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Increased SuccessRate in Delayed Reverse Sural Artery Flap

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Abstract
Background:*Soft-tissue defects of the distal third of the lower extremity, ankle and foot present significant challenges to the reconstructive surgeon. The options in this region are limited. The reverse superficial sural artery flap (RSSAF) is a popular option for the defects. Our initial experience with this flap resulted in 50% failure rate, mostly because of critical venous congestion. To overcome this, we have modified our operative technique, which has resulted in a more reliable and increased survival of the flap.*
Methods:*All patients reconstructed were having lower third leg, ankle and foot defects. In response to a high rate of venous congestion in the earlier flaps, we adopted a uniform change in the operative technique .A key modification was to delay the flap both in regular and extended flaps. And we kept the pedicle width of about 4 cm.*
Results:Twenty one *patients were reconstructed with Reverse superficial sural artery flap. Salvage rate in the earlier group was 50% compared with almost 98% in the delayed sural flap cases.*
Conclusion:*Venous congestion greatly impairs the survival of the RSSAF. A pedicle width of at least 4 cm is recommended to maintain venous drainage and preserve flap viability. We observed that the delayed flap had the survival rate of almost 98%.*
Keywords:*lower third defects, ankle defects, delayed sural flap, reverse sural flap and venous congestion.*

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I. Introduction

Soft tissue defect 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 are dorsalispedis artery flap, abductor hallucis and abductor digitiminimi muscle flaps, having inadequate tissue and a limited arc of rotation thereby limiting their 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 an another option but its reliability is questionable in case of vascular compromise(7). Free tissue transfer is an 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 an another option for coverage of lower 1/3 of leg, ankle and foot defects.

Anatomyof Sural Nerve

The sural nerve is the sensory nerve supplying the skin of the lateral and posterior aspects of the distal third of the leg and the lateral aspect of the foot. In adults, the distal portion of the sural nerve can be located 1 to 1.5 cm posterior to and parallel with the posterior border of the lateral malleolus. In most cases (approximately 67 percent), the sural nerve is formed by the union of the medial sural cutaneous nerve and the lateral sural cutaneous nerve (also sometimes referred to as the peroneal communicating branch). The medial sural cutaneous nerve and lateral sural cutaneous nerve are branches of the tibial nerve and common fibular nerve, respectively. The site at which these two nerves join is most commonly in the lower third of the leg, but ranges from the popliteal fossa to just below the ankle. In the remaining approximately 33 percent of cases where the medial sural cutaneous nerve and lateral sural cutaneous nerve do not unite to form the sural nerve ,the sural nerve is almost always an extension of the medial sural cutaneous nerve, in which case the terms can be used interchangeably. In these cases, the lateral sural cutaneous nerve is most commonly diminished or not present at all, but it may be present and run parallel to the medial sural cutaneous nerve. Very rarely (1.5 percent), the medial sural cutaneous nerve is not present or diminished, in which case, the sural nerve is an extension of the lateral sural cutaneous nerve.

Retrograde Arterial Supply

The superficial sural arteries and the musculocutaneous perforators from the gastrocnemius are divided in the course of raising the distally based sural flap. Thus, the flap relies on retrograde blood supply by means of distal sources rather than the proximal anterograde supply.There are at least four sources of blood supply in this retrograde blood supply: 1.fasciocutaneous perforators from the peroneal artery, 2.fasciocutaneous perforators from the posterior tibial artery, 3.venocutaneous perforators from the lesser saphenous vein, and 4, neurocutaneous perforators from the sural nerve(18-20). The classically described arterial supply to the distally based sural flap is provided by septocutaneous perforators arising from the peroneal artery, of which the average leg has three to six. These perforators pass between the fibula and flexor halluces longus proximally and between the soleus and peroneus longus more distally. The most distal of these is located 4 to 7 cm proximal to the lateral malleolus. These vessels connect directly with the superficial sural arteries(3,21). The sural flap is also supplied by four or five septocutaneous perforators arising from the posterior tibial artery.Nakajima et al. have demonstrated the presence of neurocutaneous perforators and venocutaneous perforators arising from the small arteries accompanying the sural nerve and the lesser saphenous vein, respectively(19,20) In addition to their intrinsic blood supply,each of these structures has an extrinsic vascular plexus that runs along its length.This extrinsic vascular supply provides perforators that supply the skin and fascia of the sural angiosome. Thus,inclusion of the sural nerve and lesser saphenous vein in the flap provides two sources of arterial supply in addition to the fascial plexus supplied by the two groups of septocutaneous perforators .

Venous Drainage

Only one study investigating the venous drainage of the distally based sural flap has been published(23) The skin and fascia of the flap is drained primarily by the lesser saphenous vein (also sometimes referred to as the small saphenous vein). The lesser saphenous vein drains directly into the popliteal vein. The lesser saphenous vein contains numerous valves that prevent retrograde blood flow. There are, however, one or more smaller collateral veins that run parallel to the lesser saphenous vein. These veins have anastomotic connections to the lesser saphenous vein, which can allow blood to bypass the valves of the lesser saphenous vein and flow in a retrograde fashion. Venous blood can then either 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. The location and prevalence of venous perforators parallels that of arterial perforators. Each arterial perforator is generally accompanied by one or two concomitant veins(3)

Surgical Technique

The pivot point for the flap is first identified posterior and superior to the lateral malleolus. Most authors contend that the pivot point must be a minimum of approximately 5 cm proximal to the lateral malleolus but some authors claim a minimal distance as large as 10 to11 cm to achieve consistent flap survival. Doppler ultrasonography may beusedtoidentifyperforatingvesselstoaidinthe planning of a pivot point.Eitheroftwoapproaches can be taken in designing the flap. If the pivot point is kept relatively low, the fascial pedicle can be kept short, and the flap can be harvested entirely from the distal two-thirds of the posterior lower leg. Alternatively, if the pivot point is taken highertopreserve potentialperforatingvessels, thefascialpedicle must be longer to reach the defect site. If this second approach is taken, the flap may betakentowithin1to2cmofthepoplitealcrease. The maximum size of the flap is another point of some controversy. Various case series report maximum flap sizes of 12 to 23 cm in length and 8 to 16 cm in width. Because of their suprafasciallocation, the mediansural nerve, superficial sural artery, and lesser saphenous vein are generally transected in the course of this incision. The median superficial sural artery and lesser saphenous vein can then be ligated as a single unit or individually. If the proximal border of the flap is taken closer to the popliteal fossa, where the suralnerveandlessersaphenousvein are located subfascially, the adipofascial connections between the fascia and the proximal portions of thesestructuresshouldbecarefullypreservedto maintain the venocutaneous and neurocutaneous perforators that arise from their extrinsic vasculature(19,20)

Sural Flap Delay and Delayed Sural Flap

In attempts to redirect blood flow and decrease the risk of flap necrosis and venous congestion, several authors have described sural flap delay procedures. The idea of a delayed sural flap was first introduced in 1984 by Angelats and Albert.A distally based sural flap delay procedure was not reported in the literature until 2004.75 Sincethis publication, three additionalauthorshavereportedtheirexperiencewith sural delay procedures.Delayingthe sural flap improves outcomes, especially in patients with significant medical comorbidities.

Two distinct delay procedures have been described.

1.InthetechniqueofErdmannetal.,theflap isfirstelevatedwithoutcompletelyincisingtheproximal edge of the skin island. A powder-free glove is then placed between the elevated fascia and the gastrocnemius muscle, and the skin is closed. Two weekslater,theflapiscompletelyelevatedandtransferred into the defect site(25) This procedure has the goal of redirecting blood flow in a longitudinal direction before complete elevation of the flap (sural flap delay procedure).

2. In the technique used by Kneseretal.,theflapisraisedinitsentirelyandthen sutured back into its donor site. The flap is then transferred into its recipient site as a second procedure(24). This technique allows the flap to becomeviableonitsdistalvascularpediclebeforecausing the additional trauma of transferring the flap, whichcanpotentiallycompromisethatpedicle(delayed sural flap procedure).

II. Materials And Methods

We operated on twenty one patients.They were operated for lower one third leg, ankle and foot defects. Nineteen cases had post traumatic defects in lower third leg and foot. In two cases, the defect was following the release of post burn contracture ankle. Nineteen cases were males. One was female and another one was a female child. Age ranging from 6-65 years. For all the patients, preoperative hand held Doppler was done to identify the perforators. Patients with comorbid conditions like diabetes and hypertension were also included in our study. Defect size ranging from 6-15 cm.

Heel defect-Parallel delay

Lower third leg defect- Complete flap delay

Ankle defect

Heel defect –RSA Cover

Discussion

The sural flap is a useful and versatile reconstructive option in patients with soft-tissue defects of the foot and lower leg. Its success, when performedcorrectlyinappropriatelyselectedpatient, is well documented. Despite these successes, flap necrosis and other complications like venous congestion remain significant.Evenifperforatingvesselsare theoretically present very far distally, these perforatorsarenotalwayssufficienttosupplyanddrain the flap, especially in a vascularity compromised patient. Inpractice,theflapsizeandpivotpointposition aredictatedbythegeometriccontoursofthedefect needing repair. Our previous cases had the flap necrosis of almost 50% .To avoid unacceptably high complication rates in the repair of larger and more distal defects, we nowadays routinelyuse the sural flap delayprocedures in all our cases and keep the pedicle width of about 4 cms. We adoptedtwo methods of delaying the sural flap. In regular RSA flap we raised the flap from the bed entirely and sutured it back. Flap inset was given after seven days. In extended RSA flap we did the parallel delay that is flap margins were raised by making parallel incisions without incising the proximal margin. After four days proximal incision was done. Flap inset was given at the end of seven days. After doing the delay in RSA flap, the venous congestion was less and the survival of the RSA flap increased to about 98%.

In careful attention to patient positioning in the early postoperative period can make a difference.Theflapshouldbefreeofpressureandother mechanicalforces.Eitherlightdressingsornodressingsatallaremostsuccessful.Limbelevationiscrucial in the prevention of venous congestion.

III. Conclusion

The distally based sural flap offers an alternativetofreetissuetransferforreconstructionofthe lower extremity. The pivot point should typically be kept at least 5 to 6 cm above the lateral malleolus, although lower pivot points are possible. The pedicle should be kept as wide to increase the survival rate. By means of delaying the RSA routinely we can avoid complications like venous congestion and flap necrosis. And the survival rate is almost 98% when the RSA was delayed.

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