



LATERAL SUPERFICIAL SURAL ARTERY CUTANEOUS FLAP - A VERSATILE SOLUTION TO DEFECTS AROUND THE KNEE

Plastic Surgery

**Dr. Debtanu
Bhattacharya**

Assistant Professor, Department of Plastic And Reconstructive Surgery, IPGMER And SSKM Hospital, Kolkata.

**Dr. Oli Das
Adhikary***

Academic Resident, Department of Plastic And Reconstructive Surgery, IPGMER And SSKM Hospital, Kolkata. *Corresponding Author

**Prof. (Dr.) Souvik
Adhikary**

Professor, Department of Plastic And Reconstructive Surgery, NBMC And Hospital.

ABSTRACT

Coverage of defects by local flaps around the knee joint, especially the posterior aspect, can be troublesome at times due to lack of appropriate and unscarred tissue. The lateral superficial sural artery flap which is an axial flap can be a viable alternative in these situations. **Method.** Between February 2019 and February 2025 twelve female patients and two male patients were operated upon using a lateral sural flap. 5 patients had bilateral involvement. Most were due to burns although 2 cases were due to trauma. Defect was created first and then the lateral sural flap was raised in a peninsular fashion from distal to proximal, up to almost the popliteal fossa and flap inset was done. **Results.** All flaps except one survived in which there was marginal distal necrosis and had to be debrided. Durable coverage was provided to the knee joint and recurrence of contracture was not seen in follow up. **Conclusion.** Lateral superficial sural artery flap is a viable, reliable and alternative method of coverage of defects around the knee joint.

KEYWORDS

Lateral sural flap-knee contracture-axial flap

INTRODUCTION

Coverage of Soft tissue defects around knee joint present a difficult problem at times and require ingenious solutions. The reasons for such defects are manifold, like post burn contractures or unstable scars, wounds as a result of trauma and post tumor excision. The posterior aspect of knee joint is especially troublesome area because the skin grafts used to cover the wounds or defects in this area often undergo re-contracture resulting in the recurrence of the original problem. Splintage and physiotherapy though helpful do not obviate the problem in many cases. Flap coverage is desirable, though, difficult. The usual options are locoregional flaps or cross leg flaps or free flaps. Gastrocnemius muscle flap has limited reach, and is bulky. Local fasciocutaneous flaps are limited in choice, namely the saphenous flap, the medial sural artery flap, the reverse ALT flap, the lateral supragenicular perforator flap and the Lateral sural artery cutaneous flap. Among the local fasciocutaneous flaps lateral sural artery cutaneous flap presents a novel solution to an old problem. It is an axial flap, does not require tedious intramuscular dissection, and therefore easier to harvest. And importantly in the series of post burn contractures encountered in our series, the medial side of knee and calf were found to be affected the most, with sparing of the lateral areas. A free flap provides a better aesthetic solution but is technically challenging.

MATERIALS AND METHODS

This is a retrospective study consisting of 14 patients operated between February 2019 and February 2025. The patients underwent reconstructions of soft tissue defects around the knee with the proximally based lateral superficial sural artery flap. All the patients who involved in this study provided written informed consent.

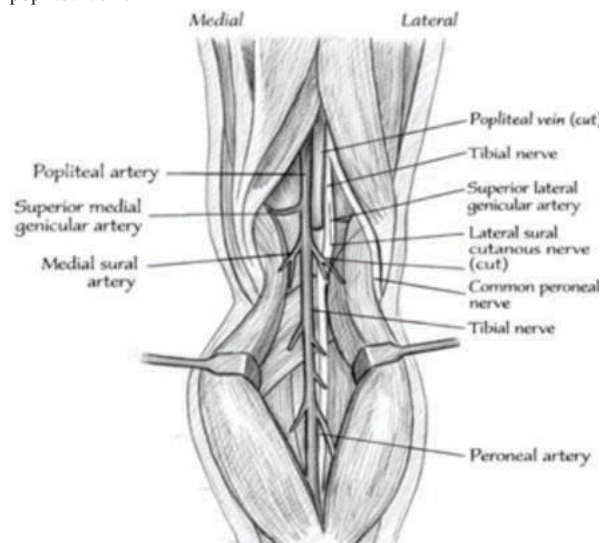
Anatomy

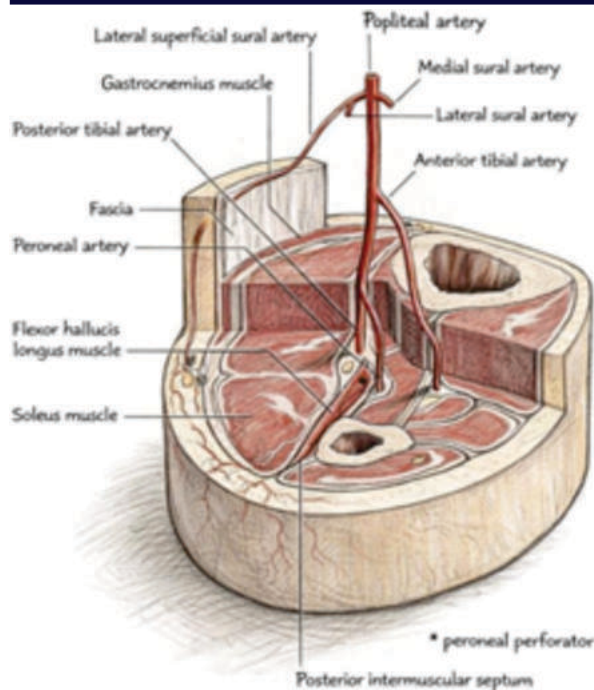
The source of blood supply of the calf angiosome is mainly by superficial sural arteries, various cutaneous perforators from sural arteries proper, posterior tibial artery and peroneal artery perforators. There exist three superficial sural arteries and are named the medial, median, and lateral superficial sural arteries. There seems to be some confusion regarding the differentiation between the medial and lateral sural arteries and the superficial sural arteries which leads to some authors naming the flap as a lateral sural flap instead of lateral superficial sural artery flap. Sural arteries proper arise from the popliteal artery in most cases and supply the two heads of gastrocnemius, along with giving perforators to the overlying skin of calf (1). Medial sural artery perforators being much more constant in number and size. Lateral sural artery cutaneous perforators are frequently absent in Asian population and hence unreliable (2). Superficial sural arteries, namely medial, median and lateral, arise

directly from the popliteal artery, or the medial or the lateral sural artery. After origin, lateral superficial sural arteries crosses the popliteal fossa and pierces the deep fascia somewhere at 3 cm lateral to the mid line and 0 to 12 cm below the fibular head and accompanied by one or two veins (3) travels lateral to the head of the gastrocnemius muscle toward the lateral malleolus. The artery accompanies the lateral sural cutaneous nerve to the distal one-third of the leg, anastomosing with the supramalleolar branch of the peroneal artery.

The median superficial sural artery runs in the midline between the heads of the gastrocnemius muscle. It arises from the popliteal, lateral sural or the inferior genicular artery and pierces the popliteal fascia to accompany the medial sural cutaneous nerve and the short saphenous vein. These structures form the landmarks of the distally based sural flap.

The other supplies to the lateral superficial sural flap may be from the peroneal perforators, muscular perforators, from lateral sural artery or posterior tibial artery, and finally from neurocutaneous perforators arising from the smaller arteries accompanying lateral sural cutaneous nerve (4). Harvesting the lateral sural cutaneous nerve makes the flap sensate without causing anesthesia in the foot. Two venae comitantes accompany the lateral superficial sural artery and drain into the popliteal vein.





Clinical Cases

Most of the patients presented with severe post burn contractures of the knees, with unstable scars. Altogether 14 patients were operated out of which 12 were females and 2 were males. The age range was 16 yrs to 44 yrs with a mean age of 27 yrs. Out of these, 5 patients had bilateral involvement. The post burn cases presented after a delay ranging from 10 to 24 months. The male patients had wounds resultant to trauma and were acute presentations. The medial gastrocnemius region was also severely scarred as was the saphenous flap territory.

DESIGN OF FLAP AND SURGICAL TECHNIQUE

Under spinal anesthesia the defect on the back of the knee was created first. Then, after application of a tourniquet the flap was marked on the posterolateral aspect of the leg, keeping the lateral superficial sural artery in the mid axis of the flap. The proximal extent of the flap was upto the tibial plateau and distally it extended to half of leg. The pivot point was almost to the popliteal fossa.

We first incised the distal and medial aspect of the flap, flap was elevated deep to the fascia and the lateral superficial sural artery and lateral sural nerve were identified on the under surface of the flap. Once identified the lateral incision was made and the entire flap dissected up to the pivot point. While dissecting proximally it was common to encounter the common peroneal nerve and extra precaution was taken to avoid injuring it. Flap was inset into the defect after tourniquet release and excessive tension and twisting avoided. All flaps in our series were peninsular. Due

to the large defects created average flap size was large and therefore, all patients underwent skin grafting of the donor area.



Case 1. Bilateral post burn knee contracture release and coverage by lateral sural cutaneous flaps



Case2. Bilateral post burn knee contracture release and coverage by lateral sural cutaneous flaps



Case 3 Coverage of anterior and lateral aspect of knee by Lateral sural flap in a post- traumatic defect.

RESULTS

Of the 14 cases there were 13 with complete survival of flap. One case had distal necrosis and had to be discarded. All cases were followed up for up to 6 months to 1 year and all flaps settled nicely.

Table 1 Patient Summary

Sl. No	Sex	Age	Cause Of Defect	Site of defect	Donor Site closure	Complications	Follow up
1	F	26	Burn	Posterior aspect of knee	Skin graft	No	6
2	F	35	Burn	Medial aspect of knee	Skin graft	No	8
3	F	32	Burn	Medial aspect of knee	Skin graft	No	12
4	F	28	Burn	Posterior & medial aspect of knee	Skin graft	No	14
5	F	26	Burn	Medial aspect of knee	Skin graft	No	6
6	F	44	Burn	Posterior aspect of knee	Skin Graft	No	7
7	F	18	Burn	Posterior aspect of knee	Skin graft	Loss of flap	
8	F	16	Burn	Medial aspect of knee	Skin graft	No	8
9	F	28	Burn	Medial aspect	Skin graft	No	12
10	M	29	Trauma	Anterior & medial aspect of knee	Skin graft	No	8
11	F	27	Burn	Posterior aspect of knee	Skin graft	No	6
12	M	32	Trauma	Anterior & medial aspect of knee	Skin graft	No	12
13	F	21	Burn	Posterior aspect of knee	Skin graft	No	7
14	F	20	Burn	Posterior aspect of knee	Skin graft	No	8

DISCUSSION

The incidence of burn injuries in India is amongst the highest in the world accounting for 7 lakh cases annually (5). The main pathological changes of the burned joint contracture are scar formation and soft tissue contracture around the articular surface due to patient's long-

term immobility, which can be prevented by early mobilization, splintage and physiotherapy. In a developing country like ours where access to well-equipped burn units is restricted to very few patients. Due to sheer acute shortage of well-equipped burn units most cases are tackled by ill-equipped peripheral hospitals where proper care like skin

grafting and splinting are not done. This leads to a high incidence of post burn contractures and deformities in burn patients.

The knee joint, especially the popliteal fossa is frequently involved in burn injuries leading to severe flexion contractures. This greatly hampers locomotion and inability to perform day to day activities. Long standing contractures often lead to shortening of underlying tendons and neurovascular structures. Soft tissue release of these joints creates large defects exposing the underlying hamstring tendons and vital structures. Skin grafting of these defects leads to suboptimal results and high chances of recurrence of the contracture.

There are multiple options for coverage of defects around the knee. The various options include, random cutaneous flaps, muscle flaps, fasciocutaneous flaps and free flaps. Each has its own pros and cons. Random cutaneous flaps are the easiest to perform like Z-plasty (6) and its modifications, V-Y plasty(7), Seven flap plasty etc.(8)(9) But these lack reliability and are restricted to a limited length and therefore can be used for small defects. Muscle flaps tend to be bulky, have limited reach and result in loss of power. Free flaps need microsurgical expertise and have a significant learning curve.

The locally available fasciocutaneous flaps are medial sural perforator flap and the medial sural perforator plus flap (10), the proximally based sural artery flap (11)(12), the saphenous venous flap(13), the superior lateral genicular artery flap(14)(15) and the superior medial genicular artery flap (16) (17).The anterolateral thigh flap has also been used , both as a free flap and as distally based island flap (18).

Saphenous flap was described by Acland et al (19) is a good choice but leads to poor cosmesis and most of the patients in this series had scarring in the saphenous flap territory.

A study by Kosutic et al by using anatomical and duplex studies show the unreliability of sural region as regards the number of dominant perforators. A dominant medial sural artery perforator being much more commonly found than a lateral sural artery perforator (1). The medial and lateral aspect of the lower thigh were often found severely scarred precluding the use of medial or lateral genicular artery flaps.

On the other hand the superficial lateral sural artery was present in more than 85% of all anatomic specimens making it a much more reliable choice. The lateral superficial sural artery flap is an axial flap with added perforators in the base of the flap making it highly reliable.

The cause of defects in our series were mostly caused by burn contractures at the posterior and medial aspect of the knee and upper legs. Therefore, medial sural territory and the saphenous territory were compromised, precluding the use of these flaps. Lateral area of the calf was mostly untouched and hence the choice of this flap.

In 1975 Taylor and Daniel first identified the lateral sural cutaneous flap as a possible free flap donor (20). Actual use as a free flap was first reported by Walter and Bunkis in 1984(21). Later it was used as an option for intra oral reconstruction also (22).

Li et al [23] described an island flap based on lateral sural cutaneous artery for covering defects around the knee. Their anatomical study of 20 legs showed that the lateral sural cutaneous arteries were constant and the outer diameter ranged from 0.4 to 0.6 mm at its origin, which descended along the posterolateral aspect of the leg together with two venae comitantes and the lateral sural cutaneous nerve. These clinical results were satisfactory and the flaps possessed normal sensation with good elasticity.

Rajacic et al [24] had used lateral sural fasciocutaneous artery island flap in 6 patients to reconstruct defects around the knee. The causes of the defect include trauma, deep burns, chronic ulcers, and post-burn scar contractures. All the flaps survived.

Deng et al [25] had used lateral superficial sural artery flap for soft tissue reconstruction in 14 patients. In his study all flaps survived and concluded that proximally based lateral superficial sural artery flap is an ideal flap that is suitable for regional soft tissue reconstruction around the knee.

CONCLUSION

Soft tissue coverage around the knee joint is a challenging task. The

needs specific to this region include a thin and sensate flap cover which should be easy to perform and with minimal donor morbidity. The lateral superficial sural artery flap confirms to all the above-mentioned criteria. The presence of an axial vessel in the flap is an added bonus. Additional supply to the flap from peroneal, posterior tibial and muscular perforators make the flap a robust one. In cases where only the lateral area of the leg is spared, lateral superficial sural artery flap is an ideal regional flap for soft tissue reconstruction around the knee.

REFERENCES

- Kosutic D., Pejckovic D., Anferhuber F., Vadjia-Donlagic S., Zic R., Gulic R., Krajnc I., Solman L. and Kocbek L. Complete mapping of lateral and medial sural perforators: Anatomical study with duplex-doppler ultra sound co relation, *J Plas Reconstr Aesthet Surg* 2012; 65:1530-1536.
- Otani M., Okamoto H., Kagami H., Narita Y., Ebisawa K., Oda T., Sekiya I., Kobayashi M., Matsushita Y., Mizutani J., Yamada S., Ueda M., Takanobuo. Anatomical study on perforators of the medial and lateral sural artery in Asians, *Nagoya Med J* (2012) 52, 89-98.
- Hallock G., A Sensate lateral sural artery muscle perforator flap. *Cirurgia Plastica Ibero-Latino Americana* 32 (4):17-18+293-297.
- Deng C., Wei Z., Wang B., Jin W., Zhang W., Tang X., Wu B., Sun G., Wang D. The proximally based lateral superficial sural artery flap: A convenient and optimal technique for the reconstruction of soft tissue defects around knee. *Int J Clin Exp Med* 2016; 9(8): 15167-15176.
- Hanumadass ML. Some thoughts on organization of delivery of burn care in India *Indian J Burns* 2003 11:18-20.
- Chan RK, Donelan MR. Use of Z-plasty in burn reconstruction. In: Hyakusoku H, Orgill DP, Teot L, editors. *Color atlas of burn reconstructive surgery*. 2017; Ch. 21; p. 172-7.
- Askar I (2003) Double reverse V-Y-plasty in postburn scar contractures: a new modification of V-Y-plasty. *Burns* 29: 721-725.
- Suliman MT (2004) Experience with the seven flap-plasty for the release of burns contractures. *Burns* 30: 374-379.
- Grishkevich VM, Vishnevsky AV (2013) Postburn Knee Flexions Contractures: Anatomy and Methods of Their Treatment. *Trop Med Surg* 1: 147.
- Kim KS, Kim ES, Hwang JH, Lee SY (2012) Medial sural perforator plus island flap: a modification of the medial sural perforator island flap for the reconstruction of postburn knee flexion contractures using burned calf skin. *J Plast Reconstr Aesthet Surg* 65: 804-809
- Cheon SJ, Kim IB, Park WR, Kim HT (2008) The proximally-based sural artery flap for coverage of soft tissue defects around the knee and on the proximal third and middle third of the lower leg: 10 patients followed for 1-2.5 years. *Acta Orthop* 79: 370-375.
- Suri MR, Friji MT, Ahmad QG, Yadav PS (2010) Utility of proximally based sural artery flap for lower thigh and knee defects. *Ann Plast Surg* 64: 462-465.
- Thattai RL, Thattai MR, The saphenous venous flap, *British Journal of Plastic Surgery*, Volume 42, Issue 4, 1989, Pages 399-404
- Hayashi A, Maruyama Y. The lateral genicular artery flap. *Ann Plast Surg*. 1990;24:310-7.
- Low OW, Loh TF, Lee H, Yap YL, Lim J, Lim TC, Nallathamby V. The superior lateral genicular artery flap for reconstruction of knee and proximal leg defects. *Arch Plast Surg*. 2022 Jan;49(1):108-114
- Hayashi A, Maruyama Y. The medial genicular artery flap. *Ann Plast Surg*. 1990 Sep;25(3):174-80.
- Nnadozie UU, Maduba CC, Popliteal fossa reconstruction with medial genicular artery flap in a low resource setting: A report of two cases, *International Journal of Surgery Case Reports*, Volume 68, 2020, Pages 129-131,
- Yildirim S, Avci G, Akan M, Misirlioglu A, Aköz T. Anterolateral thigh flap in the treatment of postburn flexion contractures of the knee. *Plast Reconstr Surg*. 2003 Apr 15;111(5):1630
- Acland R.D., Schusterman M., Godina M., Eder E., Taylor G.I and Carlisle I.R (1981) The Saphenous Neuro Vascular Free Flap, *Plastic And Reconstructive Surgery* 67:763.
- Taylor GI and Daniel RK (1975) The anatomy of several free flap donor sites. *Plastic and reconstructive surgery*, 56,243.
- Walton RL and Bunkis J (1984) The posterior calf fasciocutaneous free flap *Plastic and Reconstructive Surgery* 74,76.
- Wolff K.D., Bauer F., Kunz S., Mitchell D.A and Kesting M.R. Superficial lateral sural artery free flap for intra oral reconstruction: anatomic study and clinical implications. *Head Neck* 2012;34:1218-1224.
- Li Z., Liu K., Lin Y., Li L. Lateral Sural Cutaneous Artery, Island flap is the treatment of soft tissue defects at the knee. October 1990. *British journal of Plastic Surgery* 43 (5) :546-50.
- Rajacic N GRK, Darweesh M. Reconstruction of soft tissue defects around the knee with the use of the lateral sural fasciocutaneous artery island flap. *Euro J Plast Surg* 1999; 22: 12-16.
- Deng C, Wei Z, Wang B, Jin W, Zhang W, Tang X, Wang D. The proximally based lateral superficial sural artery flap: a convenient and optimal technique for the reconstruction of soft-tissue defects around the knee. *Int J Clin Exp Med*. 2016 Jan 1;9(8):15167-76.