

Reconstruction of Lower One Third Leg Defects in Single Vessel Lower Limb by Medial Hemisoleus Muscle Flap Based on Distal Posterior Tibial Artery Perforators

KHALED A. REYAD, M.D., M.R.C.S. and HANY SAAD SETTA, M.D.

The Departments of Plastic & Reconstructive Surgery, Faculty of Medicine, Ain Shams University, Egypt

ABSTRACT

Background: Crushing injuries of the lower 1/3 of the lower limb always represent a challenge for reconstruction. Reconstructive options diminish with the injury of one or more of the major vessels of the lower limb. This is a revisit of distally based medial hemi-soleus muscle flap as a valuable option in such reconstruction.

Patients and Methods: 16 patients with skin loss over lower one third of leg of various causes had pre-operative duplex done to detect affection of anterior tibial and/or peroneal vessels and confirm patency of the posterior tibial vessels. CT angiography was done for confirmation. In case of one or two vessels affection, sparing the posterior tibial artery, the defects in the distal one third of the leg were reconstructed by distally based hemi-soleus muscle flap; based on the distal perforators of the medial head of the soleus muscle from the posterior tibial artery.

Results: The flap survived completely in twelve cases with total loss in one patient, partial loss in two case and local recurrence of the excised tumour in one case.

Conclusion: The distally based medial hemi-soleus muscle flap is a very good option in reconstruction of problematic lower one third skin defects especially that associated with vascular injury other than the posterior tibial vessels.

Key Words: *Distally based soleus – Lower leg defects – Single vessel leg – Osteomyelitis treatment.*

INTRODUCTION

High energy leg injuries usually result in soft tissue losses and skin defects and are usually accompanied with bony fractures or even bony defects. These injuries may be severe enough to be associated with major leg vessel injuries rendering reconstructive options limited. The lower one third skin defects of leg usually represents a reconstructive challenge and the role of local skin flaps and distally based fasciocutaneous flaps may be limited especially if their vascular pedicles fall within the zone of injury. Free flaps are the golden operation in reconstruction [1] of these defects but it may not be applicable in vascular compromised limbs as those suffering injury of one or two large

vessels from the three major vessels supplying the lower limb (Posterior tibial, Anterior tibial and Peroneal vessels). Perforator flaps [2,3] based on either direct or indirect perforator may be useful especially in small defects but has tedious dissection and partial flap loss rate at 11.3%. Cross leg flaps are another option but it may render impossible if the patient has another proximal femur or pelvic fractures or even if they have external fixator to leg bones with difficult flap inset, with local flap necrosis of 40% [4]. Distally based neuro-vascular sural flap is used with local flap necrosis rate of 21% [5]. The reversed flow hemi-soleus flap with sacrifice of the posterior tibial artery to be included within the flap was described by Guyron [6]. However the flap did not gain much popularity because it has the great disadvantage of sacrificing major leg blood vessel [6,7,8]. The distally based Soleus muscle flap based on the distal perforators of the posterior tibial was introduced by Townsend [9] and later on by Fayman et al., [10], is a good option in reconstruction of lower one third leg defects in vascular compromised leg (one or two vessels injury) owing to the following advantages; no disruption of major blood vessels, stable coverage and profound circulation that is able to supply the underlying bone with blood especially bone grafts or osteomyelic bone after less than radical excision.

So our aim in this study is to re-evaluate the reliability of the distally based hemi-soleus muscle flap in the reconstruction of lower third leg defects in vascular compromised cases where only the posterior tibial artery is always preserved.

PATIENTS AND METHODS

The study was compiled from a retrospective chart review of sixteen patients in a two year period (September 2014 till July 2016) at the Plastic and Reconstructive Surgical Departments in Ain Shams

University and Alzayton Hospitals. These patients suffered from lower one third skin defects of leg with injury of one or more leg vessels sparing the posterior tibial vessels. The defects were due to one of the following causes; post traumatic, post tumour excision or osteomyelitis and unstable scar. The injured vessels in these patients were either the anterior tibial alone, peroneal alone or both the anterior tibial and the peroneal vessels. All patients underwent reconstruction of the skin defects by distally based medial hemi-soleus muscle flaps based on distal posterior tibial perforators arising from the posterior tibial artery distally and directly entering the medial side of the soleus muscle. These perforators were identified intraoperatively and preserved. Patients had early debridement and careful assessment of the injured leg vascular tree. That was done routinely using Duplex ultrasound and in case of confirmed vascular injury by the duplex, CT angiography is done to confirm the findings and confirm the level of vessel interruption. The integrity of the posterior tibial vessels till distal leg was confirmed before proceeding to the flap coverage.

Operative procedure:

The technique described by Townsend [9] then Fayman [10] was done. Incision was done 2cm posterior to the medial border of the tibia then the gastrocnemius muscle was encountered and bluntly dissected from the underlying soleus muscle owing to the natural plane between them except at the beginning of the tendo-achillis where sharp dissection is the role. The vascular pedicle of the soleus muscle is explored to confirm adequacy and location of the distal perforators of the posterior tibial artery, also preservation of the blood supply to the lateral portion of the muscle coming through the proximal vascular pedicles that shared to a limited part in the supply to the muscle distally as the medial and lateral portions of the muscle are proven to be not a watershed level concerning its vascularity [10]. After pedicle adequacy confirmation, the flap is dissected from the deep muscles of the

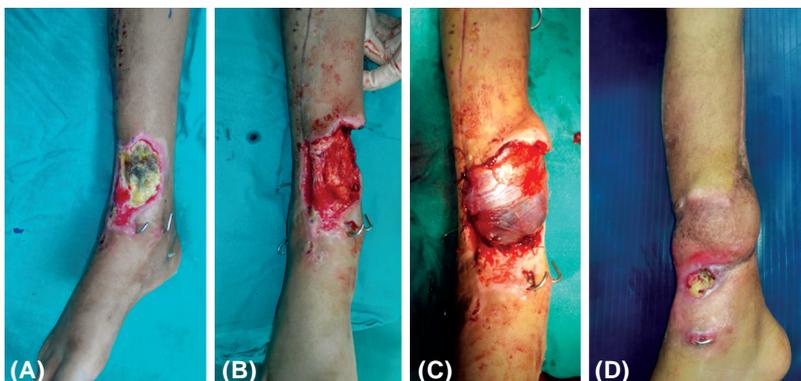
back of the leg and splitting of the soleus muscle ensue along its natural plain if available, harvesting the medial hemi-soleus as needed to reach the defect safely without tension. Extreme care during dissection was taken to avoid injury of the major vessels as the legs were already suffering one or two vessel injury.

RESULTS

Sixteen patients shared in this study; fourteen males and two female with ages ranging from 12 to 54 years, suffering from skin defects in the lower one third of the leg (pretibial in fourteen cases and tendoachilis in two cases). They suffered also from major leg vessel disruption either anterior tibial or peroneal or both as detected by the pre-operative duplex and proven by CT lower limb arterial angiography. Ten patients suffer from anterior tibial vessels injury alone, four patients suffered from peroneal vessels injury and two patient suffered from both anterior tibial and peroneal vessels injury. The causes of the skin defects were due to trauma in most of cases (14 cases), osteomyelitis and unstable scar (one case) or post tumour excision (one case). The average presentation of patients ranged from 4 to 183 days.

In all patients distally based medial hemi-soleus muscle flap based were used without sacrifice of the posterior tibial vessels. Twelve flaps healed well (75%) (Figs. 1,2), one flap suffered total loss due to ischemia (6%) (Fig. 3), three flaps suffered venous congestion and partial loss (distal one centimetre) (19%) (Fig. 4). One of the three flaps that suffered venous congestion; local recurrence from the tumour excised before occurred with partial loss of the flap. All surviving flaps underwent grafting on the seventh day except for flaps that suffered congestion and partial loss, underwent grafting after 21 days. All patients had excellent take of the skin graft. Two patients needed further operation in the form of bone grafting to the tibia after one month. Table (1) summarizes the data of the patients.

Fig. (1): 43 years old male with post traumatic defect of the distal one third of the tibia that resulted after a period of negligence in osteomyelitis. A- After radical debridement of the chronic osteomyelitis, B- The resultant defect was reconstructed using distally based medial hemi-soleus muscle flap, C- after one week. D- Followed by skin grafting.



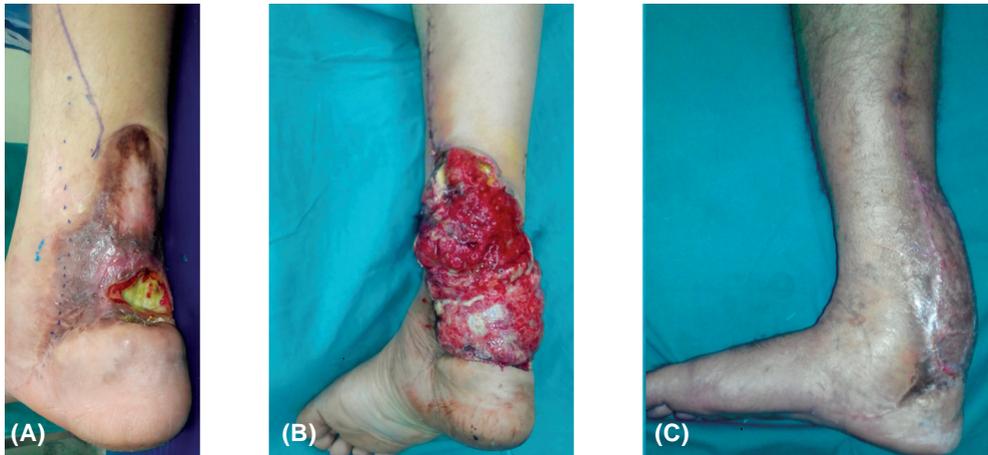


Fig. (2): 37 years old male A- with post traumatic unstable scar over the tendoachilis that was presented 50 days following the trauma. B- He underwent excision of the scar and resurfacing by distally based medial hemi-soleus muscle flap. C- Followed by its skin grafting.

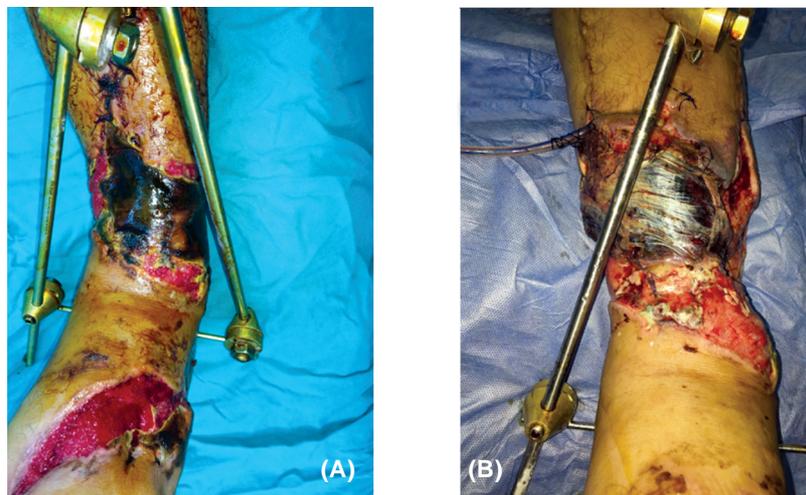


Fig. (3): 55 years old, heavy smoker male with A- Post traumatic pretibial skin defect with injury to the anterior tibial vessels, first free rectus muscle flap was done to cover the whole defect, but total loss of the free flap occurred so another option was done. B- That was reconstructed by distally based medial soleus suffering ischemia and eventually total loss.

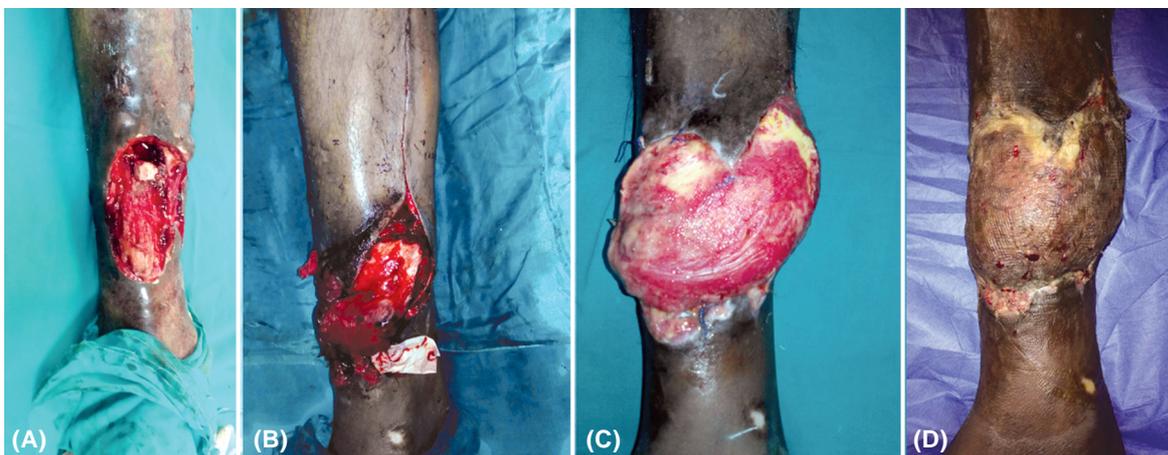


Fig. (4): 12 years old male with. A- Sarcoma of the lower tibia with local invasion of the skin. B- The patient underwent radical excision of the bone and external freezing followed by its reinsertion as a bone graft fixed by k wires. C- The resultant defect was reconstructed by distally based medial hemi-soleus that suffered congestion and partial loss about less than one centimetre. D- Two months later the flap was infiltrated with local recurrence of the tumour.

Table (1): Data of patients in the study.

Case number	Age	Gender	Cause	Duration (days)	Defect Location and size	Associated conditions	Vessel affected	Result	Period before graft (days)	Graft healing	Complication (s)	Need for another procedures
1	12	Male	Post sarcoma excision of the tibia with bone freezing and application as bone graft then fixation by k wires	21	Distal one third of tibia, total surface area of the defect 87cm ²	Sarcoma metastasis in the lung	Both the anterior tibial and peroneal vessels were ligated in the procedure of sarcoma excision	The flap healed well but venous congestion with partial flap loss about one cm followed by local recurrence occurred in the distal part of the tibia	18	Excellent	Disruption of the distal part of the flap due to venous congestion followed by local recurrence of sarcoma in the distal part of the flap and general metastasis in the lungs, the patient died five months later	No
2	43	Male	Osteomyelitis following internal fixation of fracture tibia with skin necrosis	183	Distal one third of tibia, total surface area of the defect 98cm ²	Seavy smoker	Anterior tibial	Flap healed well	8	Excellent	No	No
3	37	Male	Post-traumatic unstable scar with tendo-achilis exposure	50	Tendo-achilis, total surface area of the defect 46 cm ²	No	Anterior tibial	Flap healed well	7	Excellent	Haematoma underneath the flap that was evacuated with no further sequel	No
4	33	Male	Post traumatic skin loss over the distal tibia	7	Distal one third of tibia, total surface area of the defect 54cm ²	Heavy smoker	Peroneal vessels	Partial loss followed by dressings	21	Excellent	Partial loss of the flap	No
5	15	Male	Post traumatic defect pretibial lower one third	150	Distal one third of tibia, total surface area of the defect 43cm ²	No	Anterior tibial	Flap healed well	7	Excellent	No	Needed bone grafting after one month

Table (1): Continued

Case number	Age	Gender	Cause	Duration (days)	Defect Location and size	Associated conditions	Vessel affected	Result	Period before graft (days)	Graft healing	Complication (s)	Need for another procedures
6	54	Female	Post traumatic defect pretibial lower one third	100	Distal one third of tibia. total surface area of the defect 33cm ²	NO	Anterior tibial	Flap healed well	7	Excellent	No	No
7	19	Male	Post traumatic skin loss over the distal tibia	4	Distal one third of tibia. total surface area of the defect 87cm ²	Smoker	Peroneal vessels	Flap healed well	7	Excellent	No	No
8	55	Male	Post traumatic skin loss over the distal tibia	4	Distal one third of tibia, free rectus flap was done followed by complete loss. total surface area of the defect 120cm ²	Diabetic, heavy smoker	Anterior tibial vessels	Flap suffered severe ischemia and loss of the whole flap	No	No	Total loss of the flap	Coverage by cross leg flap
9	42	Female	Post traumatic skin loss over the tendo achillis	21	Tendoachillis total surface area of the defect 40cm ²	No	Peroneal vessels	Flap suffered venous congestion and partial loss about one cm	17	Good with partial loss of the skin heal by secondary intention	Flap congestion with partial loss of the flap	No
10	33	Male	Post traumatic defect pretibial lower one third	2	Distal one third of tibia. total surface area of the defect 34cm ²	No	Anterior tibial vessels	Flap healed well	9	Infection occurred with more than 70% loss of the skin graft followed by re-grafting	Loss of the skin graft	Another skin grafting operation
11	27	Male	Post traumatic defect pretibial lower one third	10	Distal one third of tibia. total surface area of the defect 56cm ²	No	Both the anterior tibial and peroneal vessels injury	Flap healed well	7	Excellent graft take	No	No

Table (1): Continued

Case number	Age	Gender	Cause	Duration (days)	Defect Location and size	Associated conditions	Vessel affected	Result	Period before graft (days)	Graft healing	Complication (s)	Need for another procedures
12	14	Male	Post traumatic defect pretibial lower one third	11	Distal one third of tibia. total surface area of the defect 72cm ²	No	Anterior tibial vessels	Flap healed well	7	Excellent graft take	No	No
13	23	Male	Post traumatic defect pretibial lower one third	2	Distal one third of tibia. total surface area of the defect 64cm ²	Heavy smoker	Peroneal vessels	Flap healed well	8	Partial loss of the skin graft then left to heal by secondary intention	No	No
14	52	Male	Post traumatic defect pretibial lower one third	4	Distal one third of tibia. total surface area of the defect 54cm ²	No	Anterior ti bial vessels	Flap healed well	8	Excellent graft take	No	No
15	54	Male	Post traumatic defect pretibial lower one third	3	Distal one third of tibia. total surface area of the defect 52cm ²	No	Anterior tibial vessels	Flap healed well	7	Excellent graft take	No	No
16	22	Male	Post traumatic defect pretibial lower one third	12	Distal one third of tibia. total surface area of the defect 70cm ²	No	Anterior tibial vessels	Flap healed well	8	Excellent graft take	No	No

DISCUSSION

The skin defects of the lower one third of the leg are considered one of the challenging defects due to skin tightness and subcutaneous nature of the bones and tendons. An added problem is injury of one or more of the major vessels of the leg, as this makes the free flaps option more difficult. So here comes the necessity of coverage by regional flap without sacrificing a major blood supply of the leg.

The distally based hemi-soleus muscle flap has these criteriae and also the advantage of neither major function loss occurs after flap harvest, nor donor site morbidity. Also it has the advantage of increasing the blood supply to the underlying bone; promoting bone salvage in chronic osteomyelitis [11,12,13] attributing to its robust blood supply from the feeding perforators of the distal posterior tibial artery, the venous plexus [9], and also keeping the lateral part of the flap preserved allowing for its additional blood supply from the proximal pedicles through the significant vascular communications between the medial and lateral portions of the muscle [10].

In our study sixteen cases with skin defects of the lower one third of the leg were reconstructed by distally based medial hemi-soleus muscle flaps where 75% healed completely.

Conclusion:

The distally based medial hemisoleus is a reliable flap for reconstruction of problematic lower one third defects in vascular compromised lower limbs as those suffering from injury to the anterior tibial and/or peroneal vessels; provided that the posterior tibial vessels are preserved. It provides reliable coverage concerning the vascularity and even can treat conditions as osteomyelitis in tibia by its robust blood supply.

REFERENCES

- 1- Spector J.A., Levine S. and Levine J.P.: Free tissue transfer to the lower extremity distal to the zone of injury: Indications and outcomes over a 25-year experience. *Plast. Reconstr. Surg.*, 120: 952, 2007.
- 2- Hyakusoku H., Yamamoto T. and Fumiiri M.: The propeller flap method. *Br. J. Plast. Surg.*, 44: 53, 1991.
- 3- Gir P., Cheng A., Oni G., et al.: Pedicled-perforator (propeller) flaps in lower extremity defects: A systematic review. *J. Reconstr. Microsurg.*, 28: 595, 2012.
- 4- Dawson R.L.: Complications of cross-leg flap operation. *Proc. R. Soc. Med.*, 65: 2, 1972.
- 5- Suga H., Oshima Y., Harii K., et al.: Distally-based sural flap for reconstruction of the lower leg and foot. *Scand. J. Plast. Reconstr. Surg.*, 38: 16, 2004.
- 6- Guyuron B., Dinner M.J., Dowlden R.V. and Labandeter H.P.: Muscle flaps and vascular detour principle: The soleus. *Ann. Plast. Surg.*, 8: 132, 1982.
- 7- Wu C.M., Chang P.Y., So C.Y., Yip F.S. and Lam L.Y.: The anatomic basis and clinical applications of flaps based on the posterior tibial vessels. *Br. J. Plast. Surg.*, 6: 470, 1993.
- 8- Shaker A., Abd El-Aziz A. and Magdy A.: The reversed flow hemisoleus in leg and foot reconstruction (an alternative to distally based hemisoleus flap). *Egypt. J. Plast. Reconstr. Surg.*, 26 (2): 347-353, 2002.
- 9- Townsend P.L.G.: An inferiorly based soleus muscle flap. *Plast. Reconstr. Surg.*, 31: 210, 1978.
- 10- Fayman M.S., Orak F., Hugo B. and Berson S.D.: The distally based split soleus muscle flap. *Br. J. Plast. Surg.*, 40: 20, 1987.
- 11- Fitzgerald R.H., Ruttle P.E., Arnold P.G., et al.: Local muscle flaps in the treatment of chronic osteomyelitis. *J. Bone. Joint. Surg. (Am.)*, 67: 175, 1985.
- 12- Mathes S.J., Alpert B.S. and Chang N.: Use of the muscle flap in chronic osteomyelitis: Experimental and clinical correlation. *Plast. Reconstr. Surg.*, 69: 5, 1982.
- 13- Salgado C., Mardini S., Jamali A., et al: Muscle versus Non muscle Flaps in the Reconstruction of Chronic Osteomyelitis Defects. *Plast. Reconstr. Surg.*, 118: 1401, 2006.