

## Original Article

# Comparison between Lateral Supramalleolar Flap and Sural Flap for Coverage of Dorsum of Foot and Ankle Defects

Siddiquei JM<sup>1</sup>, Roy SK<sup>2</sup>, Mannan MA<sup>3</sup>, Rahman MM<sup>4</sup>, Rahman MM<sup>5</sup>, Kamruzzaman M<sup>6</sup>, Nurunnabi M<sup>7</sup>

### Abstract

**Background:** Reconstruction of dorsum of the foot and ankle is challenging due to exposed tendons, nerves, and bones. Sural (SF) and Lateral Supramalleolar flaps (LSF) are commonly used for reliable coverage and functional restoration. **Objective:** To assess and compare the effectiveness and outcomes of Lateral Supramalleolar and Sural flaps in reconstructing dorsum of foot and ankle defects. **Methods:** This prospective cohort study at Sylhet MAG Osmani Medical College Hospital was conducted from September 2021 to February 2024, enrolling 30 patients who met the inclusion criteria and were randomly assigned to Group A (Sural, n= 15) and Group B (Lateral Supramalleolar, n= 15). All patients had clinical and Doppler assessments, flap surgery under spinal anesthesia, and outcomes were evaluated at 1, 2, and 3 months using the “Hashmi Flap Outcome Score”. **Results:** The groups were comparable in age ( $35.2 \pm 13.5$  vs.  $35.0 \pm 11.9$  years,  $p= 0.966$ ) and gender ( $p= 0.321$ ). Trauma was the leading cause of defects (83.3%,  $p=0.041$ ), with right-sided defects more frequent in Group B (56.7%,  $p=0.032$ ). Defect size ( $7.43 \pm 0.84$  vs.  $7.07 \pm 0.70$  cm,  $p=0.206$ ) and flap size ( $8.08 \pm 0.92$  vs.  $7.65 \pm 0.71$  cm,  $p=0.16$ ) were similar. Sural flaps were longer ( $9.80 \pm 0.98$  vs.  $9.13 \pm 1.03$  cm,  $p=0.041$ ), but Lateral Supramalleolar flaps required shorter operative time ( $112.2 \pm 4.7$  vs.  $115.8 \pm 5.7$  minutes,  $p=0.038$ ). Flap survival was 100% in both groups. Postoperative complications were minimal. Functional outcomes favored Lateral Supramalleolar flaps, with more patients achieving excellent recovery (86.7% vs. 53.3%,  $p=0.029$ ) and higher HFOS scores ( $19.6 \pm 1.2$  vs.  $18.5 \pm 1.9$ ,  $p=0.043$ ). **Conclusion:** The LSF provides shorter operative time and superior functional outcomes, making it a preferable option for dorsum of foot and ankle defect reconstruction.

**Keywords:** Sural flap, Lateral Supramalleolar flap, dorsum of foot, ankle defects, flap survival, functional outcome.

**Introduction:** The distal lower extremity is vital for mobility and stability but highly vulnerable to trauma due to its thin skin and minimal soft tissue coverage. Injuries to the dorsum of the foot and ankle often expose tendons, nerves, or bones, making reconstruction difficult as grafts and local flaps are

limited.<sup>1</sup> Common causes include road traffic accidents, industrial injuries, infections, and tumor excision, often resulting in complex soft tissue defects requiring durable coverage to restore function and prevent complications.<sup>2,3</sup>

1. **Dr. Javed Minhaz Siddiquei**, Medical Officer, Department of Orthopedic Surgery, Sylhet MAG Osmani Medical College Hospital, Sylhet, Bangladesh.
2. **Dr. Shankar Kumar Roy**, Associate Professor, Department of Orthopedic Surgery, Sylhet MAG Osmani Medical College Hospital, Sylhet, Bangladesh.
3. **Dr. Md Abdul Mannan**, Assistant Professor, Department of Burn and Plastic Surgery, Sylhet MAG Osmani Medical College Hospital, Sylhet, Bangladesh.
4. **Dr. Md Mostafezur Rahman**, Medical Officer, Department of Orthopedic Surgery, Sylhet MAG Osmani Medical College Hospital, Sylhet, Bangladesh.
5. **Dr. Md. Mizanur Rahman**, OSD, On Deputation, Department of Orthopedic Surgery, Sylhet MAG Osmani Medical College Hospital, Sylhet, Bangladesh.
6. **Dr. Md. Kamruzzaman**, OSD, On Deputation, Department of Orthopedic Surgery, Sylhet MAG Osmani Medical College Hospital, Sylhet, Bangladesh.
7. **Dr. Mohammad Nurunnabi**, Assistant Professor, Department of Community Medicine and Public Health, Sylhet Women's Medical College, Sylhet, Bangladesh.

**Correspondence:** Dr. Mohammad Nurunnabi, Mobile: +8801717870559; Email: [nur.somch@gmail.com](mailto:nur.somch@gmail.com); ORCID: <https://orcid.org/0000-0001-9472-9369>

Reconstruction aims to provide stable, pliable soft tissue coverage while preserving mobility. Local, regional, and free flaps have been used, but each has limitations regarding vascular reliability, technical demand, and donor site morbidity.<sup>4</sup> Local flaps remain preferred in many centers because they are simpler, require less operative time, and avoid microvascular anastomosis.<sup>5</sup> Among these, the Sural and Lateral Supramalleolar flaps are widely used for distal leg, ankle, and foot reconstruction.

The Sural flap is a distally based fasciocutaneous flap relying on the sural artery and peroneal perforators, offering a large skin paddle and a wide arc of rotation.<sup>6</sup> The Lateral Supramalleolar flap is based on the perforating branch of the peroneal artery and provides thin, pliable coverage, ideal for dorsal foot and ankle defects.<sup>7-9</sup> Both flaps are reliable, versatile, and technically straightforward, with high survival rates and minimal complications when properly executed.<sup>10,11</sup>

Several studies demonstrated comparable survival rates between the two flaps, though the SF allows coverage of larger defects, while the LSF offers better contour and functional outcomes.<sup>12-15</sup> However, evidence directly comparing their performance remains limited.

This study aims to evaluate and compare the outcomes of Sural and LSFs for dorsum of foot and ankle defects in terms of flap survival, complications, and functional results. Findings from this study will help identify the most suitable flap for optimal coverage and functional restoration in patients with such challenging defects.

## METHODS AND MATERIALS

### Study design and settings

This study was designed as a prospective cohort study to evaluate and compare the outcomes of Lateral Supramalleolar and Sural flaps for coverage of dorsum of foot and ankle defects at the Department of Orthopedic Surgery and Burn and Plastic Surgery, Sylhet MAG Osmani Medical College Hospital, Sylhet, over a 30-month period from September 2021 to February 2024.

### Study population and sampling methods

All patients admitted with dorsum of foot and ankle defects during the study period constituted the target population, and those meeting the inclusion criteria were enrolled as the study population.

A non-probability convenient sampling method was used. Based on the mean flap size and standard deviation values reported by Hashmi et al.<sup>12</sup> (2022), the calculated sample size was 15 per group, totaling 30 patients. Patients with defects exposing tendon, nerve, or bone were included, while those with grossly infected wounds, donor site scars, peripheral vascular disease, or severe comorbidities (ASA>2) were excluded. The 30 eligible patients were randomly allocated into two equal groups: Group A (Sural flap, n= 15) and Group B (Lateral Supramalleolar flap, n= 15). Allocation was performed alternately after the first patient was assigned by toss. All participants underwent clinical and Doppler-based vascular assessment, routine investigations, and preoperative antibiotic prophylaxis. Surgeries were performed under spinal anesthesia by senior surgeons after ensuring the operative field was free of infection.

### Surgical procedures

In Group A, patients were positioned prone with a thigh tourniquet. After debridement and defect measurement, the flap was designed around the sural neurovascular pedicle, preserving the sural nerve, superficial sural artery, and short saphenous vein. The flap was rotated to the defect, and the donor site was closed primarily or with a thigh skin graft. In Group B, patients were positioned supine or lateral with a thigh tourniquet. The flap was planned over the perforating branch of the peroneal artery, about four fingerbreadths above the lateral malleolus, carefully raised with the septocutaneous perforator preserved, and the donor site closed with sutures or a split-thickness skin graft. Equipment included a measuring scale, surgical marker, and hand-held vascular Doppler. Postoperatively, limbs were immobilized with a POP slab, and intravenous antibiotics were administered. Flaps were monitored for color, temperature, capillary refill, and complications up to 14 days, with stitches removed thereafter. Follow-up at 1, 2, and 3 months assessed functional and aesthetic outcomes using the "Hashmi Flap Outcome Score (HFOS)".

### Data processing and analysis

All collected data were checked for completeness and consistency, then analyzed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Qualitative variables were summarized using frequency and percentage, while quantitative variables were expressed as mean and standard deviation. The independent t-test was used for continuous variables, and the Chi-square test for categorical data. A p-value < 0.05 was considered statistically significant.

### Ethical consideration

The study was conducted after obtaining formal ethical clearance from the Sylhet MAG Osmani Medical College Ethical Review Committee (Reference: SOMC/2023/32). Participant confidentiality was maintained, and informed written consent was obtained. The consent explained the study's purpose, procedures, the right to refuse or withdraw, and participants did not receive any financial benefit.

### RESULTS

The study population was comparable in terms of age and gender between Group A and Group B. In the table 1, most participants were aged 19–40 years, and males predominated. There was no statistically significant difference in age ( $p= 0.966$ ) or gender distribution ( $p= 0.321$ ) between the groups, indicating demographic homogeneity.

Table 2 shows that trauma was the most common cause of dorsum of foot and ankle defects, accounting for over 80% of cases, with a statistically significant difference between groups ( $p= 0.041$ ). Right-sided defects were more frequent in Group B, showing a significant association with the side of defect ( $p= 0.032$ ).

Table 3 shows that the mean defect dimensions were slightly larger in Group A than Group B, but these differences were not statistically significant ( $p> 0.05$ ). However, the mean flap length was significantly greater in Group A compared to Group B ( $p= 0.041$ ), indicating that the Sural flap allowed harvesting of a longer flap. Other flap parameters, including width and average flap size, did not differ significantly between the groups.

Table 4 shows that most operations in both groups were completed in under 120 minutes, with a significantly higher proportion in Group B compared to Group A ( $p= 0.045$ ). The mean operation duration was also significantly shorter in Group B ( $p= 0.038$ ). Flap survival was 100% in both groups, showing excellent reliability of both flap types.

Table 5 shows that postoperative flap complications were minimal in both groups. Group A had a few cases of infection and venous congestion, while Group B had none. Most patients in both groups experienced no complications (93.3% overall). Donor site complications were rare, with all patients experiencing loss of sensation, and very few showing partial skin

loss or hyperpigmentation. No statistically significant differences were observed between the groups ( $p> 0.05$ ).

Table 6 indicates that functional outcomes were significantly better in LSF group compared to SF group. A higher proportion of patients in Group B achieved excellent outcomes (86.7% vs. 53.3%), while good and fair outcomes were more common in Group A. The mean HFOS score was also significantly higher in LSF group ( $19.6 \pm 1.2$ ) than in SF group ( $18.5 \pm 1.9$ ), reflecting superior overall functional recovery ( $p< 0.05$ ).

**Table- 1: Demographic characteristics of study subjects (n= 30)**

Variables	Group A (n=15)	Group B (n=15)	Total (n=30)	p-value
	n (%)	n (%)	n (%)	
<b>Age group (years)</b>				
10–18	2 (13.3)	2 (13.3)	4 (13.3)	0.985
19–40	8 (53.3)	9 (60.0)	17 (56.7)	
41–60	5 (33.3)	4 (26.7)	9 (30.0)	
Mean $\pm$ SD	35.2 $\pm$ 13.5	35.0 $\pm$ 11.9	35.1 $\pm$ 12.5	0.966
<b>Gender</b>				
Male	10 (66.7)	12 (80.0)	22 (73.3)	0.321
Female	5 (33.3)	3 (20.0)	8 (26.7)	

*Chi-square test and Independent t-test done;  $p<0.05$  considered as significant value*

**Table- 2: Clinical characteristics of defects (n= 30)**

Parameters	Group A (n=15)	Group B (n=15)	Total (n=30)	p-value
	n (%)	n (%)	n (%)	
<b>Cause of defect</b>				
Trauma	13 (86.7)	12 (80.0)	25 (83.3)	<b>0.041*</b>
Tumor	1 (6.7)	1 (6.7)	2 (6.7)	
Infection	1 (6.7)	2 (13.3)	3 (10.0)	
<b>Side of defect</b>				
Right	6 (40.0)	11 (73.3)	17 (56.7)	<b>0.032*</b>
Left	9 (60.0)	4 (26.7)	13 (43.3)	

*Chi-square test done;  $p<0.05$  considered as significant value*

**Table- 3: Defect and flap measurements (n= 30)**

Parameters	Group A (Mean $\pm$ SD)	Group B (Mean $\pm$ SD)	p-value
Defect length (cm)	9.20 $\pm$ 0.94	8.53 $\pm$ 0.99	0.069
Defect width (cm)	5.67 $\pm$ 1.18	5.60 $\pm$ 1.06	0.871
Average defect size (cm)	7.43 $\pm$ 0.84	7.07 $\pm$ 0.70	0.206
Flap length (cm)	9.80 $\pm$ 0.98	9.13 $\pm$ 1.03	<b>0.041*</b>
Flap width (cm)	6.36 $\pm$ 1.26	6.17 $\pm$ 1.03	0.638
Average flap size (cm)	8.08 $\pm$ 0.92	7.65 $\pm$ 0.71	0.160

*Independent t-test done;  $p<0.05$  considered as significant value*

**Table- 4: Duration of operation and flap survival (n= 30)**

Parameters	Group A (n=15)	Group B (n=15)	Total (n=30)	p-value
	n (%)	n (%)	n (%)	
<b>Operation duration (minutes)</b>				
<120	11 (73.3)	14 (93.3)	25 (83.3)	<b>0.045*</b>
≥120	4 (26.7)	1 (6.7)	5 (16.7)	
Mean ± SD	115.80± 5.7	112.2 ± 4.7	113.9 ± 5.4	<b>0.038*</b>
<b>Flap survival</b>				
Complete survival	15 (100)	15 (100)	30 (100)	-

*Chi-square test and Independent t-test done; p<0.05 considered as significant value*

**Table- 5: Postoperative outcomes (n= 30)**

Parameters	Group A (n=15)	Group B (n=15)	Total (n=30)	p-value
	n (%)	n (%)	n (%)	
<b>Postoperative flap complications</b>				
Marginal necrosis	0 (0.0)	0 (0.0)	0 (0.0)	0.343
Infection	1 (6.7)	0 (0.0)	1 (3.3)	
Venous congestion	1 (6.7)	0 (0.0)	1 (3.3)	
No complication	13 (86.7)	15 (100)	28 (93.3)	
<b>Donor site complications</b>				
Partial skin loss	1 (6.7)	0 (0.0)	1 (3.3)	0.131
Loss of sensation	15 (100)	15 (100)	30 (100)	
Hyperpigmentation	1 (6.7)	0 (0.0)	1 (3.3)	

*Chi-square test done; p<0.05 considered as significant value*

**Table- 6: Functional outcomes (n= 30)**

Functional outcomes	Group A (n=15)	Group B (n=15)	Total (n=30)	p-value
	n (%)	n (%)	n (%)	
Excellent	8 (53.3)	13 (86.7)	21 (70.0)	<b>0.029*</b>
Good	6 (40.0)	2 (13.3)	8 (26.7)	
Fair	1 (6.7)	0 (0.0)	1 (3.3)	
<b>Mean HFOS scores</b>	<b>18.5 ± 1.9</b>	<b>19.6 ± 1.2</b>	<b>19.1 ± 1.7</b>	<b>0.043*</b>

*Chi-square test and Independent t-test done; p<0.05 considered as significant value*

## DISCUSSION

Soft tissue alterations on the dorsum of the foot and ankle provide considerable reconstructive problems due to limited mobile skin, poor coverage, and vulnerability to trauma.<sup>16,17</sup> In this study, all patients were randomly assigned to either SF group and LSF group. The mean age was  $35.1 \pm 12.5$  years, with a predominance of males (73.3%) aged 19–40 years (56.7%). Trauma was the leading cause of defects (83.3%), followed by tumor (10%) and infection (6.7%), consistent with prior studies.<sup>12,14</sup> Both groups were comparable in demographics and defect etiology, minimizing confounding effects.

Flap-related complications were minimal. No patient in the LSF experienced complications, whereas the SF group had one case of venous congestion and one

infection (6.7% each). Flap survival was 100% in both groups, aligning with previously reported high success rates for both flaps.<sup>12,15</sup> Average defect size ( $7.43 \pm 0.84$  cm vs.  $7.07 \pm 0.70$  cm,  $p=0.206$ ) and flap size ( $8.08 \pm 0.92$  cm vs.  $7.65 \pm 0.71$  cm,  $p=0.16$ ) did not differ significantly between groups, and both flaps provided 100% coverage adequacy.

Donor site complications were rare; one patient in each group had partial skin loss, and one SF case developed hyperpigmentation. All patients experienced loss of sensation, but no infection or unsightly scars occurred. Functional outcomes favored the LSF. A higher proportion achieved excellent results (86.7% vs. 53.3%), and mean HFOS scores were higher in Group B ( $19.6 \pm 1.2$  vs.  $18.5 \pm 1.85$ ,  $p<0.05$ ), indicating superior functional recovery. These results support previous findings suggesting better patient satisfaction and functional outcomes with the LSF for dorsum foot and ankle reconstruction.<sup>12,14</sup>

This study exhibits that the LSF is a reliable and effective option for dorsum foot and ankle reconstruction, with lower complication rates, excellent flap survival, and better functional outcomes than the SF. Both flaps offered complete coverage with minimal donor site morbidity, indicating their safety and efficacy. According to the findings, the LSF is the best option for rebuilding dorsum foot and ankle deformities, especially when it comes to optimizing functional recovery and minimizing postoperative problems.

## CONCLUSION

The Lateral Supramalleolar flap revealed lower complication rates, full survival, and better functional outcomes, making it the preferred choice. Both flaps are safe and effective, but the LSF is recommended for dorsum foot and ankle reconstruction.

## LIMITATIONS OF THE STUDY

The limitations of this study include the small sample size of 30 patients, which may limit the generalizability of the findings. The study was conducted at a single center, restricting variability in surgical technique and patient demographics. Follow-up duration was relatively short, which may not capture long-term functional outcomes or late complications. Additionally, the study did not include a cost analysis or patient-reported quality of life measures, which could provide a more comprehensive assessment of flap efficacy.

### ACKNOWLEDGEMENTS:

The authors express sincere gratitude to the faculty and staff of Sylhet MAG Osmani Medical College Hospital for their guidance and support, and to all patients who participated in the study.

### CONFLICT OF INTEREST:

The authors declare no competing interests.

### FINANCIAL DISCLOSURE:

This study received no funding.

### REFERENCES

1. Suliman MT. Distally based adipofascial flaps for dorsal foot and ankle soft tissue defects. *The Journal of foot and ankle surgery*. 2007;46 (6): 464-9.
2. Heitmann C, Levin LS. The orthoplastic approach for management of the severely traumatized foot and ankle. *Journal of Trauma and Acute Care Surgery*. 2003;54(2):379-90.
3. Shen ZL, Jia WX, Hou MZ, Huang XQ, Cai YX, Wang L, Huang YX. Application of flaps for coverage of foot wounds with tendon and bone exposure based on a subunit principle. In *Innovations in Plastic and Aesthetic Surgery*. Berlin, Heidelberg: Springer Berlin Heidelberg. 2008:119–126.
4. Chang SM, Wang X, Huang YG, Zhu XZ, Tao YL, Zhang YQ. Distally based perforator propeller sural flap for foot and ankle reconstruction: a modified flap dissection technique. *Annals of plastic surgery*. 2014; 72(3):340-5.
5. Concha JM, Camaro PL, David A, Concha C. The lateral supramalleolar flap for the treatment of open foot and ankle fractures. *Orthoplastic Surgery*. 2022;9(C):80-5.
6. Muhammad A, Muhammad A, Muhammad Zafar I, Ch Naseer A. Outcome of sural and lateral supramalleolar flap in patients with exposed distal tibia and heel. *Journal of Sheikh Zayed Medical College*. 2013; 4(2):440–443.
7. Jeng SF, Wei FC. Distally based sural island flap for foot and ankle reconstruction. *Plastic and reconstructive surgery*. 1997;99(3):744-50.
8. Rong K, Chen C, Hao LW, Xu XY, Wang ZT. Redefining the vascular classifications of the lateral supramalleolar flap. *Annals of plastic surgery*. 2016;77(3):341-4.
9. Demiri E, Foroglou P, Dionyssiou D, Antoniou A, Kakas P, Pavlidis L, Lazaridis L. Our experience with the lateral supramalleolar island flap for reconstruction of the distal leg and foot: a review of 20 cases. *Scandinavian journal of plastic and reconstructive surgery and hand surgery*. 2006;40(2):106-10.
10. Touam C, Rostoucher P, Bhatia A, Oberlin C, Touam C. Comparative study of two series of distally based fasciocutaneous flaps for coverage of the lower one-fourth of the leg, the ankle, and the foot. *Plastic and reconstructive surgery*. 2001;107(2):383-92.
11. 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. *International journal of clinical and experimental medicine*. 2016;9(8):15167-76.
12. Hashmi PM, Musaddiq A, Hashmi A, Zahid M. Comparison of distally based sural artery and supramalleolar flap for coverage of dorsum of foot and ankle defects; a cross-sectional study of 53 patients. *Annals of medicine and surgery*. 2022;73:103109.
13. Mahmoud WH. Foot and ankle reconstruction using the distally based sural artery flap versus the medial plantar flap: a comparative study. *The Journal of Foot and Ankle Surgery*. 2017;56 (3):514-8.
14. Jaiswal KS, Gupta S, Goil P, Mohammad A, Gupta P. Empirical evidence on the reliability of lateral supramalleolar flap over reverse sural flap for local soft tissue coverage of dorsum of the foot and ankle defects. *Indian Journal of Plastic Surgery*. 2023;56(02):159-65.
15. Nguyen TN, Trong Mai T, Cao T, Thai TT. Lateral supramalleolar flap for soft-tissue coverage of ankle and foot defects. *Journal of Plastic Surgery and Hand Surgery*. 2023;57 (1-6):459-65.
16. Johnson L, Liette MD, Green C, Rodriguez P, Masadeh S. The reverse sural artery flap: a reliable and versatile flap for wound coverage of the distal lower extremity and hindfoot. *Clinics in Podiatric Medicine and Surgery*. 2020; 37(4): 699-726.
17. Wang W. Anterior tibial artery perforator propeller flap relay peroneal artery terminal perforator propeller flap for foot and ankle defect. *Chinese Journal of Reparative and Reconstructive Surgery*. 2020:87-91.