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Hindfoot Reconstruction Using the Distally Based Hemisoleus Muscle Versus the Distally Based Sural Flap: A Comparative Study

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ABSTRACT

Background: Reconstruction of soft tissue defects of the heel area has always been problematic. The importance of this area as a pressure point, lack of soft tissue bulk in the surroundings and the prevalence of the cases has made it of great interest. The main goals of reconstruction of heel defects include appropriate soft tissue coverage to facilitate weight bearing, overcome friction and sufficient blood supply to prevent osteomyelitis and overcome infection. Heel defects are stubborn and liable for recurrences and complications. In this study we had thirty cases of soft tissue defects of the heel region, cases were divided into two equal groups: Group A were reconstructed by distally based sural flaps, while defects in Group B were covered by distally based hemisoleus muscle flaps. We studied the requirement of the different defects and the availability, durability, advantages and disadvantages of each flap.

Aim of the Work: To assess the advantages ,disadvantages and contraindications of using both the distally based sural fasciocutaneous flap and distally based hemisoleus muscle flap in the management of defects of the hindfoot.

Conclusion: Hemisoleus muscle flap showed more superior results than distally based sural flap in coverage of heel defects especially in cases with osteomyelitis, fracture calcaneous and exposed hardware. The muscle flap provided viable vascular bulky coverage with high tolerance to pressure and friction, control of osteomyelitis and infection and acceleration of fracture healing. The muscle flap was bulky enough to fill the deep defects and showed good resistance to shearing forces. Distally based sural flap provided a thin pliable easy flap to elevate and proved a good alternative to muscle flaps in cases of injured or occluded posterior tibial artery. Donor site was closed directly in all cases of hemi-soleus muscle flap but not routinely in distally based sural flaps that made this flap more preferable in female population.

INTRODUCTION

The hindfoot is a special anatomical location, requiring unique forms of reconstruction of the thick, durable heel pad and the underlying calcaneus,also the achilles tendon and its thin, pliable soft tissue envelope. Perhaps more than in any other region of the foot, the heel poses a reconstructive challenge to the surgeon who must consider both form and function when repairing wounds in this location. There are many possible reconstructive options, including local, distant, and free flaps. These flaps could be of muscular, myocutaneous or fasciocutaneous tissues.

The toes, distal and mid-metatarsal region, and lateral-border of the foot and the heel are the weight-bearing zones of the foot. The heel and hallux bear the majority of the weight, whereas the arch carries no load [1-4]. The etiology of heel defects includes trauma,vascular disease, tumor excision, infection, and metabolic disease, and the surgeon must consider these different pathologies when repairing wounds in this area. Chronic ulcers located on the weight-bearing surface of the foot limit patient's activities and increase the load on the contra lateral foot. Plantar defects may also progress to advanced stages in patients with neurologic deficits or diabetes, which frequently results in osteomyelitis of the calcaneus [1-4]. Tissues that provide adequate coverage, stability, and sufficient blood supply to prevent osteomyelitis are preferred for reconstruction of these defects.

Numerous techniques have been proposed for repair of foot defects, with each carrying its own relative benefits and disadvantages. Simple defects may be covered with skin grafts, which yield better results if applied to areas of the sole that do not receive weight [1,5]. Full-thickness skin grafts have also been associated with hyperkeratosis and ulcerative changes on long-term follow-up [1,6,7]. Skin grafts may also be less successful in patients with diabetes,vascular compromise, neurotrophic ulcers, and osteomyelitis [1,7].

Several types of flaps also exist. The thick and non-elastic skin of the sole of the foot limits the use of random pattern rotation, transposition, V-Y advancement and bipedicled flaps to selected situations [1,6-8]. In addition, hyperkeratosis of local tissues, maceration, osteomyelitis, and vasculopathies limit the indications for these flaps [9,10,11].

Both the flexor digitorum brevis and abductor digiti minimi muscle flaps may be used for calcaneal defects. Both flaps carry insufficient padding because of their thin nature, although some studies suggest that an additional procedure may provide these flaps with sensate tissue [1,8]. In addition, use of the flexor digitorum brevis muscle may limit plantar flexion of the toes and create an unwanted mass prone to increased pressure as the muscle is folded back on itself. The abductor hallucis muscle is located in the medial compartment of the foot between the medial and superficial plantar fascia, coursing from the calcaneal tubercle to the proximal phalanx of the hallux [2-4]. The muscle is surrounded by the intermuscular septum laterally and the first metatarsal bone dorsally. Anatomic studies have shown this muscle's arterial supply to be from 3 sources: The medial plantar artery, the deep branch of medial plantar artery, and superficial branches of medial plantar artery. Sensory and motor innervation is provided by medial plantar nerve [2,4].

Townsend was the first to use the soleus muscle flap based on distal minor pedicle from the posterior tibial artery for reconstruction of distal leg defects, at least the most two distal perforators are sufficient to maintain the flap viability in coverage defects of the malleolar region [12]. The reversed hemisoleus flap, based on the distal minor pedicles was used to cover defects exposing the medial malleolus, the ankle joint or the tarsus. Functional part of the muscle was retained to preserve plantar flexion of the foot in ambulatory patients and to maintain its role as a major pump for venous return from the lower limb [13]. Reconstruction of leg and foot defects by free tissue transfer has several advantages. It is not dependent on the vascularity of the wound bed and allows replacement of composite tissue defects [14,15]. The increased capillary density in muscle provides greater antibacterial activity in cases of chronic osteomyelitis [16-18].

Fasciocutaneous flaps of the distal lower leg and ankle have been rediscovered nowadays. They do not sacrifice any discrete named vessel and can be rapidly elevated and inset to the defect [19-20]. The use of distally based sural flap was introduced by Donski and Fogdestam, and revised later by Masquelet et al., [21,22]. It is considered a mainstay in reconstruction of the lower leg, heel and ankle regions [23]. The flap can be used despite of diminution of the blood supply from peripheral vascular disease or local trauma.

It is difficult to replace the functional complexity of the weight bearing area of the foot. Transferred tissues have to resist the shearing forces in order to prevent complications as ulcerations, hypertrophic scar formation and hyperkeratosis. The skin on the plantar area of the foot is the thickest in the body and is supported by dense subcutaneous tissue with vertically oriented fibrous septae that anchor the plantar skin to the underlying fascia [24]. On contrary the calcaneal area has a unique form and is covered by thin mobile skin. In this work we studied using both distally based sural fasciocutaneous flap and distally based hemisoleus muscle flap in management of defects of the hindfoot region (calcaneal and tendoachililis region).

PATIENTS AND METHODS

Thirty patients suffering hind foot soft tissue defects (calcaneal, heel and tendoachilis region) were operated upon in the Plastic Surgery Department of Ain Shams University during the period from January 2010 to January 2011. Cases were divided into two equal groups; Group A included fifteen cases managed by distally based sural fasciocutaneous flap coverage, and group B in which fifteen cases were managed using the distally based hemisoleus muscle flap. In three of these cases the soleus muscle flap, it was raised in a reverse flow pattern based on the posterior tibial artery itself. Defects were of various etiologies; post traumatic defects in 14 cases, 7 diabetic, 3 cases with neurotrophic ulcers and 6 cases with unstable scars. Ages ranged from 24-50 years old 19 females and 11 males (Table 1).

The study required the presence of a complete medical record, including information regarding the patient's gender, age, occupation, functional needs, vascularity, neurological status, and specific wound characteristics, including aetiology, size and depth, and the status of the Achilles tendon (exposed or lacerated), condition of calcaneal bone fracture or comminuted. Routine investigations include full laboratory investigations, fasting and post-prandial glucose level, glycated hemoglobin, plain X-rays and douplex ultrasound and angiography for conditions of limb vessels (posterior tibial, anterior tibial and peroneal artery). Exclusion criteria included extremities of age, uncontrolled diabetes ,deformed or charcots foot and mutilating foot injuries that may require amputation. We excluded all cases with large size defects as they required coverage by microvascular free tissue transfer. All lesions were deep, and were classified according to size, exposed bone, tendons and hard-wear (exposed calcaneous with or without exposed tendoachillis) and osteomyelitis. Unnecessary metal hardwear were removed before reconstruction and 3 cases were included with exposed part of metal wire. All cases were classified into small and medium sized defects, there were 17 cases with defects smaller than 4 x 5cms small size defects and the rest medium sized defects smaller than or equal 9 x 8. There were 8 cases with underlying fracture calcaneus and 15 cases with exposed bone and tendoachilies and 3 cases with metal hardwear, 6 cases with osteomyelitis (Table 2).

Surgical technique:

Group A:

Preparation of donor site: The recipient site is prepared by excising all necrotic and scar tissue.

Angiography was done to all cases and cases with thrombosis and occlusion of peroneal artery were excluded With the patient in the prone position, a skin island is marked in the lower 2/3 of the leg along the axis of sural nerve and small saphenous vein, from the midline of the popliteal fossa to a point midway between Achilles tendon and the lateral malleolus. The pivot point ranges from 4-7cm proximal to the tip of the lateral malleolus depending on the length of the leg. This is important to protect the feeding distal peroneal artery perforators. Skin incision is begun from the proximal margin of the designed flap dividing the small saphenous vein, and the superficial sural artery superficial to the deep fascia. The sural nerve is usually found deep to the deep fascia in the upper half of the leg. In case of large flaps extending up to few centimeters from the popliteal crease, the medial border of the flap is first incised and dissection is carried from medial to lateral in order to identify the proximal part sural nerve running underneath the deep fascia before piercing it. In all cases, the fascia containing the neurocutaneous vessels between the sural nerve and the deep fascia was preserved. The proximal end of the sural nerve is cut short and buried deep between the two heads of gastrocnemius muscle. The flap was raised as an island flap with a teardrop configuration so that there is a cutaneous extension over the subcutaneous pedicle. This triangular skin was sutured to the both sides of the cut edges of the skin bridge rather than tunneling the pedicle underneath it to avoid compression. The flap was raised with part of gastrocnemius muscle as a musculo-fascio-cutaneous flap in 2 cases and as a fasciocutaneous flap with muscle cuff to protect the sural neurocutaneous vessels in one case.

Closure of donor site:

All donor sites were grafted primarily with STSG from the contralateral thigh except in 3 cases in which direct closure was possible. Preoperative photos, flap design and intra-operative photos were recorded (Figs. 1a,b,c, 2a,b,c).

Group B:

Preparation of the reciepient site: The recipient site is prepared by excising all necrotic and scar tissue. Any orthopedic hardware is removed when indicated.

The presence of patent posterior tibial artery and dorsalis pedis artery were confirmed preoperatively by angiography. Flap elevation was performed through a medial approach. Intra operative exploration of the posterior tibial artery perforators was done routinely in all cases, presence of two distal perforators was necessary for flap elevation. In cases with insufficient number of perforators or failure of identification due to severe fibrosis and adhesions,or high location of these perforators, or due to nature of injury, the flap was elevated in a reverse flow nature including the posterior tibial artery. The arc of flap rotation was tested before elevation of the flap. If the flap was to be raised in a reverse flow pattern, the posterior tibial artery was dissected from the adjacent tibial nerve, care is taken not to jeopardize the tibial nerve blood supply and to maintain continuity with the flap and nerve, and perforators that will not be included will be ligated on this case. A microvascular clamp is applied on the artery proximal to the perforators included in the flap, aim of this is to ensure flap viability and also vascularity of the limb based on peroneal and anterior tibial artery if sufficient to support the limb. The proximal part of the artery is double ligated and flap is elevated and applied to recipient site.

Closure of donor site: All donor sites with direct closure. Preoperative photos, flap design and intra-operative photos were recorded (Figs. 3a-e, 4a-d).

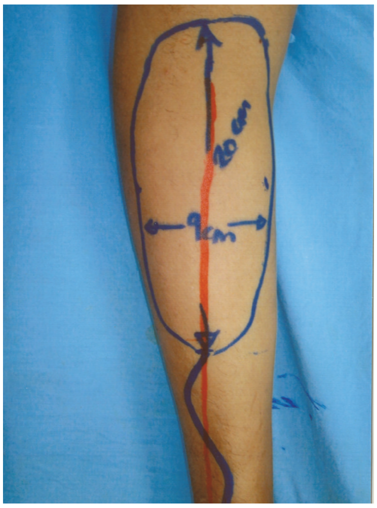
RESULTS

Objective evaluation was done through regular visits for follow-up till one year and by pre,intra and post-operative photography. We had no total flap loss in both groups. In Group A the distally based sural flap showed early congestion of the distal one third in 60% of the cases. We had 14% partial loss of the distal fourth which was followed by dressing, debridement and advancement of the flap. Recurrence of ulceration occured in two cases and one case of sinus and another case with bone exposure in Group A. Post-operative infection occurred in 5 cases of Group A, all improved with dressing. One patient in Group A complained of painful neuroma from the proximal cut end of the sural nerve which was not cut short and buried deep to the muscles. Primary closure of the donor site was done in three cases, immediate closure of the donor site by split thickness skin grafts in the rest of the cases. Cosmetic appearance was not acceptable for grafted donor site appearance especially in female patients. Postoperative photos were recorded (Figs. 1d,e, 2d,e).

In group B one week delay was used to make sure of muscle viability and control of infection then Split thickness skin graft was applied. There was partial muscle flap loss in the distal third in 6% cases. The muscle showed early bulkiness which was important to fill the depth and showed later shrinkage within the first six month of follow-up. This bulkiness did not impade the movement instead it resisted the shearing force and provided good pading. Stable, pain-free coverage was provided in all cases. The muscle flap showed good control of infection and osteomyelities, accelerated bone healing and coverage of exposed underlying structures together with no infection, ulceration or sinuses. There was no late functional complications in both groups. Postoperative photos were recorded (Figs. 3f, 4e).

Complications of both groups were recorded in Table (3) Resumption of weight bearing was possible after 4 weeks in all cases except when dictated by an associated fracture or vascular complications requiring a secondary reconstructive procedure. Follow-up of all cases continued for one year with monthly visits. Comparison of the results in Table (4).

1-A: Preoperative.



1-B: Planning of distally based sural Flap design.

1-C: Flap showing early congestion.

Group A: Case 1,2:

Fig. (1a,b,c,d,e) (Case 1): Case of unstable scar of the heel region, reconstructed by distally based sural flap.

1-D: Postoperative.

1-E: Late postoperative.

Fig. (2-a,b,c,d,e) (Case 2): Case of fracture calcaneus and exposed bone and tendoachilis.

2-A: Preoperative.

2-B: X-ray of calcaneal bone.

2-C: Flap design.

2-D: Early postoperative.

2-E: Late postoperative.

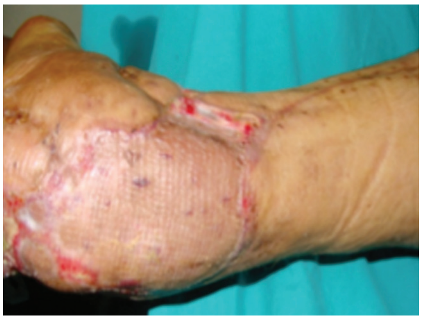
3-A: Preoperative.

3-B: Preoperative.

3-C: Intr-operative distally based hemisoleus muscle flap based on two distal perforators.

3-D: Intraoperative rotated distally based hemisoleus muscle falp.

3-E: Immediate postoperative.



3-F: Latepostoperative after application of STSG.

Group B: Case 3,4

Fig. (3-a,b,c,d,e,f) (Case 3): Case of exposed tendoachilis area reconstructed by distally based hemisoleus muscle flap based on distal two posterior tibial artery perforators.

Fig. (4-a,b,c,d,e) (Case 4): Case of post-traumatic defect of heel region and exposed calcaneal bone reconstructed by reverse hemisoleus muscle flap based on posterior tibial artery.

4-A: Preoperative.

4-B: Intraoperative reverse hemisoleus.

4-C: Intraoperative photo showing posterior tibial artery included with the flap.

4-D: Reverse flow hemisoleus rotated and covering heel defect.

4-E: Late postoperative.

Table (1): Aetiology of hindfoot defects in both groups.

	Post traumatic	Diabetic	Neurotrophic ulcers	Unstable scar
Group A	6	3	3	3
Group B	8	4	0	3

Table (2): Classification of cases according to size, exposed underlying structures (bone, tendon, hardwear) and osteomyelitis in both groups.

	Size		Fracture calcaneous	Exposed underlying structures	Exposed metal hardwear	Osteo-myelitis
Group A	Small	10	3	7	1	3
	Medium	5				
Group B	Small	7	5	8	2	3
	Medium	8				

Table (3): Complications in each group.

	Group A	Group B
Partial Flap loss	14% distal third	6% distal third
Infection	5	NO
Early congestion	60%	No
Bone exposure	One	No
Donor site	Hypertrophic scars on top of skin grafts	No
Early bulky flap	–	+
Recurrence of ulceration	Two cases	No
Sinus	One	No
Neuroma	One case	–

Table (4): Comparison between the two groups.

	Group A	Group B
Partial Flap loss	14%	6%
Resistance to infection	+	++
Early bulky flap	–	++
Control of osteomyelitis	+	++
Resistance to ulceration	13% less resistant	++
Donor site morbidity	+	No

DISCUSSION

The weight-bearing plantar portion of the foot can be divided into the heel (hind foot, plantar calcaneus), the lateral plantar foot (midfoot sole) and the plantar forefoot (forefoot sole), excluding the medial plantar (instep) area. Plantar skin has characteristics that differ from those of the skin covering other parts of the body. The epidermis and dermis are much thicker, and the fibrous septa binding plantar skin to plantar aponeurosis construct fat loculations that produce a shock-absorbing system. This special skin-aponeurosis system is crucial for the weight-bearing area of the foot. In addition, plantar skin has a specific pattern of pigmentation and is highly durable [25].

Reconstruction of defects of the weight-bearing surface of the foot represents a particular challenge to the foot and ankle surgeon. Although conventional local flaps can be used for the coverage of small defects, extensive and more complex defects can only be treated by microsurgical flap transfer. A reliable and Consistent method for reconstruction of the heel and the sole has yet to be proposed. Each of the numerous methods currently used carry certain advantages and disadvantages [5,15,17,18].

The loss of soft tissue at the level of the ankle and heel, with exposure of tendon or bone, represents a complicated problem for reconstructive surgeons because of lack of locally available tissues for transposition, relatively poor skin circulation, and the weight-bearing requirement of the region [1,2]. Specific surgical goals include maintaining the function of the Achilles tendon, restoration of the normal anatomy and reconstruction of soft tissue and bone deficiencies, recreation of the normal foot contour, and selection of a suitable donor site, in accordance with therequirements of the wound [3,4].

There are many reported flap modalities available for reconstructing of heel defects including local flaps such as transposition, rotation, and V-Y advancements flaps; island flaps such as medial plantar and lateral calcaneal flaps; local muscle flaps such as abductor hallucis, flexor digitorum brevis, and abductor digiti minimi muscle flaps; reversed fasciocutaneous flaps, such as that based on the sural nerve and its associated vessels; and free flaps that require micro vascular reanastomosis [1-4,8].

Before selection of a suitable graft or flap, the blood supply to the region should be assessed. As can be seen, the surgeon has a number of factors to consider in regard to selecting a reconstructive method that is likely to be successful. Additional consideration should also be given to the patient's age, whether or not the arterial supply is adequate for the reconstructive needs, whether or not the weight bearing and contact areas of the heel will be sensate, how the achilles tendon and calcaneus are to be covered or restored, and whether the functional needs of the patient will be met by the reconstructive efforts [26,27].

Defects over the weight-bearing part of the heel require a well-vascularized reconstruction having the characteristics of stability, adequate padding and durability. Different forms of soft tissue coverage are available, including muscle, fasciocutaneous, and free flaps [7]. However, in the presence of hindfoot soft tissue defects, particularly those involving exposure of the posterior tuberosity of the calcaneus, in patients who are not candidates for microsurgical free-tissue transfer, ipsilateral fasciocutaneous, or local muscle flaps, very few solutions are available in order to attempt limb salvage [28].

Pedicled and island medial plantar flaps proved to be very satisfactory in patients with small (_3cm diameter) ulcers in the plantar aspect of the heel, in terms of sole durability and similarity with the nearby tissues. In cases involving exposed achilles tendon and/or bone, flap coverage is mandatory. Whereas local transposition, local muscle, pedicled, and island flaps are suitable for small defects (_3cm), reversed local flaps and free flaps are essential for larger defects with no available local tissues [4,7,10,26,27].

The reversed flow sural flap reconstruction proved to be optimal for patients with clinically free distal leg collateral blood supply who also displayed a shortage of local tissues for potential coverage options, while avoiding the need to resort to more complex procedures requiring micro vascular reanastomosis of free flaps. This option provides relatively large flaps for coverage of large soft tissue defects, and inclusion of the short saphenous vein in our flaps appeared to overcome the common problem of venous congestion [21,23].

The vascular supply to the distally based sural fasciocutaneuos flap is derived from the retrograde perfusion of the arteries that accompany the lesser saphenous vein and sural nerve. These arteries descend along both sides of the lesser saphenous vein, either terminating or anastomosing with the septo cutaneous perforators of the peroneal artery 5 to 10cm above the lateral malleolus. The blood supply courses in a retrograde fashion from these perforators when the nerve and the arteries are cut proximally. The distally based lower-leg fasciocutaneous and adipofascial local flaps, described by Masquelet et al offer an easy and reliable surgical option, to free flaps in presence of distal third soft tissues defects of the leg and foot of small and medium extension [22]. Their use in acute and chronic traumatic soft tissue injuries, namely degloving, crush, and avulsion injuries with resultant loss of wound coverage, is well documented and is gaining widespread acceptance [1,9,10,11].

In our study, we performed distally based ipsilateral sural flap in fifteen cases. We marked a skin island lower 2/3 of the leg along the axis of sural nerve and small saphenous vein from the mid line of the popliteal fossa to a point midway between Achilles' tendon and the lateral malleolus. The pivot point ranges from 4-7cm proximal to the tip of the lateral malleolus depending on the length of the leg. This is important to protect the feeding distal peroneal artery perforators. Although no total flap loss occurred but early congestion occurred in 60% of cases. This flap was highly versatile and can be used in different aetiologies especially in cases with occluded posterior tibial artery. In this group we had 6 cases with post traumatic defects, 3 cases of diabetic feet, 3 cases with neurotrophic ulcers and another 3 with unstable scarring.

Neither occlusion of the anterior and posterior tibial arteries nor varicose veins is considered as an absolute contraindication for distally based sural flap [29]. However, most surgeons do consider that occlusion of the peroneal artery as a contraindication to this operation [30]. The flap has been shown to be successful in diabetic, medically compromised and pediatric patients [30]. The distally based sural flap may include part of gastrocnemius muscle to add bulk or to adequately fill bone defects [31]. It may include a midline cuff of gastrocnemius muscle around the sural pedicle to improve its blood supply and reduce the vascular complications [10].

A comparative study between it and the lateral supramalleolar flap showed that the distally based sural flap is easier to execute with easier postoperative care. It has a more reliable constant blood supply and its pedicle is less liable to anatomical variations or injury at the time of original trauma [32].

The sural angiosome was described as one of the four main angiosomes of the leg [33,34]. The distally based sural flap receives retrograde arterial supply from 3-6 septocutaneous perforators, the most distal of which is located between soleus and peroneus longus 4-7cm from the tip of the lateral malleolus [35], and the fasciocutaneous perforators of the lateral supramalleolar and lateral calcaneal arteries 3 and 1cm from the tip of the lateral malleolus respectively [36]. The flap also receives 4-5 septocutaneous perforators from the posterior tibial artery, the most distal of which is located 4-10cm from the tip of the medial malleolus [37]. Additional neurocutaneous and venocutaneous arterial supply is provided by small arteries that accompany the sural nerve and small saphenous vein [38]. Retrograde venous drainage is through the small saphenous vein and collateral veins that bypass its valves [39].

In our study both doublex US and angiography were done to all patients, cases with thrombosis and occlusion of peroneal artery were excluded. Neither of the cases were adipofascial flaps, the flap was raised with part of gastrocnemius muscle as a musculo-fascio-cutaneous flap in 2 cases and as a fasciocutaneous flap with muscle cuff to protect the sural neurocutaneous vessels in one case. There was 60% congestion of the edges. The flap was raised from the ipsilateral side in order to avoid uncomfortable positioning and scars of the contralateral leg. We found partial flap loss in the distal one third of the flap in 14% of our cases. We used to follow-up the cases by dressing for two weeks followed by advancement of the flap and coverage by split thickness skin graft. Recurrent ulcer occurred in two cases and one case showed sinus and another case with exposed bone. Cosmetically the grafted donor site especially in females were relatively unaccepted.

Distally based hemisoleus muscle flap has many advantages. Being a muscle flap, it provides a bulk and vascularity that combats infection in cases of osteomyelities [16,17]. It has less donor site scarring in comparison to fasciocutaneous flap. In case of more proximal location of the distal perforators and more distal defects, increasing the arc of rotation may be achieved by decreasing the number of perforators or increasing the muscle length but these may be associated with failure. The distal perforators are never abscent but may be variable in number, position and size, this may explain the recorded failure rate of the flap which is about 21% [12,13,40,41].

We performed distally based hemisoleus muscle flap on fifteen cases three of them were reversed flow based on the posterior tibial artery. Angiography was done to exclude injury, thrombosis of the posterior tibial artery, also to study the flow and condition of the major vessels of the limb and whether they supports limb vascularity. Posterior tibial artery perforators were explored before elevation of the hemisoleus muscle, in case if non sufficient number of distal perforators, severe adhesion or traumatized perforators we raised the flap as reverse flow. Posterior tibial artery was clamped prior to its inclusion of the flap in order to re-check the limb vascularity. We had no total flap loss in this group, there was 6% partial loss of the distal third of the distally based hemisoleus muscle flap which was advanced later on to cover the exposed parts. No functional deficit of the donor site as it was elevated as hemisoleus flap,also the part preserved provide its action as functional pump to help the venous return of the leg. The flap provided good control of infection and osteomyelitic bone. Muscle flap carried good blood supply that improved bone healing. No sinuses, bone exposure or cosmetic disfigurement of the donor site.

The final choice of the most suitable treatment relies on both the needs of the patient, clinical variables, namely, patient age, wound site, size, depth, etiology, vascularity, sensation, Achilles tendon condition, bone exposure or bone loss, functional needs and rehabilitation potential, and proposes what we believe to be the optimal surgical technique for coverage of heel defects. The main goals of reconstruction of plantar defects include appropriate soft tissue coverage to facilitate weight bearing, bear shearing forces, sufficient blood supply to prevent osteomyelitis and also resist soft tissue infection and fascities as in diabetic cases. Hemisoleus muscle flap can fulfill these criteria and at the same time should not affect the function of the limb, easy to elevate with good success rate. The only contraindication of this flap is the traumatized, occluded posterior tibial artery and in limbs dependent only on posterior tibial artery.

According to our study distally based hemisoleus muscle flap had proved to be a better choice in cases with osteomyelitis, fracture calcaneous and exposed underlying structures as bone, tendons and metal hardwear and provided satisfying coverage of the heel defect. This flap has no donor site morbidity with salvage of the leg function through elevation of hemisoleus muscle that has widely extended its use.

Distally based sural flap is a durable easy flap to elevate, although it shows relatively high rate of early congestion but it was durable and can be used as a good alternative to hemisoleus muscle in cases with limb vascularity depended only on posterior tibial artery. The only contraindication of this flap was in cases with thrombosis and atherosclerosis of peroneal artery.

Conclusion:

Hemisoleus muscle flap showed more superior results than distally based sural flap in coverage of heel defects especially in cases with previous osteomyelitis, fracture calcaneous and exposed hardware. The muscle flap provided vascular, viable, bulky coverage with high tolerance to pressure and friction, control of osteomyelitis and infection and acceleration of fracture healing. It was, bulky enough to fill the deep defects and showed good resistance to shearing forces. Distally based sural flap provided thin pliable easy flap to elevate and a good alternative to muscle flap in cases of injured or occluded posterior tibial artery. Donor site was closed directly in all cases of hemisoleus muscle flap but not routinely in distally based sural flaps that made this flap more preferable in female population.

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