

**Original Research Article****Functional Outcome of Reconstruction for Small to Medium Size Defect around Ankle Joint by Various Pedicle Flaps – An Retrospective Analysis****Dr. Biswajit Mishra<sup>1</sup>, Dr. Deepak Sahu<sup>2</sup>, Dr. Surya Mallik<sup>3</sup>, Dr. Meenakshi Parasar<sup>4</sup>,  
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**ABSTRACT****Background**

Soft tissue reconstruction around ankle and distal third of the leg is challenging due to paucity of the skin around ankle and prominence of lateral and medial malleolus. Lower third of the leg and ankle defects are best reconstructed by a free flap particularly if the defect is larger in size. However small to medium size defects around ankle and distal third of leg, lateral malleolus, medial malleolus and tendoachilles areas can be managed by locoregional flap. Local flaps are also useful in situations where patient is unfit for prolong duration of surgery. With better understanding of vascular anatomy and pre operative localization of perforators many local flaps can be designed for such defects.

Commonly used pedicle flaps for ankle and distal third leg includes reverse sural artery flap, posterior tibial artery based perforator flap, peroneal artery perforator based flap, propeller flap, lateral supramalleolar flap, and peroneus brevis muscle flap.

However there is no algorithm for their use in these sites.

**Method**

Retrospective analysis of 31 post traumatic patients who underwent reconstruction for small to medium size defects over lateral malleolus, medial malleolus, posterior aspect of heel and tendoachilles area were included in the study.

Large defects reconstructed with free flap were excluded from the study.

Defects were analyzed in term of site, size of the defect, mode of reconstruction and functional outcome using AOAFS.

## Result

Out of the 31 patients who were eligible, 25 (80.64 %) were men and 6 (19.35%) were women with a mean age 36.41 with SD 1.07 . (Range 8-58) years. 83.87 % were less than 50 years. Size of the defect ranged from 4 cm<sup>2</sup> to 120 cm<sup>2</sup>. Lateral malleolus was involved in 7 cases. Medial malleolus in 10 cases, tendoachilles in 12 cases, intermalleolar area in 2 cases. Small to moderate size defects of lateral malleolar area < 4 cm were reconstructed with peroneus brevis muscle flap (5 cases). Large defects of lateral malleolar area > 4cm were reconstructed with RSA flap (2 cases). Medial malleolus was reconstructed with propeller flap in 3 cases, Posterior tibial artery based perforator flap in 3 cases and Reverse Sural artery flap in 4 cases. Tendoachilles area were reconstructed with RSA flap in 9 cases, peroneal perforator flap in 3 cases. Anterior aspect of ankle resurfaced with lateral supramalleolar flap in 2 cases. The mean follow-up was 8 month. Statistical analysis of functional outcome was done using ANOVA method. There were no statistically significant difference between various methods used for reconstruction of flaps (P= 0.58)

## Conclusion

Good functional outcome can be achieved with careful selection of flap for small and medium size defect around ankle defect.

**Key Words:** functional outcome, AOFAS score, pedicle flap, peroneus brevis, supramalleolar flap.

## INTRODUCTION

Soft tissue reconstruction around ankle and distal third of the leg is challenging due to paucity of the skin around ankle and prominence of lateral and medial malleolus. Lower third of the leg and ankle defects are best reconstructed by a free flap particularly if the defect is larger in size. However small to medium size defects around ankle and distal third of leg, lateral malleolus, medial malleolus and tendoachilles areas can be managed by locoregional flap.<sup>1</sup> Local flaps are also useful in situations where patient is unfit for prolong duration of surgery. With better understanding of vascular anatomy and pre operative localization of perforators many local flaps can be designed for such defects.

Commonly used flaps for ankle and distal third leg includes reverse sural artery flap<sup>2</sup>, posterior tibial artery based perforator flap, peroneal artery perforator based flap, propeller flap<sup>3</sup>, lateral supramalleolar flap,<sup>4</sup> and peroneus brevis muscle flap.<sup>5</sup>

Since its description by Masquelet Reverse sural flap had been the workhorse flap for smaller to medium size defects around tendoachilles region and ankle region. Venous congestion, loss of sensation along lateral aspect of foot and donor site morbidity are other major concern for reverse sural flap.<sup>6</sup> Lateral supramalleolar flap can be used same area where RSA s been used. The pivot point of LSMF is located more anteriorly compared to RSA flap. The maximum width of the skin that can be harvested with LSMF is the area between tibia and fibula. The maximum upper limit of the skin is up to middle third of the leg.

Lateral malleolar defects can be covered with peroneus brevis muscle flap or reverse sural flap or supramaleolar flap or propeller flap. Advantages of peroneus muscle flap is that it results in primary closure of donor sites without any secondary defect where as RSA, Lateral supramalleolar flap and propeller flap all results in secondary defect. It has be found reliable even if plating has been done in fibula bone. There is no functional loss since proneus longus is preserved.<sup>7</sup>

Harvest of peroneus brevis flap is technically easier than a propeller flap. However the limiting factor for peroneus brevis is the width of the flap and the reach of the flap. Defects of width more than 4 cm is not possible to be covered with peroneus brevis muscle flap. The

chance of flap necrosis increases with the use of peroneus brevis flap for medial malleolar defects.

Now a days perforator based pedicle flap has been used frequently for reconstruction in distal third leg and ankle region.

Perforator flaps are newer flaps, which require pre op localization of perforator with help of hand held Doppler and meticulous dissection of perforators. In presence of edema surrounding the defect harvesting a perforator propeller flap may not be possible and increases the chance of flap failure. In such conditions harvesting a pedicled perforator flap and perforator plus flap can be another suitable alternative.

However there is no algorithm for the selection of flaps based on size of the defect according to the anatomic characteristics of the flap.

In this study we try to develop an algorithm for the use of pedicle flaps based on the anatomical characteristic of the defect and anatomic characteristics of the flap. There are few papers which have assessed the functional outcome after pedicle flap reconstruction.

### **AIM AND OBJECTIVE**

1. To develop an algorithm for small to moderate size defects around the ankle, posterior heel and tendoachilles.
2. Assess the functional outcome through AOFAS ankle hind foot score.

### **MATERIAL AND METHOD**

The vascular status of the involved limb were assessed clinically by palpation of posterior tibial artery, dorsalis pedis artery and was confirmed by 8 hz hand held Doppler. Perforator was localized by hand held Doppler in all cases. Demographic characteristics of the patients e.g. age, site, size of the defect, post operative complication, patient satisfaction, functional outcome were noted.

#### **Inclusion criteria**

Small to moderate defect size defect around tendoachilles, medial malleolus, lateral malleolus, with exposed bone, tendon, implant were included in the study.

#### **Exclusion Criteria**

Patients with recent MI (60 days) or unstable angina, decompensated heart failure, high-grade arrhythmias, or haemodynamically important valvular heart disease (aortic stenosis in particular);

Peripheral arterial disease; Acute infection; Uncontrolled diabetes mellitus; Heavy smokers (>25 cigarettes per day).

Flap were selected based on following algorithm.

- **Lateral malleolus-**

1. Defect width < 4cm - peroneus brevis
2. Defect with > 4 cm – reverse sural flap /peroneal perforator based fc flap / propeller flap

- **Medial Malleolus**

1. If perforators detectable, there is no skin degloving, no edema- Propeller flap based on posterior tibial artery perforator and Posterior tibial artery based fasciocutaneous flap were selected .
2. If perforators were not detectable, skin was degloved and surrounding skin was oedematous then Reverse sural artery flap was selected .

- **Tendoachilles area** - Reverse sural artery flap, Peroneus brevis muscle flap and Lateral supramalleolar flap were used .
- **Defect around ankle involving medial malleolus and extending to heel or intermalleolar area** – Reverse sural artery flap was used.
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- **Intermalleolar area and dorsum of foot** – lateral supramalleolar flap Functional assessment of the patient was recorded by means of the 0-100 AOFAS ankle-hindfoot score<sup>8</sup> with 0 indicating worst clinical condition and 100 indicating best clinical condition. Outcome was classified as "fair", at least (greater than 60 points) or "poor" (60 or less)<sup>9,10</sup>

### Statistical analysis

Data were collected and entered in Microsoft excel 2007 (Microsoft, USA). Data were analyzed using SPSS version 16 (SPSS Inc, Chicago, USA). Data were described using mean, median and percentage. A test of significance was performed using ANOVA test. P value of less than 0.05 was considered to be statistically significant.

### RESULT

Thirty five cases were initially included in the study out of which 4 were excluded because there were multiple trauma. Of the 31 patients who were eligible, 25 (80.64 %) were men and 6 (19.35%) were women with a mean age at injury of 36.41 with SD 1.07. (range, 8-58) years. 83.87 % were less than 50 years. Size of the defect ranged from 4 cm<sup>2</sup> to 120 cm<sup>2</sup>. Lateral malleolus was involved in 7 cases .Medial malleolus in 10 cases. Tendoachilles in 12 cases. Intermalleolar area in 2 cases. Small to moderate size defects of lateral malleolar area < 4 cm were reconstructed with peroneus brevis muscle flap 5 cases. Large defects of lateral malleolar area > 4cm were reconstructed with RSA flap in 2 cases. Medial malleolus was reconstructed with propeller flap in 3 cases , PTA perforator flap in 3 cases and RSA in 4 cases. Tendoachilles area were reconstructed with RSA flap in 9 cases and peroneal perforator flap in 3 cases. Intermalleolar area with supramalleolar in 2 cases. The mean follow-up was 8 month.

Functional outcomes was measured by AOFAS SCORE as shown in the table. There was no complete loss of the flap. Only two patient has marginal necrosis which settled conservatively. Two patient had graft loss due to hematoma both in peroneus brevis group.

**Table 1: Demographic Data**

Patient characteristics	N= 31
Age (mean )	36.41
Range	8 to 58
0-10	1
10-20	2
20-30	8
30-40	8
40-50	7
50-60	5
Gender	

Male	25
Female	6
<b>Etiology</b>	
Traumatic	26
Post infective	5
<b>Site</b>	
Lateral malleolus <4 cm	5
Lateral malleolus >4 cm	2
Medial malleolus	6
Medial malleolus + anterior aspect of ankle	3
Medial malleolus + sole+ ankle	1
Intermalleolar area	2
Tendoachilles area	12
<b>Reconstructive procedure /type of flap</b>	
Peroneus brevis muscle flap (PB)	5
Reverse sural artery flap (RSA)	15
Propellar flap	3
Posterior Tibial artery perforator flap	3
Peroneal perforator flap	3
Lateral supra malleolar flap	2

**Table 2: AOAFS in relation to type of reconstitition and location of defect.**

TYPE OF RECONSTRUCTION	FREQUENCY	AHS SCORE MAX =100 MEAN +SD		Anova f p value
Peroneus brevis muscle flap (PB)	5	87.8	5.63	
RSA reverse sural flap	15	92.73	6.60	
Propellar	3	92.66	3.51	F=0.716 p= 0.588
Perforator flap	6	91.66	4.57	
Lateral supramalleolar flap	2	91	2.82	
<b>ACCORDING TO THE SITE</b>				
Lateral malleolus	7	89.71	5.70	
Medial malleolus	10	89.7	7.986	F=13.23 p=1.68
Intermalleolar area	3	90.33	2.30	
Ta	11	94.75	1.88	



**Figure 1: Defect over lateral malleolus**



**Figure 2: Intra op harvest of reverse sural artery flap**



**Figure 3: long term result of reverse sural artery flap**

## DISCUSSION

Though large defects around ankle regions are most effectively covered with free flap, smaller and medium size defects can be covered by locoregional flap.<sup>1</sup>

Studies on perforators and vascularity of the skin of lower limb by pioneering work of salmon, has enabled to raise various flaps based on perforator in various regions of the leg.<sup>11</sup>

Since its description by Masquelet Reverse sural flap had been the workhorse flap for smaller to medium size defects around tendoachilles region and ankle region.<sup>12</sup>

The major drawback of RSA is risk of venous congestion. In our case none of the flap was lost completely due to venous congestion Venous congestion was avoided by inclusion of lesser saphenous vein, pre op localization of perforator, making the vascular pedicle width to be at least 2.5 cm in all the cases. For larger defects we have deepithelialized the intervening segment.

Though donor site morbidity was reported in literature by meticulous hemostasis and careful dressing we have avoided that complication We have used RSA mostly for the coverage of exposed tendoachilles and also in presence of segmental loss of tendoachilles. For smaller defects 2 cm X 2 cm we were able to close the donor site primarily without need for skin graft. Though peroneus brevis flap, and lateral supramalleolar flap has also been described for tendoachilles defect we have not used in any of the flap for exposed tendoachilles. None of our cases have flap loss for exposed tendoachilles.

Defects over lateral malleolus- Since maximum width of the peroneus brevis muscle flap is 4 cm we have selected peroneus brevis flap for defects up to maximum width of 4 cm. There was no loss of flap in any of the case. There was hematoma in in one case which was evacuated. Ankle hind foot score was  $87.80 \pm 5.630$ .

For defects more than 4 cm width or defect extending towards lateral aspect of foot we have used Reverse Sural Flap as an suitable alternative. In our case though there was epidermal loss of the flap in one case which was managed conservatively without any major intervention.

Medial malleolar defects can be reconstructed with propeller flap, pedicled posterior tibial artery perforator flaps and reverse sural artery flap. We have selected flaps based on size of

the defect, availability of perforator, condition of surrounding skin, presence or absence of degloving of skin.

In presence of a suitable perforator either propeller or posterior tibial artery perforator flap can be harvested. We have used 3 propeller and 3 posterior tibial perforator based flap. In the initial period we have used pedicled perforator flap and with experience we have used propeller flap. None of the flap have any necrosis. However the sample size is less in our series. In presence of degloving of the skin, or surrounding scarring on the medial aspect of the leg or larger defects extending to anterior aspect of the leg reverse sural artery flap was used successfully. As the pivot point is located on the postero lateral aspect of the leg it is not affected due to trauma involving the medial side of the leg. For anteriorly located defects over intermalleolar area extending to dorsum of foot we have opted for lateral supra malleolar flap. The lateral supramalleolar flap was first described by Masquelet et al in 1988 as a pedicled fasciocutaneous flap. Lateral supramalleolar flap(LSMF) has the advantages over reverse sural artery flap for defect around anterior aspect of leg and dorsum of foot. LSMF can be harvested with supine position where as RSA flap harvest require prone or lateral decubitus position. RSA flaps require either deepithelialisation or division of the intervening skin segment between the pivot point and proximal margin of the defect. This result in additional morbidity in the lower third of leg which can be avoided if lateral supramalleolar flap is used. Lateral supramalleolar flap has been found to be very safe, reliable for these area. Being a thinner flap it provides a thin pliable coverage without any difficulty in wearing foot wear in future. Disadvantages the lateral supramalleolar flap over the reverse sural flap are (1) lesser bulk, (2) limited skin area, (3) increased area of anesthesia over the dorsum of the foot, and (4) increased incidences of venous congestion compared with the reverse sural flap.<sup>12</sup>

Mean AOASF score was maximum ( $92.73 \pm 6.60$ ) among the patients with RSA flap and minimum ( $87.80 \pm 5.630$ ) among patients with PB flap. AOASF score among patients with Propeller flap, PTA flap and LSMF flap were  $92.67 \pm 3.51$ ,  $91.17 \pm 4.57$ , and  $91.00 \pm 2.82$ , respectively. After applying ANOVA test among different AOASF score among the types of flap in patients, there was no significant difference in AOASF score among different types of flaps ( $p = .58$ ).

RSA flap was used with highest AOFAS hind foot score and minimal flap complication. Our result were similar to finding by Zhu YL et al .

A meta-analysis of 50 articles that reported the use of 720 distally based sural flaps, suggested 82% success rate of the flap. Complete flap necrosis was reported in 3.3%, and partial or marginal flap necrosis in 11% which supports the use of reverse sural flap in our series.<sup>13</sup>

ANOVA test for AOASF score among the sites showed that there was no significant difference in AOASF score among reconstruction for different sites .

AOFAS- ankle hind foot score after reconstruction over tendoachilles region was comparable to other studies.<sup>14</sup>

## CONCLUSION

Complication rates can be minimized and good functional results can be obtained by careful selection of flap based on the anatomic characteristic of the flap.

## LIMITATION OF THE STUDY

Being smaller in number we have not compared the long term result of propeller flap versus reverse sural flap though we have used both the flap for medial malleolus defect.



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