamental problem is the presence of venous valves that can prevent the retrograde flow of blood out of the flap in spite of the venous collateral vessels. The methods reported to improve venous outflow are exteriorising the pedicle[24], intermittent drainage of short saphenous vein[16], leaches, and the supercharging of the flap by anastomosing the proximal end of the lesser saphenous vein to a vein in the recipient defect[25]. In our patients that experienced marginal or partial loss venous congestion was noted postoperatively. We exteriorized the pedicle if found the bridging skin tight or if congestion of the flap was noted after tunnelling of the pedicle. Notable improvement in the congestion of flaps was seen in these cases.

CONCLUSION

The distally based sural flap is a versatile and reliable flap for the coverage of soft tissue defects of the distal lower extremity. The procedure is done as a single stage; the dissection is easy with a short operating time and minimal morbidity.

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