

## **The Use of Island Soleus Muscle Flap in Reconstruction of Pretibial Skin Defects**

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### **ABSTRACT**

The use of distally based hemisoleus flap is well known option in reconstruction of distal leg defects. However, its use is usually associated with a high failure rate due to variation of the vascular anatomy of its distal minor pedicles. The reversed flow hemisoleus flap supplied by the posterior tibial artery is another alternative in reconstruction of lower third leg skin defects but it has the great disadvantage of sacrificing a major leg blood vessel. To overcome the problems associated with these two techniques, the island soleus muscle flap was described. This flap is directly nourished by one or two perforators arising from the posterior tibial artery and it can be used to cover small and large leg defects. This article will further describe the use of this flap in coverage of leg defects. Another modification of the flap by raising it on many perforators is also described. The flap and its newer modification are used in reconstruction of various pretibial skin defects in 28 patients. The technique of flap elevation, the versatility of the flap in coverage of any pretibial leg defect whatever its site or size is demonstrated.

### **INTRODUCTION**

Severe injuries of leg usually result in soft tissue losses and skin defects ranging from small to large defects. They are usually accompanied with bony fractures or losses and they may be severe enough to be associated with major leg vessel injuries rendering reconstructive options limited. A pretibial skin defect especially in the lower third of leg usually represents a reconstructive challenge. Here the role of local skin flaps and distally based fasciocutaneous flaps may become limited especially if their pedicles fall within the zone of injury. Conventional cross-leg flap is another alternative but in cases associated with fractures and in the presence of external fixator it may be difficult to apply. Free tissue transfer is another good solution [1], yet it is not available in all plastic surgery centers and has a higher failure rate [2].

Local muscle flaps since first reported by Stark [3] became an established procedure in reconstruc-

tion of pretibial skin defects especially in the presence of osteomyelitis [4]. Proximally based Soleus muscle flap was described by Mathes et al. [5] and has been employed in coverage of soft tissue defects of the middle third of the leg especially in cases of compound fractures. It has been also used for treatment of chronic osteomyelitis of leg bones [3,5,6]. But it carried the disadvantage of sacrificing the whole or one lobe of the muscle.

The distally based hemisoleus muscle flap was introduced by Townsend [7] and later by Fayman et al. [8] is another option but it is associated with a high failure incidence [6,9].

The reversed flow hemisoleus flap was described by Guyron [10]. However the flap did not gain much popularity because it has the great disadvantage of sacrificing major leg blood vessel [10,11,12].

The island soleus muscle flap was first described by Yajima et al. [13]. This flap was based on one or two perforators and it was used to cover small pretibial skin defects in only six cases. It has the advantage of being a reliable flap as it is nourished directly by the posterior tibial artery perforators which should be identified before flap elevation and this explains its high success rate. It has minimal functional deficit due to the use of a small portion of the muscle. This flap has two disadvantages, the first one is being of small size which limits its use for small defects and the second is that the reconstructed defect should be located very close to the site of the supplying perforator which is unpredictable. This article will describe the use of the island soleus flap in reconstruction of various pretibial leg defects in 28 patients and will demonstrate its versatility in coverage of any of these pretibial defects whatever their sizes or sites.

## PATIENTS AND METHODS

The study was conducted in the Department of Plastic Surgery of Ain Shams University Hospitals from January 2003 to September 2006 with follow-up of an average 11 months. It was carried on 28 patients with different skin defects along the chin of the tibia. Of these 28 patients there were 23 males and 5 females. The age ranged from 12 to 52 years. The causes of these defects were trauma, unstable scarring and chronic osteomyelitis of the tibia and third degree burn of the leg. The sites of these defects were in the middle third of leg (6 cases) lower third of leg (10 cases) combined middle and lower thirds (8 cases) and the medial malleolus (4 cases) (Table 1). Defect sizes ranged from 18x6cm to 12x6 cm.

Sixteen patients presented with fractures and had undergone either external or internal fixation by orthopedic surgeons according to the type of their fracture. All of them suffered from bone exposure and osteomyelitis.

Seven patients presented with chronic osteomyelitis and long standing discharging sinuses. In three of them the sinuses were located over the middle third of the leg (Fig. 1). The other three patients had discharging sinuses over lower 1/3 of the leg and medial malleolus and the last patient was having multiple discharging sinuses along the whole chin of tibia due to sclerosing osteomyelitis.

The last five patients presented with unstable scarring over the middle and lower 2/3 of the chin of the tibia.

### *Operative technique:*

All cases were operated upon under general anesthesia at variable intervals according to the time of their presentation which ranged from few days up to thirteen months.

In cases presented with osteomyelitis, aggressive debridement of the wound was done with simultaneous removal of all the sequestered bones. Internal fixation was replaced by external fixation and medial external fixation was replaced by lateral one by the aid of orthopedic surgeons. In cases presented with unstable scars preoperative excision biopsies and histopathological examination was done to exclude any malignant change.

Through a medial approach and under pneumatic tourniquet using loop magnification, all the minor pedicles (perforators) of soleus muscle were exposed and identified. According to the defect

size, site and extension, the suitable perforators were chosen and then the exact muscle segment needed was divided proximally and distally changing the flap to an island one. In half the patients where the defects were small, only 1 or 2 perforators were used and chosen to be adjacent to the site of the defect. In the other half of patients where long defects were found, 4-5 perforators were included in the flap and they were having proximal, middle or distal location.

Defects over the medial side of the tibia were covered either by simple advancement or turnover of the muscle flap laterally. On the other hand, defects on the anterior side of the tibia were covered by further advancement of the flap after mobilization of the posterior tibial vessels from the posterior tibial nerve (Fig. 2).

In cases of distal malleolar defects, in order to allow the flap to cover the part of the defect beyond the muscle end, the most distal perforator was ligated leaving the muscle nourished by the second distal perforator and thus increasing the arc of flap rotation more distally.

In four patients the defect extended into the proximal 1/3 of the leg and the medial head of gastrocnemius muscle flap was used to cover it. Skin grafting was done to all the flaps at a period of 7 to 10 days after flap cover to be sure that the flap completely survived.

## RESULTS

The whole twenty eight flaps survived completely without single flap loss (Figs. 3-7). In one patient persistent discharge occurred from the underlying bone infection and partial disruption occurred. This was managed by flap elevation, further debridement of necrotic bone and secondary sutures followed by skin grafting of the muscle in a third session.

Complete take of the skin grafts occurred in all patients with complete healing of graft donors, except one patient needed another skin grafting session due to persistence of discharging sinus under the applied muscle flap.

All patients had stable wound coverage during the follow-up period without the need of secondary procedures. None of the patients showed any sort of vascular impairment or any manifestations of venous insufficiency during the same follow-up period. No functional deficits were encountered and flap donor sites were esthetically accepted.



Fig. (1): Multiple discharging sinuses located over the middle third of the leg.

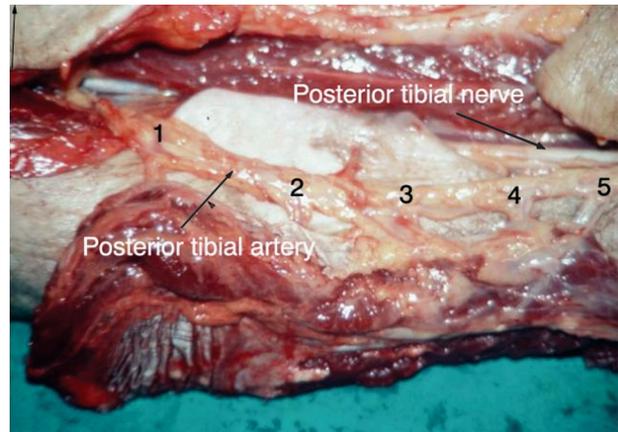


Fig. (2): Intra-operative dissection under tourniquet showing 5 minor pedicles (perforators) supplying the muscle, with complete mobilization of the posterior tibial artery from the posterior tibial nerve.



Fig. (3): (A) Osteomyelitis of upper 1/3 leg with skin defect (B) Island soleus muscle based on two perforators, covering the defect.



Fig. (4): (A) Unstable scarring and ulceration of middle 1/3 leg. (B) good cover with healed STSG.





Fig. (5): (A) Unstable scar of middle 1/3 leg with tibial exposure. (B) Stable cover with island soleus with overlying skin graft.



Fig. (6-A): Osteomyelitis and exposure of lower 1/3 leg and medial malleolus.



Fig. (6-B): The island soleus muscle covering the defect completely before skin grafting.



Fig. (7-A): Pretibial skin defect extending involving upper middle and lower third of the left leg.



Fig. (7-B): Coverage of long pretibial defect by combining the medial head of gastrocnemius and island soleus muscle flaps based on four perforators.

Table (1): Site and number of the defects.

Site of the defect	No. of defects
Middle 1/3 of the leg.	6
Lower 1/3 of the leg.	10
Combined middle & lower 1/3 of the leg.	8
Medial malleolus.	4
Total	28

## DISCUSSION

Severe injuries of lower extremities usually result in soft tissue losses and leg skin defects ranging from small to large ones. They are usually accompanied by bony fractures or losses and even vascular injuries adding another difficulty to reconstruction. These pretibial skin defects especially in the lower third of the leg usually represent a reconstructive challenge. Here the role of local skin flaps is very limited due to poor vascularity of the area and the paucity of local available tissues. Conventional cross-leg flap may not be suitable in cases of fractures, external fixation and osteomyelitis. Free tissue transfer is not available in all plastic surgery centers. The problem of pretibial skin defects in the lower third of leg becomes more apparent, especially if it is associated with exposed fractures or chronic osteomyelitis of the tibia.

In these situations muscle flaps are needed to cover these defects in order to combat infection and to bring more vascularity to the area to enhance bone healing. Distally based hemisoleus muscle flap is a good solution but it carried a high failure incidence [9,14]. This was explained by variation in the number and site of its distal perforators. Several anatomical studies were carried on the vascular anatomy of the soleus muscle minor pedicles. The number of perforators was extremely variable [11,12,13]. However, in no single report, there have been no cases in which these pedicles were absent [9]. Yajima et al., found that the most distal soleus perforator was found at fixed distance of about 61-145mm above the medial malleolus [13]. Shaker [9] studied the site of the second most distal perforator of soleus muscle and it was found to be at a distance of 15cm or more above the medial malleolus in 50% of his dissections. He explained the high failure incidence of distally based soleus muscle flap to be due to: (1) Limitation of arc of flap rotation distally by the position of this high second distal perforator. (2) Not including adequate number of perforators in the flap itself.

(3) Direct injury of the distal perforators by the severe bone comminution.

To increase the number of perforators and to augment the vascular supply of the distally based hemisoleus flap, the reversed flow hemisoleus flap was described by Guyron [10]. However the flap did not gain much popularity because it has the great disadvantage of sacrificing a major leg blood vessel and cannot also be used if there is associated vascular injury or disease in the same leg.

To overcome the problems associated with distally based and reversed flow hemisoleus muscle flaps, the island soleus muscle flap was introduced by Yajima et al. [13], based on one or two minor perforators. It was described as being reliable flap specified only to small pretibial skin defects using a small portion of the soleus muscle with no functional deficit. Being of small size, it has the disadvantage that the defect must be very close to the flap and the supplying perforator should be located near to the defect.

In the present study the island soleus muscle flap was employed in small and large pretibial skin defects but unlike Yajima's report [13], any number of perforators can be used. Regarding distal arc of rotation Yajima et al. [13] addressed that the most distal point that can be covered with this flap is the end of this muscle tail. In this study the flap was able to reach more distal defects distal to the muscle end itself by ligating the most distal perforator, leaving the other perforators supplying the flap.

The flap has reliable vascularity. The perforators can be seen easily during dissection. This gives the surgeon the free hand to change his surgical plan if the required perforators are not available due to anatomical variation or due to injury from the trauma.

The island soleus muscle flap has the advantage of easiness of its technique, vascular reliability and minimal functional muscle morbidity because only a small portion of the muscle is used. It can cover small and large pretibial skin defects. It can be advanced to cover medial pretibial skin defects and if mobilized from the posterior tibial nerve it can cover anterior tibial skin defects. It represents a good option if local fasciocutaneous flaps are not available or insufficient. Patients who cannot withstand prolonged operations as elderly, obese, diabetics and pregnant woman are good candidates for this flap. Its harvest does not sacrifice any major arterial trunk in the leg so it can be safely used. Being a muscle flap it resists bone infection

and promotes bone healing so it is advisable in cases of osteomyelitis. The whole muscle length can be raised and this can cover any pretibial defect whatever its length omitting the need for free tissue transfer if combined with medial head of gastrocnemius.

#### *Conclusion:*

In conclusion, the island soleus muscle flap represents a good option in reconstruction of pretibial skin defects especially in the lower two thirds of the leg. It is a single stage procedure with high success rate and does not sacrificing any major leg blood vessel. It has reliable vascularity and can be easily harvested with minimal muscle morbidity. It gives the surgeon the opportunity to change his reconstructive plan early if the perforators were found unhealthy or injured. It can be combined with the medial head of gastrocnemius to cover the whole exposed tibia as an alternative to free flap if not available.

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