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Review Article

Reverse Sural Flap for Lower Limb Reconstruction: A Literature Review

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Abstract: Soft tissue reconstruction of the lower third of the leg, the ankle, and the foot is challenging for reconstructive surgeons. The options for reconstruction are limited. Reverse sural flap is relatively easy to perform and considered a good option for reconstruction. The complication rates are variable in studies. These defects commonly occur as a result of trauma, infection and tumor excision. Sural artery neurovascular island flap is a relatively thin, pliable and insensate flap with minimum donor-site morbidity and acceptable aesthetic outcome.

Keywords: Lower Extremity. Surgical Flaps. Leg Injuries. Plastic Surgery, Fasciocutaneous Flap, Limb Preserving Surgery, Soft Tissue Defect.

INTRODUCTION

Reconstruction of the foot and ankle wounds, especially when complicated with deep vital structures such as bone, joint, nerves or tendon are exposed, remains a challenging problem for the treating surgeon. The foot with the features of weight bearing requirement, the lack of intervening muscle between the skeleton and the skin, and the limited movement of the overlying skin, make the soft-tissue coverage even more difficult. In general, there are several methods of surgical procedures, including vascular- pedicled loco-regional transposition and microsurgical free transfer of muscle or myocutaneous flaps, and fascial or fasciocutaneous flaps, and each procedure has its own merits and drawbacks on indications, technical requirement, flap size, range of vascular pedicle, and limitations of patient's local and general conditions. The first distally based sural fasciocutaneous flap was defined by Donski *et al.*, in 1983 for Achilles tendon coverage. The detailed anatomy of distally based sural fasciocutaneous flap for the reconstruction of distal third of leg, foot, and ankle defect was described by Masquelet *et al.*, in 1992. The distally based sural fasciocutaneous flap is the workhorse flap for many reconstructive surgeons, especially when they lack microsurgical skills or when other reconstructive options are not available. Many surgeons believe the sural flap is a good alternative to the free flap. The major advantage of this flap is that it does not require microsurgical skills and can be done in a minimal-resource center. It is a versatile and reliable technique with 180-degrees rotation. There are options using pedicled vascular flaps, those flaps can be categorized into three patterns: (1) The reverse- flow island flaps, such as the reversed anterior tibial artery flap, the posterior tibial artery flap, and the peroneal artery flap; (2) The distally perforator- based flaps, which avoid the sacrifice of the main deep arteries, such as the lateral and medial supra- malleolar flap; and (3) The distally based neuro-veno- fasciocutaneous flaps that are supplied by the chain- linked longitudinal directed vascular plexuses from a wide neuro-veno-adipofascial pedicle. These three loco-regional kinds of flaps can be elevated easily and substituted for microsurgical free flaps for foot and ankle reconstructions.

Surgical Technique

When creating a surgical flap, it is important to take into account five crucial factors: The key components of flap rotation are as follows: (1) pivot

point, which refers to the axial vascular perforator originating from the deep main vascular stem and serves as the rotational axis for the flap; (2) axial line, which represents the direction of vascularization of the flap and guides the design of the flap; (3) flap area, which is determined based on the size of the defect to be reconstructed; (4) dissection plane, which corresponds to the surface along which the flap is elevated; and (5) rotation arc, which indicates the maximum extent to which the flap can be rotated distally. A longitudinal line is drawn to represent the trajectory of the posterior tibial artery, extending from the midpoint of the popliteal fossa to the midpoint of the Achilles tendon and either the medial or lateral malleolus in the lower limb. All perforator flaps based on distal anatomy are positioned along one of the two mentioned lines. The last step involves the reverse outline of the necessary skin paddle on the lower leg, taking into consideration the specific position and dimensions of the tissue defect. A pneumatic tourniquet is applied to the thigh, followed by the elevation of the leg and manual compression for a duration of 1-2 minutes to remove blood. Following the surgical procedure, a first incision is performed along the posterior border of the defect, namely on the Achilles side. This incision is characterized by its sharpness and length, measuring around 5-7 cm. The incision is created in a straight manner, extending from the wound to the distal portion of the flap, reaching the deep fascia. Next, the flap is raised anteriorly from the sub-fascial plane to the septum in order to locate the perforator. Once a suitable perforator has been selected, the design of the flap is reassessed and modified based on the precise positioning of the perforator. The perforator exhibited effective skeletonization of the perforating vessels in order to enable unrestricted rotation. The flap is twisted through 180 degrees so that it may reach the foot or heel of the receiver, and then it is inset without any strain. There is no venous anastomosis done at this time. It is possible to cover the donor sites with skin grafts of a divided thickness.

FIGURES

1: Sural flap design

2: Ankle defect

3: Flap dissection

4: Flap Rotation / Cover defect

5: Cover defect result

DISCUSSION

The field of plastic surgery has long recognized lower limb repair as a complex endeavor, with increasing challenges as the severity of injuries increases. The challenge might be attributed to the lack of available donor tissue and the probable insufficiency of vascularization in the affected area, particularly in cases of high-energy injuries. As a result, free flaps have received significant attention and have become as the primary approach for reconstructing large damage.

These medical devices are often used for the purpose of reconstructing the distal third of the leg, as well as the anterior and lateral aspects of the ankle, the posterior aspect of the heel, the instep, and the lateral aspect of the hindfoot. Nevertheless, the use of this particular reconstruction method may be limited for some patients owing to factors such as extended surgical duration, potential complications in the donor location, and the need for a specialist team and facility. The use of muscle flaps in this particular area is limited, since they are mostly employed for the purpose of reconstructing abnormalities in the proximal and central segments of the leg. Cutaneous and Fasciocutaneous flaps including a distal pedicle provide an additional viable option that warrants consideration. The reverse sural flap has been extensively researched as a viable technique for addressing deficiencies in the lower extremities, namely in the regions of the leg, ankle, and foot. The procedure involves the manipulation and penetration of the branches of the fibular artery, which have their origin around 5 to 6 cm proximal to the lateral malleolus. Individuals diagnosed with diabetes, individuals who engage in smoking, and patients suffering from peripheral vascular disease should exercise caution in relation to this matter. The primary constraint of this method is in its ability to address distal abnormalities, particularly those located in the plantar region, as a result of the restricted range of its perforation. The reverse sural flap may be classified as an axial flap. The arterial blood supply of the subject in question relies on the retrograde flow originating from sept cutaneous perforators located inside the fibular artery. The posterior tibial artery receives contributions from its branches as well. The venous draining of the structure is accomplished via Ven cutaneous branches that go towards the small saphenous vein, hence preserving sensory innervation through the sural nerve. The drawbacks associated with this flap include the restricted ability to rotate the pedicle, the aesthetic implications of scarring at the donor site, reliance on the patient's peroneal artery, and the necessity to sacrifice the sural nerve during the reconstruction process. However, it is worth noting that the significance of this limitation appears to be minimal when considering the broader objective of preserving the limb. An important contraindication for using a reverse sural flap procedure is the presence of an active soft tissue infection and the lack of in-line flow to the peroneal artery.

CONCLUSION

The reverse sural fasciocutaneous flap has shown its efficacy, reliability, and safety as an ideal option for the reconstruction of complex injuries occurring in the distal part of the leg and foot. Additionally, this therapeutic modality has the potential to be used in the treatment of both acute wounds, defined as wounds with a duration of less than 30 days, and chronic wounds, characterized by a duration beyond 30 days. The benefits include the capacity to transfer tissue from a nearby donor area to a distant recipient site, the avoidance of dependence on the foot, the quicker one-step procedure that does not necessitate microsurgical skills, a comparable outcome to that of the free flap technique when executed with great care, and often, a superior outcomes.

CONFLICTS OF INTERESTS

The authors have shown no conflicts of interest, ensuring the integrity and objectivity of their study results.

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