Section: Plastic Surgery

Original Research Article

MODIFICATION IN ISLANDED REVERSE SURAL ARTERY FLAP WITH TAILED SKIN PEDICLE FOR RECONSTRUCTION OF LOWER THIRD LEG DEFECTS

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Received : 05/10/2025
Received in revised form : 22/11/2025
Accepted : 11/12/2025

Keywords:
Reverse sural flap, sural artery, peroneal perforators, tail.

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DOI: 10.47009/jamp.2025.7.6.183

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (6); 987-990

ABSTRACT

Background: The objective is to present our experience in soft tissue coverage using islanded reverse sural artery flap with tailed skin pedicle for soft tissue defects of the lower third leg and ankle region, and analysis of the cases with respect to result. **Materials and Methods:** This study was conducted at a tertiary care plastic surgery department between January 2022 and December 2024. 21 patients who underwent adipofascial islanded reverse artery flap with tailed skin pedicle for reconstruction of defects of lower 3rd leg and ankle were included. The results were analyzed based on Survival of flap, Complication, need for secondary procedure and Hospital stay. **Result:** In the 21 patients subjected to this procedure, complications were observed in 2 patients. **Conclusion:** This flap is a robust flap with advantage of being a single stage procedure for coverage of soft tissue defects in the lower 3rd of leg and ankle region, when executed meticulously.

INTRODUCTION

Pedicled flap plays an important role in the armamentarium of plastic surgery for soft tissue reconstruction in many areas, with minimal complication, even in the era of microsurgery. Reverse sural flap described by Masquelet et al is such a pedicled flap based on the communication between peroneal vessels and the median sural vessel. It is used for soft tissue coverage of medial aspect and anterior aspect of lower 3rd leg, ankle, dorsum of hind foot, tendoachilles region and posterior aspect or non-weight bearing aspect of heel region. With certain modifications in the flap, it can be used to provide soft tissue coverage in forefoot dorsum, lateral aspect of the foot below lateral malleolus and weight bearing aspect of heel.[1-3]

As the name of the flap depicts, it as a reverse flow flap and the chance of venous congestion with impaired lymphatic return is more. This paper describes the technique of executing islanded reverse sural artery flaps with adipofascial pedicle with overlying tailed skin pedicle in order to overcome the aforementioned problems, making this a robust flap.

MATERIALS AND METHODS

Between January 2022 and December 2024, 21 patients presented with soft tissue defects around the ankle, lower third leg region. These defects were resurfaced with islanded reverse sural artery flap with tailed skin pedicle and they were included in this study. All 21 patients sustained injuries due road traffic accident. In patients with fractures, external fixator was applied and resurfacing was done later. Patients were taken up for surgery under regional anesthesia. Under tourniquet control with loupe magnification thorough debridement was done and planning for reverse sural flap was done after assessing the post debridement defect. Most procedures were performed in prone position, and in few patients, it was performed in lateral decubitus position with hip knee flexed and leg with ankle supported. Preoperative Doppler was performed only if the peroneal perforator site was in the zone of injury or if patient is a diabetic or older age or if patient is a chronic smoker. Once the patient is positioned on table, flap axis and distal limit of flap is marked. Flap is harvested and inset given, and donor area covered with SSG with immobilization using POP slab. In all cases where extended flap was done, 'delay' of the random portion was first done and flap harvested one week after the delay. Patients were subjected to strict foot end elevation for a week. All patients were under clinical observation for 3 weeks. Complications such as infection, venous congestion, and flap dehiscence and donor site graft loss were noted. Patients were discharged at end of 2

weeks and advised follow up in orthopedic and physiotherapy department and later reassessed at the end of 6 to 8 weeks for donor site scar and suture line healing of the flap. The results were analyzed in regard to survival of flap, mean hospital stay, and occurrence of complications.

Vascular anatomy of the flap: The reverse sural flap is supplied by peroneal septocutaneous perforators emerging in between tip of lateral malleolus and tendoachilles that communicates with arteriosomes supplying sural nerve and also by means of arteriosomes supplying the lesser saphenous vein, which accompany the sural nerve.

Popliteal artery in the popliteal region gives off medial and lateral sural branches that supply the two heads of gastrocnemius muscle. Another constant branch, the median sural artery, arises in this area from the popliteal artery and runs downward sub-fascially and accompanies the sural nerve just above or near the upper 3rd and middle 3rd junction of posterior aspect of leg. It then penetrates the deep fascia of the leg, to run supra-fascially along with the lesser saphenous vein. Lesser saphenous vein dips inside the deep fascia often where sural nerve along with plexus exit the deep fascia, which guide as a land mark while dissecting the distal most seam line of the flap.

Branches from the median sural artery form a plexus around the sural nerve and supply the skin and subcutaneous tissue of the mid-3rd of the calf region. This suprafascial plexus arborizes both longitudinally and radially, and anastomoses with septocutaneous perforators of peroneal artery in the distal 3rd of the leg laterally. This vascular network forms the basis of the reverse sural flap. The peroneal septocutaneous perforators are about 1 to 8 in number and a constant sizeable one is given off well within 5cm proximal to the tip of lateral malleolus.[3-5]

Marking for axis of flap:

A point is marked, 5 to 7 cm proximally to a point marked between tip of lateral malleolus and tendoachilles, where always a constant perforator communication exists between the sural plexus and peroneal vessel.

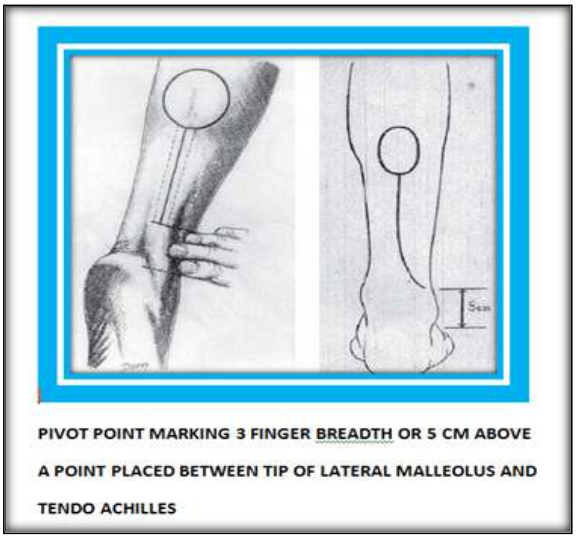

Figure 1: Axis of the flap

Another point is marked in midline (line between midpoint of popliteal crease and midpoint between two malleolus) at the junction of upper 3rd and middle 3rd.

A line connecting these two points forms the axis of the flap. Flap is harvested in the middle 3rd of posterior aspect of leg with longitudinal axis in the center and adipofascial tailed skin pedicle being in the lower 3rd region

The posterior aspect of the leg was divided into equal thirds by marking a line between midpoint of popliteal crease and midpoint between two malleoli. The middle 3rd region in the posterior aspect of leg is the flap harvest area supplied by sural vessels. The junction between upper 3rd and middle 3rd in the posterior aspect of leg is taken as the distal most site for harvesting the flap. Beyond that region if flap is needed, then delay procedure is done.[6,7]

Operative technique:

Procedure was done in regional anesthesia in prone position or lateral decubitus position. Under tourniquet control, with loupe magnification, thorough debridement of wound done and planning in reverse done, for Reverse sural flap. Once planning is completed deflate the tourniquet and patient is positioned either in prone with a sand bag in thigh or in lateral decubitus position with a pillow placed between two legs supporting the flexed hip, flexed knee and the leg. Draping done and lint marking taken and flap markings done along the axis of the flap in the middle 3rd calf region.

After inflating the tourniquet skin incision is done in the upper 3rd and middle 3rd junction of posterior calf region and the subcutaneous tissue is gently teased out for the identification of lesser saphenous vein. Once it is identified it is ligated and cut between the sutures and secured. Diathermy to be avoided. Then carefully incise the deep fascia and search for the sural nerve. If it not in the suprafascial plane, the sural nerve will be seen in between the gastrocnemius muscle bellies somewhat deeper which should not be left out. The flap is then raised subfacially.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

If we left out the sural nerve and raise the flap below the deep fascia, we will encounter the nerve within a few mm of raising the flap piercing the deep fascia. If it happens so, then we can ligate the nerve between sutures and divide it.

After identifying and ligating both lesser saphenous vein and sural nerve, once again reassess the axis of the flap whether the marked axis is in the midline of flap going to be harvested. Reassessment of axis is done by the sural nerve and lesser saphenous (i.e.) the both structures should be in midline of flap.

After reorienting the axis, flap incisions are made, incising skin subcutaneous tissue and deep fascia and tagging sutures including deep fascia are taken in the seam line of flap, and these tagging sutures are to be held with haemostat by the assistant. Now the flap can be raised below the deep fascia and any sizeable perforator or vein has to ligated and divided. Never cauterize them. Never touch or hold the flap undersurface with the gloved hand as it may lead to contusion of all arborized plexus and leads to flap edema. We always have flap pedicle width not less than 4 cm. Once the flap elevation reaches just above the mid-3rd and lower-3rd junction skin islanding is done with incorporating tailed cutaneous paddle along with adipofascial pedicle along the axis marked, with elevation of dermal flap for about 1.5cms on both sides of cutaneous paddle. Narrowing the adipofascial pedicle less than 4cm may lead to congestion of flap as there are venous channels running parallel to lessor saphenous vein, which will bypass the LSV valve and drain directly into the deep peroneal vein. Tailed cutaneous adipofascial pedicle dissection should be stopped just above the pivot point marked area, or at any point when flap length is adequate. Once the flap is elevated fully, the under surface should be in prominent yellow color without any red streak. After elevating the flap, it is replaced in position and saline soaked bandage is applied and tourniquet is released. Wait patiently for 20 minutes and assesses the viability. There should be slow sustained bleeding in dermal edge of the seam line of flap, and more over there should not be edema in flap. If gross edema is noted, then the probability of venous congestion as a complication will be higher. Flap inset is given by raising of dermal flap in the bridging segment, to accommodate the adipofascial pedicle, and donor area covered with SSG and secured with dressing.

Mild compression bandage dressing applied in pedicle area to avoid flap kinking, with a window to inspect flap, and the leg is immobilized in below knee POP slab. In our center, we raise the foot end of the cot to provide elevation and instruct the patient to lie in prone position. Flap is reassessed at 48 hours and 5th post-operative day. If there is no congestion on the 5th day, the flap settles uneventfully and the patient is then referred for physiotherapy and orthopedic management at end of 2 weeks.

RESULTS

Out of these 21 patients where islanded reverse sural artery flap with tailed skin pedicle was done, in 19 (90%) patients the flap settled well. Only 2 (9.5%) patients had complication of skin graft loss over adipofascial pedicle area, later managed by secondary SSG. The mean hospital stay was 18 days. The problem of bulkiness after division and inset, in reverse sural flap due to impaired lymphatic drainage is overcome in islanded reverse sural artery flap with tailed skin pedicle, and more over it remains a single stage procedure.

DISCUSSION

In the angiosomal concept described by Taylor, he mentioned that vessels hitchhike along with nerves. Based on this concept, vascularization of the superficial nerves of the leg was studied by Taylor and Ham. But little attention was paid at the time and Masquelet et al reported using colored latex injection in 1992 that the arteries accompanying the cutaneous nerve gives of several cutaneous arterial branches along the supra-fascial course and described the concept of neuro-skin island flap.[1,2]

Median sural artery a constant branch arising from popliteal artery accompany the sural nerve just above or near the upper 3rd and middle 3rd junction of posterior aspect of leg and penetrates the deep fascia, runs supra fascially with lesser saphenous vein. Branches from the median sural artery form a plexus around the sural nerve and supply the skin subcutaneous tissue of the mid-3rd of the calf region. These suprafascial plexus arborizes both longitudinally and radially and anastomoses with septocutaneous perforators of peroneal artery in the distal 3rd of the leg laterally. This vascular network

ISSN (O): 2687-5365; ISSN (P): 2753-6556

forms the basis of the sural flap. Apart from the above blood supply, the arteriosomes that supplying the lesser saphenous vein which accompany along the sural nerve also take part in providing vascularity for that area. Hence the reverse sural flap has three types of vascularity pattern (i.e) peroneal septocutaneous perforator, arterial plexus around sural nerve, arteriosomes of lesser saphenous vein. Yang and Morris reported that the size of vascular territory of the flap was relatively constant and upper margin of the flap was localized at a level 10 cm below the knee.[3-5]

As the term REVERSE sural flap indicate, that the vascularity is by the reverse flow through the anastomosis between the peroneal artery and the vascular plexus accompanying sural nerve. Moreover, the venous drainage of the flap has to be established by the reverse flow pattern by the increasing pressure in venous return causes the venous valves to have back flow pattern which is a main disadvantage causing congestion in the flap.

Imanishi et al, discovered a small caliber network of veins that surround the sural nerve, which allow the bypass of valves of the lesser saphenous vein. The lesser saphenous vein which drains into popliteal vein contains numerous valves that prevent retrograde blood flow. However, one or more smaller collateral veins that run parallel to the lesser saphenous vein have anastomotic connections to the lesser saphenous vein, which can allow blood to bypass the valves of lesser saphenous vein and flow in a retrograde fashion and can drain directly from this small vein into the concomitant vein of a perforator from the peroneal artery or it can drain back into the lesser saphenous vein, which then drains into a similar concomitant vein.[6,7]

Advantages of this flap are easy to raise with minimal blood loss, preservation of major vascular structure, long pedicle length with 90-180 deg arc of rotation.

Disadvantages of the flap are 1) patient has to lie in prone position causing discomfort,2) loss of sensation in sural nerve distribution,3) aesthetic problem and as stated above & 4) more prone for venous congestion.[7-10]

The operative technique for doing the islanded reverse sural artery flap with tailed skin pedicle is easy to learn and execute. By proper execution, 1) Anteromedial aspect of lower 3rd leg, 2) Tendoachilles region, 3) Dorsum of hind foot, and 4) Ankle can be resurfaced without complications. In old age individuals, as the peroneal vessels are the last to undergo atherosclerosis, reverse sural flap can be executed safely.[10,11]

CONCLUSION

Islanded reverse sural artery flap with tailed skin pedicle harvested from its domain with meticulous surgical technique gives promising results in terms of less complication, shorter hospital stays, quicker healing time for resurfacing of the Anteromedial aspect of distal 3rd leg, Tendoachilles region, ankle and Dorsum of hind foot. There is no need to identify or isolate the perforator during dissection of the flap. There is no age predisposition in the flap.

The learning curve for executing the flap is also easy. Its long pedicle helps in distalization of the flap and does not require sacrificing any major arteries. The adipofascial cutaneous pedicle must be between 3-4cm. Though there is loss of sensation in sural nerve distribution areas and donor area scar is cosmetically unacceptable in female patients, the islanded reverse sural artery flap with tailed skin pedicle can be a workhorse flap for resurfacing the regions as enumerated earlier.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556