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## Original Article

# Exposed Distal Tibia Coverage by Reversed Soleus Muscle Flap: Our Experiences

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## ABSTRACT

Reconstruction of the exposed lower third tibia and ankle region remains a difficult task and a challenge for reconstructive surgeons. Microsurgical flaps have been the method of choice for this reconstruction, but in our hospital, we do not have equipment or a microsurgical-trained team for this type of procedure. Moreover, free muscle flaps have more risk of failure and sometimes the patient's clinical condition does not allow a more complex surgery in some cases. Local muscle flaps are preferred in these situations.

**Methodology:** This study was carried out in the Burn and Plastic Surgery Department, Rajshahi Medical College Hospital, Rajshahi from July 2015 to December 2021 on 100 patients ( 89 males and 11 females with ages ranging between 21 and 62 years). Patients with tibial defects in the distal third of the tibia which need soft tissue coverage were selected.

**Results:** Our study shows that reversed medial hemisoleus muscle flap had an excellent outcome with short surgical duration, easy implementation, excellent resolution, and low morbidity of the donor area. Moreover, preservation of the lateral portion is suitable for plantar flexion showing a long arc of rotation.

**Conclusion:** Medial hemisoleus muscle flap is a reliable option for the reconstruction of soft tissue defects with the exposed bone of the distal leg based on perforators of the posterior tibial artery.

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Careful flap dissection with preservation of as many perforators as possible is the key to success.

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## Introduction

Wound coverage of the exposed lower third tibia remains a difficult problem. Defects in the lower third of the leg quickly result in the exposure of relevant structures, such as bone and tendon, the correction of which requires reconstruction with well-vascularized tissue.<sup>1,2</sup> Although the microsurgical flap has been the method of choice for this reconstruction, many hospitals do not have equipment or a microsurgical-trained team for this type of procedure. Moreover, some patients are not fit enough for lengthy microsurgical reconstruction because of their clinical conditions, and the surgeon is therefore needed to think about the alternative.<sup>3–7</sup> The soleus muscle is located in the posterior region of the leg, inferior to the gastrocnemius muscles, and is classified as its major pedicle is the posterior tibial artery and the perforating branches of this artery are the secondary pedicles.<sup>3–4</sup> The viable use of the soleus muscle in a reverse manner based on its secondary pedicles has been described by several authors for the reconstruction of defects of the lower third of the leg as an alternative to the use of microsurgical flaps.<sup>1–8</sup> An advantage of using the hemisoleus flap rather than the entire soleus muscle flap is the preservation of plantar flexion of the foot performed by the lateral portion of the muscle, which is left in its original location. Moreover, the medial flap has a greater rotation angle than that of a conventional soleus muscle flap.<sup>9–12</sup> The medial part of the muscle is supplied in its whole length by perforators of the posterior tibial artery. Because of this constant arterial supply, the medial part of the soleus muscle is viable as a flap distally based in a reverse manner.<sup>9–12</sup> This paper reports our experience in the application of this flap. A distally based medial hemisoleus muscle flap for wound coverage in the distal third of the leg is one of the preferable options as logistic support and a trained team for the microsurgical technique are not available here. For this reason, we have to refer these patients to the superspecialized institutes. Another relevant point is the long hospital stay and prolonged operation time; hospital expenses were significantly lower for the patients undergoing this pedicled flap reconstruction.

## Objectives

- (a) To evaluate clinical applicability and functional outcome.
- (b) To analyze the complications.
- (c) To observe the recovery period and treatment cost.

## Materials and Methods

This study was carried out in the Burn and Plastic Surgery Department, Rajshahi Medical College Hospital, Rajshahi from July 2015 to December 2021. Patients with tibial defects were enrolled and stratified according to their site of wound. Only wounds in the distal third of the tibia which need soft tissue coverage were selected. Soft tissue coverage was provided with a reversed medial hemisoleus muscle flap on which a split-thickness skin graft was applied. Postoperatively, patients were followed up after 1 week of discharge and then fortnightly for at least 2 months. Outcome variables were taken as flap viability.

**Table 1**  
Result of Flap Viability and Graft Taken.

Flap viability	Viable	89
	Congested	04
	Marginal flap necrosis	07
Graft taken	Taken	88
	Partially lost	08
	Completely loss	04

**Table 2**  
Age Distribution.

Age	Number of patients
21–30	34
31–40	29
41–50	26
51–60	08
60 and above	03
Total	100

## Results

In our study, we operated on 100 patients who presented with lower leg defect. All the patients were post-traumatic with exposed distal tibia and, sometimes, with external fixator *in situ*. Sites of skin defects are: 94 patients with skin defects in the lower third of the leg and six patients with skin defects around the ankle joint; the mean age of patients was 38 years (Table 2). Flap viability assessment showed (Table 1) 89 patients showing viable medial hemisoleus muscle flap (89.0%), four patients showing mild congested flap, which improved spontaneously (4.0%), and seven patients (7.0%) showing loss of about 2-cm marginal flap necrosis. About 88 patients (88.0%) showed complete graft taken, eight patients (8.0%) showed partial loss of skin graft; patients management done conservatively that healed completely within 10 days. Four patients (4.0%) showed complete skin graft loss that necessitated another skin grafting session. Lower limb assessment showed no functional motor deficit after hemisoleus muscle harvesting.

## Discussion

Management of wounds at the distal one-third of the leg and near ankle regions remains a challenging problem. Muscle flap is always a better option for exposed bone coverage as the most significant advantage of hemisoleus muscle flap is the preservation of foot plantar flexion power by the hemisoleus muscle belly left *in situ*. The medial half of the muscle is supplied constantly throughout its length by the perforators from the posterior tibial artery. This feature makes the medial hemisoleus muscle flap more reliable than the lateral half.<sup>13</sup> The medial hemisoleus muscle flap based on muscular branches of the posterior tibial vessels bears the advantages of a muscle flap and has an appropriate arc of rotation if it is used for covering the lower third defect in the leg.<sup>14</sup> The size of the muscle flap can be up to about 9 cm long × 5 cm wide. This is suitable for most small to medium size defects. Table 3 shows Gustilo types of injury of the study populations and Table 4 shows the size of the defects to cover. The bulk of the muscle flap is not a serious problem as it will gradually be atrophied. Donor site cosmesis is very acceptable. The operation is not technically complex, and no microvascular anastomosis is required. The main advantage of this method is not to sacrifice the posterior tibial artery. We have been using flaps based on the posterior tibial muscular branches for the soleus for more than 6.5 years, provided that the patients are carefully selected and preoperative vascular assessment by Doppler ultrasonography study and the indications are appropriate; so we encounter no long-term problems after the use of these flaps. Figs. 1, 5 and 8 showing different patients with exposed distal third of Tibia. In this study, we used the distal flap of the soleus muscle in a reverse manner, based on the distal perforators of the posterior tibial artery. Figs. 2, 3 and 6 shows preoperative flap harvesting and Figs. 4 and 9 shows split thickness skin grafting over the Soleus muscle.

**Table 3**  
Gustilo Types of Injury.

Types	Number of patients
Type I	None
Type II	None
Type III A	None
Type III B	100
Type III C	None
Total	100

**Table 4**  
Size of the Defect.

Size	Number of patients
<3 cm	72
3–6 cm	28
>6 cm	None
Total	100



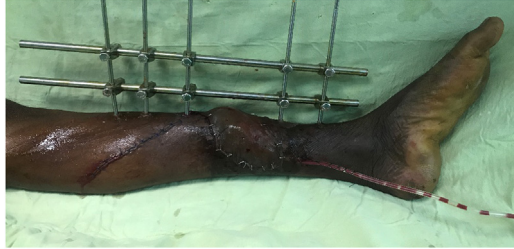
**Figure 1.** Post-Traumatic Exposed Tibia with External Fixator *in situ*.



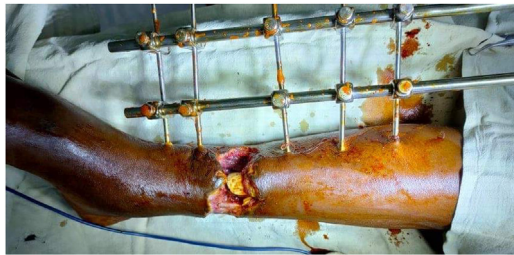
**Figure 2.** A Curved Incision Given Proximally for Harvesting Hemisoleus Muscle.



**Figure 3.** Medial Hemisoleus Muscle Harvested and Rotated Over the Exposed Tibia.



**Figure 4.** Perioperative Picture After Insetting Grafted Skin Over the Muscle.



**Figure 5.** Another Distal Leg Defect.



**Figure 6.** After Medial Hemi-soleus Muscle Flap Coverage.



**Figure 7.** One-Month Postoperative.

Figs. 7 and 10 are the one month and three weeks post-operative flap status. The use of the flap was successful in almost all cases. Table 5 shows the smoking status of the patients, though in this study we are unable to make a relationship of flap viability among smoker or non-smoker. Table 6 shows that the time of reconstruction after injury is a factor, as more the delay, there is an increased chance of severe infection even chronic osteomyelitis. In this study, flap viability assessment showed 89 patients showing viable medial hemi-soleus muscle flap (89.0%), four patients showing mild congested



**Figure 8.** Post-Traumatic Defect Over Lower One-Third of Leg with Exposed Tibia.



**Figure 9.** Perioperative Picture After Grafting Over Reversed Medial Hemisoleus Muscle Flap.



**Figure 10.** Three Weeks After Operation.

**Table 5**  
Smoking Status.

Status	Number of patients
Smoker	72
Non-Smoker	28
Total	100

flap, which improved spontaneously (4.0%), and seven patients (7.0%) showing loss of about 1-cm marginal flap necrosis. A study conducted by Makboul et al.<sup>15</sup> showed 23 patients showing viable medial hemisoleus muscle flap (76.7%), five patients showing mild congested flap, which improved spontaneously (16.7%), and two patients (6.7%) showing loss of about 2-cm distal part of (tip) flap. The procedure was performed in a quick and safe manner, and extensive morbidity was not observed in the donor area. The defect with exposure to the relevant area was suitably covered, and the patient did not have to undergo the prolonged surgical procedures of a microsurgical flap. However, this coverage was only possible because of the small size of the exposure, and it may be safer to use a microsurgical flap in cases with larger defects. The reverse hemisoleus flap can be used for defects of up to 50 cm<sup>2</sup>, but flap impairment is possible in cases where these measures are exceeded. This flap should not be used for patients with significant peripheral vascular disease. But in some cases of diabetes (21 cases), we tried this procedure with minimum complications like long-term antibiotic therapy.

**Table 6**  
Time of Reconstruction.

Time (Weeks)	Number of patient
<1	None
1–3	37
3–5	42
5–7	13
>7	08
Total	100

Few of our patients had hematoma but those were not significant and the wound healed without much effort. On the other hand, infection was also common in our study populations. These patients were referred to us after several days or even months after injury. They came to our department with pus at the injury site mostly caused by antibiotic-resistant organisms. In every patient, we did a wound swab for culture and sensitivity test and treated accordingly. Most of them needed long-duration antibiotic therapy even up to 3 months. After all, our overall success is satisfactory as follow-up shows all the patients can walk on that limb comfortably.

In addition to the advantages already discussed, another relevant point is the hospital cost of the procedures. Thornton et al.<sup>7</sup> compared the hospital costs between the reverse soleus flap and microsurgical flaps in patients with similar profiles and defects and observed that the hospitalization time, surgical time, hospital expenses, and the use of the intensive care unit were significantly lower in the group of patients undergoing soleus flap reconstruction. Therefore, when this type of reconstruction is possible, it should be the first choice.

In this study, we have some limitations including that the free flap option is not available to compare results. There is also no option of using different tissues or chimeric flaps. Furthermore, patient-reported outcomes cannot be included in this study. Because our patients were all happy not to undergo amputation of their affected limb. They were all satisfied with their limbs with some donor site morbidity and some restriction of ankle movement.

## Conclusion

The medial hemisoleus muscle flap has a longer arc of rotation, easier to inset for a variety of lower leg defects compared to the whole soleus, and is less bulky, so it provides a better contour of reconstruction. For this, it is a reliable option for the reconstruction of soft tissue defects of the lower leg based on a minor pedicle or reversed flow based on a posterior tibial artery. Careful flap dissection with preservation of as many perforators as possible is the key to success. The reported cases demonstrated excellent resolution, good progress, and significant sequelae in the donor area.

## Conflicts of interest

None declared

## Funding

None.

## Ethical approval

Approved by ethical review committee Rajshahi Medical College RMC/ERC/2023/142

## References

1. Pu LL. Soft-tissue reconstruction of an open tibial wound in the distal third of the leg: a new treatment algorithm. *Ann Plast Surg.* 2007;58(1):78–83.

2. Pu LL. Successful soft-tissue coverage of a tibial wound in the distal third of the leg with a medial hemisoleus muscle flap. *Plast Reconstr Surg.* 2005;115(1):245–251.
3. Pu LL. The reversed medial hemisoleus muscle flap and its role in reconstruction of an open tibial wound in the lower third of the leg. *Ann Plast Surg.* 2006;56(1):59–63.
4. Pu LL. Soft-tissue coverage of an open tibial wound in the junction of the middle and distal thirds of the leg with the medial hemisoleus muscle flap. *Ann Plast Surg.* 2006;56(6):639–643.
5. Pu LL. Further experience with the medial hemisoleus muscle flap for soft-tissue coverage of a tibial wound in the distal third of the leg. *Plast Reconstr Surg.* 2008;121(6):2024–2028.
6. Kauffman CA, Lahoda LU, Cederna PS, Kuzon WM. Use of soleus muscle flaps for coverage of distal third tibial defects. *J Reconstr Microsurg.* 2004;20(8):593–597.
7. Thornton BP, Rosenblum WJ, Pu LL. Reconstruction of limited soft-tissue defect with open tibial fracture in the distal third of the leg: a cost and outcome study. *Ann Plast Surg.* 2005;54(3):276–280.
8. Beck JB, Stile F, Lineaweaver W. Reconsidering the soleus muscle flap for coverage of wounds of the distal third of the leg. *Ann Plast Surg.* 2003;50(6):631–635.
9. Barclay TL, Sharpe DT, Chisholm EM. Cross-leg fasciocutaneous flaps. *Plast Reconstr Surg.* 1983;72:843–846.
10. Bostwick J. Reconstruction of the heel pad by muscle transposition and split skin graft. *Surg Gynaecol Obstet.* 1976;143:972–974.
11. Clemente CD. *Anatomy of the human body.* Philadelphia: Lea & Febiger; 1985:577.
12. De Roche R, Vogelín E, Regazzoni P, Luscher NJ. How does a pure muscle cross-leg flap survive? An unusual salvage procedure reviewed. *Plast Reconstr Surg.* 1994;94:540–543.
13. Raveendran SS, Kumaragama KGJL. Arterial supply of the soleus muscle: anatomical study of fifty lower limbs. *Clin Anat.* 2003;16:248–252.
14. Wee JTK. Reconstruction of the lower leg and foot with the reverse-pedicled anterior tibial flap: preliminary report of a new fasciocutaneous flap. *Br J Plast Surg.* 1986;39:327–337.
15. Makboul M, Mousa A, Elotiefy M, Hamdy M, Ahmed M. Medial hemisoleus muscle flap in reconstruction of soft tissue defects of lower leg. *Egyptian J Hospital Med.* January 2019;74(6) 1330–133.