



## Surgical Reconstruction of Sole by Sural Flap among Patients with Loss of Soft Tissue at Distal Portion of Lower Limb: A Non-Randomized Single Arm Clinical Trial



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### Abstract

**Background:** Soft tissue loss on distal one third of leg, around ankle and foot is a big problem. There are many options, but each of them has advantages and disadvantages. Sural fasciocutaneous flap is an option for this problem which has excellent results with minimum morbidity. **Objective:** The purpose of the present study was to role of surgical reconstruction of sole by sural flap among patients with loss of soft tissue at distal portion of lower limb. **Methodology:** This interventional study was carried out in the Department of Orthopedic Surgery, Ad-Din Sokhina Women's Medical College, Jashore, Bangladesh from January 2022 to December 2022 for a period of one year. All patients with open fracture on the distal third of the tibia, exposed Achilles tendon, ankle, lateral and medial malleoli or heel reconstruction were performed by sural flap. The flap viability rate and durability of the flap at these sites were evaluated. **Results:** A total number of 14 patients from 14 to 70 years old were included in this study. It was obtained excellent results with this type of flap in all the patients and success rate was considered as 100.0% approximately. **Conclusion:** With a few limitations, high success rate and collaboratively easy operative procedure; sural flap may be a good option for soft tissue loss at distal leg, ankle and foot. [Journal of National Institute of Neurosciences Bangladesh, July 2023;9(2):127-131]

**Keywords:** Sural artery flap; distally based; fasciocutaneous; reverse flow

### Introduction

Soft tissue resurfacing of the lower extremity remains a challenging but a common problem<sup>1-4</sup>. Reconstruction of the lower extremity with a huge soft tissue loss; free flaps are recently the standard procedure<sup>5</sup>. But this flap done by a specialist microsurgical team and there required a long time. A cross- leg flap may be another procedure for coverage soft tissue loss, but has the associated difficulties of immobilization and positioning of the limb from the time of flap resurface to division of the flap<sup>6</sup>. A distally based sural flap was one of the recently introduced method. Masquelet et al<sup>7</sup> first described the use of neurocutaneous flap based on the vascular axis around the sural nerve. The sural island flap has become popular for soft tissue resurface of the distal leg, ankle and foot<sup>8-11</sup>.

The distally based sural island flap gets its blood supply by the reverse flow from the perforators of the peroneal

artery, and the pivot point within 5 to 7 cm above the lateral malleolus<sup>10-11</sup>. With its constant anatomy and blood supply, this flap can be elevated reliably without micro vascular techniques. As no major artery is needed, the flap may possibly be elevated even in cases with peripheral vascular disease, or when major arteries have been damaged in trauma<sup>2,9,10</sup>. The flap also has the largest arc of rotation (upto180°), so can be transferred to any direction.

### Methodology

**Study Settings and Population:** This interventional study was carried out in the Department of Orthopedic Surgery, Ad-Din Sokhina Women's Medical College, Jashore, Bangladesh from January 2022 to December 2022 for a period of one year. We studied 14 patients over a period of 4.5 years in whom the sural flap was performed for soft tissue defects of the distal 3 around

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ankle and foot due to various causes. The patients included 11 males and 3 females. Their age ranged from 14 to 70 years. The soft tissue loss were over the distal leg anteriorly and posteriorly, over the medial surface distal part of tibia, medial and lateral malleoli, exposed Achilles tendon (AT), calcaneus and proximal sole and dorsal aspect of foot. Some patients had associated fractures of the tibia and fibula, chronic osteomyelitis and chronic ulcers. The age of the defect varied from a few weeks to months. Island flaps were used in majority of patients. The diameter of the flap depended on the area of the defect.

**Surgical Procedure:** All wounds were first treated by surgical debridement of necrotic tissue. Open fractures type IIIB was stabilized by external fixator. Within 5 to 10 days the soft tissue defects were covered with the flap. Every operation was performed under spinal anaesthesia, in prone position with tourniquet control. The flap was designed along the course of the short saphenous vein. The distal pivot point was marked 5 cm above the lateral malleolus and the flap was outlined according to the size and shape of the defect. Dissection of the flap was started from upper border of the flap, the deep fascia was also incised and fixed to the skin with 4/0 vicryl<sup>18</sup>. The medial and lateral borders of the flap were incised and the flap was dissected downward together with the deep fascia. Meticulous dissection essential in the subfascial plane, the sural nerve and artery were included with the skin and flap pedicle. When lesser saphenous vein and its accompanying arteries are included with flap and its pedicle, flap survival rate also increased<sup>12</sup>. The pedicle of the flap contains superficial and deep fascia, sural nerve, small saphenous vein and its accompanying vessels, median superficial sural artery (neuro-veno-adipofascial pedicle)<sup>13,14</sup> with a 2.5-3 cm width soft tissue. The flap proper includes the skin island, subcutaneous tissue and the fascias (neuro-veno-fasciocutaneous flap)<sup>13,14,15</sup>. After complete dissection, the flap rotated 90-180° according to required and sutured over the defects. No subcutaneous pedicle tunneling was performed. Partial-thickness skin graft was covered the donor site (Figure I) or was closed directly for flaps less than 5 cm in width, depending on the degree of skin laxity.

#### Statistical Analysis

Statistical analysis was performed by Windows based software named as Statistical Package for Social Science (SPSS), versions 22.0 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Continuous data were expressed as mean, standard deviation, minimum and maximum. Categorical data

were summarized in terms of frequency counts and percentages.

#### Ethical Consideration

All the procedures of the present study were carried out in accordance with the International Conference on Harmonization Good Clinical Practice guidelines and the principles for human investigations (i.e., Helsinki Declaration) and also with the ethical guidelines of the Institutional research ethics. Before starting the study, the study protocol, patient information sheet, and informed consent form were approved by the independent ethics committees of the study place and the competent regulatory authorities in accordance with local legal requirements in participating centre. Formal ethics approval was granted by the Local Ethics Review Committee. Participants in the study were informed about the procedure and purpose of the study and confidentiality of information provided. All participants consented willingly to be a part of the study during the data collection periods. All data were collected anonymously and analyzed using the coding system.

#### Results

Among the cases studied (Table 1) the injury to the lower limb was due to road traffic accident in 10 patients, physical trauma in one patient, and three others had history of falling from height. Soft tissue loss over the Achilles tendon were 3 cases, skin loss over dorsum foot with exposed extensor tendons in one case and antero-lateral lower leg skin and periosteum loss in 3 cases. The range of rotation of the flaps were 90 to 180. The flap was rotated by 180 to cover the defects over the AT and heel in 4 patients. The flaps were raised

Table 1: Clinical Characteristics of the Patients

SL No	Age	Sex	Etiology	Recipient Site	Flap size (cm)
1	70 Years	Female	RTA	Sole	16×8
2	58 Years	Male	RTA	Sole	12×6
3	28 Years	Male	Fall from Height	Sole	8×5
4	25 Years	Male	RTA	Sole	9×7
5	14 Years	Male	Fall from Height	Sole	15×8
6	55 Years	Female	RTA	Sole	15×8
7	32 Years	Male	RTA	Sole	18×9
8	55 Years	Male	RTA	Sole	14×5
9	42 Years	Female	Fall from Height	Sole	15×9
10	60 Years	Male	RTA	Sole	15×9
11	35 Years	Male	RTA	Sole	15×9
12	44 Years	Male	RTA	Sole	12×5
13	28 Years	Male	RTA	Sole	15×9
14	39 Years	Female	Trauma	Sole	20×9

15 to 25cm above the tip of the lateral malleolus. The width of the flap ranged from 5 to 8cm, at its widest region and length 10 to 25cm. The flap survived in all patients and the average healing time was 21 days.

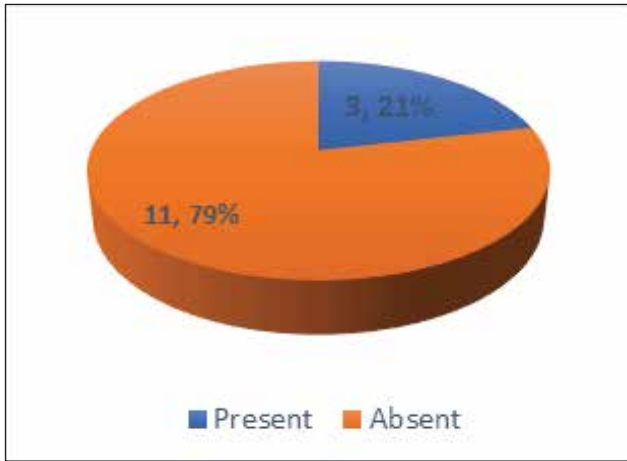


Figure I: Showing the status of Diabetes Mellitus (n=14)

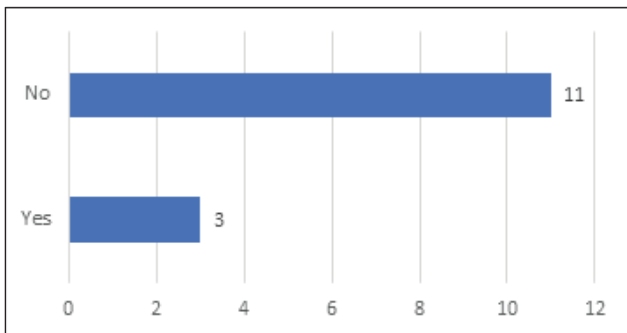


Figure II: Showing History of Smoking among Study Population (n=14)

(Table 1).

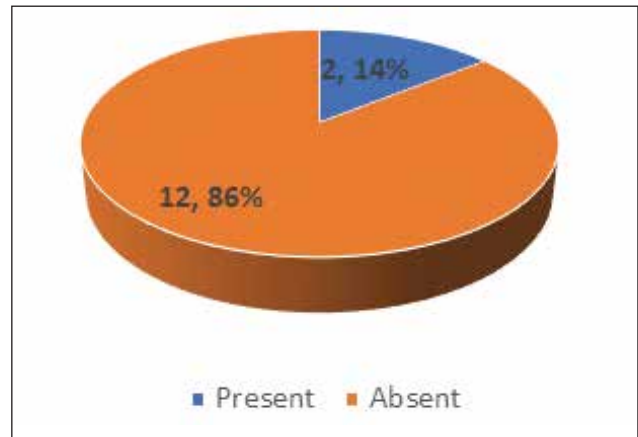


Figure III: Showing the Complication of the Study Population (n=14)

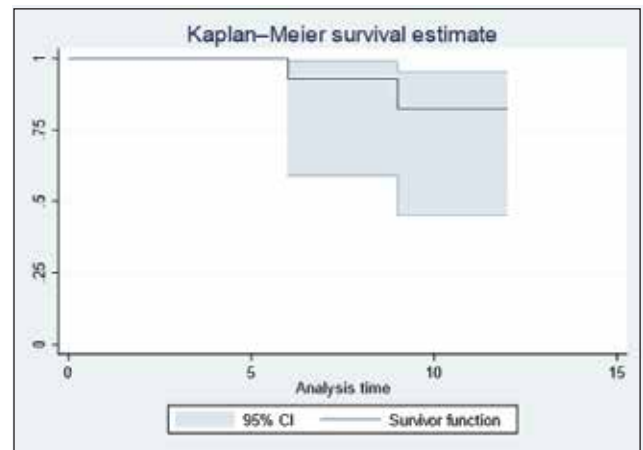


Figure IV: Showing the Kaplan-Meier Survival Curve among the Study Population

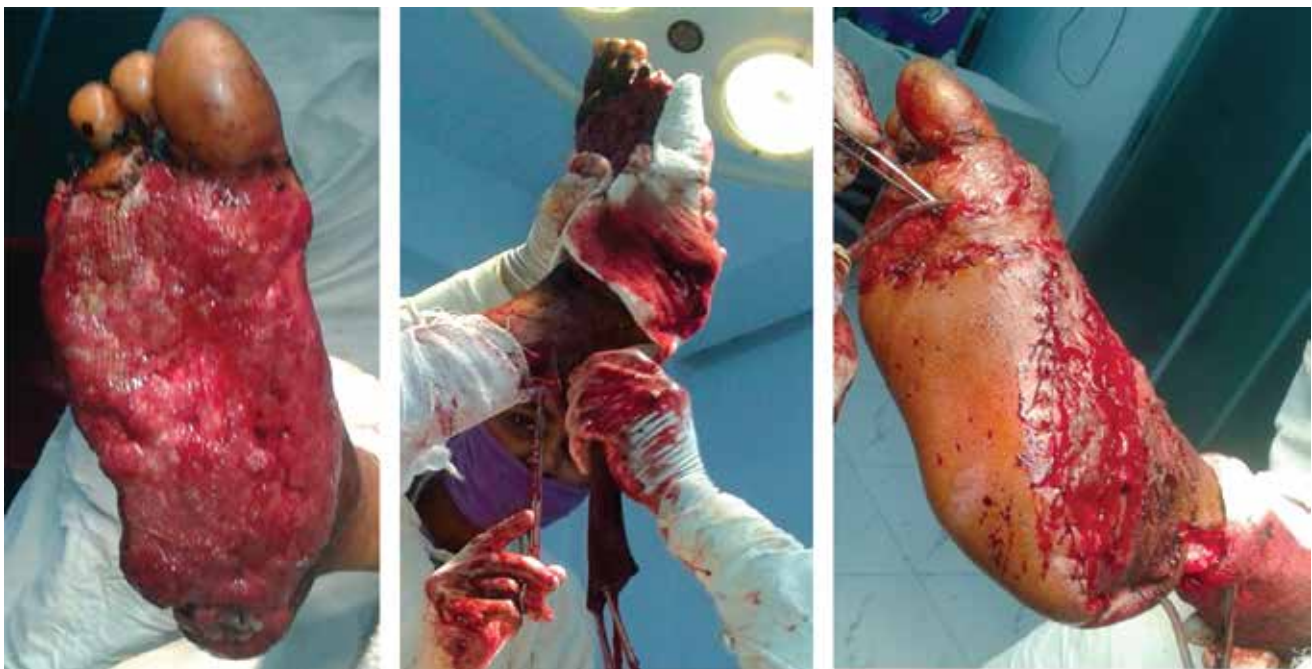


Figure V: Procedures of Measuring the nose inclination (A) and Ear Inclination (B) in a Participant using an Angle Finder

Only in one 70-year smoker, Diabetic patient had partial loss (about 3 cm) at distal margin of the flap but resurfaced by a partial thickness skin grafting after wound debridement. Wound infection was only seen in one case, which resolved a few days postoperatively. No complications were observed in the donor site. No symptomatic neuroma was noted from the proximal stump of the sural nerve, which was buried in the surrounding muscle tissue (Figure II, III, IV).

### Discussion

In defects exposing the underlying tendons, ligaments, or bone and tissue loss localized in the areas on the distal part of the leg and foot; flaps which are durable to trauma, ensuring the weight-bearing tissue and having a more aesthetic appearance, are preferred to skin grafts. However, local flap has enough limitations, like no adequate soft tissue, and tight skin for reconstruction and scarce blood supply. Distant flaps and free flaps have more disadvantages, such as the need for a microsurgery team and equipment, long operation times, and difficulty finding the appropriate vessels. On the other hand, regional flaps (e.g. muscle or fasciocutaneous) are quite popular.

However, inferiorly based muscle flaps have a high failure rate<sup>16</sup>, while reverse peroneal<sup>17</sup>, posterior tibial<sup>18</sup>, and anterior tibial flaps<sup>19,20</sup>, sacrifice a major artery in the leg. Masquelet et al<sup>7</sup> who were the first describe the neurocutaneous island flap, the management of leg and foot defect<sup>6</sup> became easier. They revealed that the superficial sural artery courses on the leg in two different ways, descending to the ankle in 65.0% or becoming an interlacing suprafacial network in 35.0% cases. Sural artery anastomosis with the septocutaneous perforators of peroneal artery.

These are usually 3 to 5 in number. Thus flap dissection must be performed under the deep fascia, including the pedicle, to preserve this anastomosis on the suprafascial plane<sup>7</sup>. The last perforator was given off 5 cm above the tip of the lateral malleolus. However, the mechanism of venous drainage if the reverse flow-sural artery flap has not been clarified exactly. Some suggested that the venous drainage was probably supplied via a suprafacial venous network in the pedicle<sup>7,21</sup>. Invariable anatomy of the sural region, easy and quick dissection, ensuring a reliable arterial supply, not sacrificing of any major artery, wide arc of rotation, elevation of large flap, minimum morbidity, no functional impairment, avoid microsurgery, a single stage procedure and obtaining a thin flap, this flap

become more popular.

Excellent result was found by distally-based superficial sural neurocutaneous flap for resurface of the ankle and foot in children<sup>22</sup>. It can be safely applied in paraplegic patients. Because the dorsal root ganglia remain intact in paraplegic patients and can preserve neural characteristics in the peripheral sensory nerve system<sup>23</sup>. This also a recommended flap as a primary procedure for soft tissue reconstruction of fourth degree burn, around ankle and foot<sup>24</sup>.

Arterial insufficiencies are rarely encountered because the reverse sural flap has a powerful and constant arterial supply from both the reverse flow system of the median superficial sural artery-peroneal artery perforators and an additional intrinsic arterial system of sural nerves. So this flap can be applied for reconstruction of soft tissue loss in an open tibial fracture with impaired circulation of anterior and posterior tibial arteries<sup>25</sup>. Venous congestion is not uncommon in diabetic or elderly cases displaying peripheral vascular disorders<sup>26</sup> or when the large flaps are planned<sup>9</sup>.

### Conclusion

Sural neurocutaneous flap is a versatile, dependable technique for soft tissue coverage of distal leg, ankle and foot. The flap elevation is simple and can provide different size and shape for resurface of the defects. In addition, these flaps can also provide good outlook and contour the recipient site. In our view, this flap not only provides an alternative to microsurgical procedure, but also can be a good option to cover the defects over mentions area.

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### Conflict of interest

There is no financial conflict of interest relevant to this paper to disclose.

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### Contribution to authors

Islam MN, Islam MR conceived and designed the study, analyzed the data, interpreted the results, and wrote up the draft manuscript. Begum T, Islam MM involved in the manuscript review and editing. All authors read and approved the final manuscript.

### Data Availability

Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.



**Ethics Approval and Consent to Participate**

Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

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