A Study of Propeller Flaps for the Reconstruction of Soft Tissue Defects of Lower Limbs

K. Raghuram Prasad[1], Rangaswamy Gurram[2], Manjula Gurram[3]

ABSTRACT

Introduction: Reconstruction of simple or complex wounds of the lower one third limb is a challenge for reconstructive surgeons. Various local Fasciocutaneous, Musculocutaneous and free flaps have been described for reconstruction with their own merits and demerits. The perforator-based propeller flaps, harvested around a perforator pedicle by means of the rotation of skin paddle, up to 180^0 are now currently used technique to cover the tissue loss in the lower extremities. There is no sacrifice of major blood vessel. The aim of this study was to assess the versatility and reliability of the use of propeller flaps for leg defects

Material and Methods: 20 Patients with traumatic lower limb defects of various sites and sizes treated in the Department of Plastic Surgery, Gandhi Hospital, Secunderabad, during the period 2010 – 2013 were included in the study. A suitable sized perforator close to the defect was identified by hand held Hunt Leigh Doppler in all the patients.

Results: Of the 20 patients 90% were males and commonest aetiology was trauma, 65% of the defects were in lower third limb and our success rate is 70%.

Conclusions: The perforator-based propeller flap adds new armamentarium of reconstructive surgeons. This is a simple versatile technique and is less time consuming with no donor site morbidity. It is ideal for reconstruction of small-to medium size defects of distal leg and ankle region with good cosmetic, excellent colour, match.

Keywords: Leg Defect, Propeller Flap, Perforator Flap, Trauma Leg

INTRODUCTION

Reconstruction of the distal leg, ankle, and foot is challenging, and local, regional and distant flaps have been used.

In the absence of specific knowledge of the pattern or reliability of the blood supply, the flaps were used initially as random pattern flaps constrained by length-to-width ratios to ensure viability. These flaps are unreliable in the lower leg because of their small dimensions and restrictions in mobility.[1] Advances in techniques of flap harvest gave birth to perforator flaps through the innovative work by Koshima and Soeda[2] and Kroll and Rosenfield[3] in 1989. Several designs and movement of perforator flaps have been designed by various authors amongst which are the keystone flap and the propeller flap.

The concept of propeller flap which described in 1991 by Hyakusoku et al.[4], as an adipocutaneous flap designed as a propeller, vascularised through a random subcutaneous pedicle and rotated 90 degrees. The term was used for the first time to define a perforator flap based on a skeletonized perforator vessel and rotated 180 degrees by Hallock[5] in 2006. The final definition and terminology of propeller perforator flaps was defined by Advisory Panel of the First Tokyo Meeting on Perforator and Propeller Flaps in 2009[6], as a skin island with two paddles which can be of the same dimensions or with a larger and a smaller one, the demarcation limit between them being the perforator vessel and the flap has to rotate around the perforator vessel for at least 90 to 180 degrees.

The series of perforators from the lower leg vessels, the anterior tibial, the posterior tibial and the peroneal are useful and has changed the pattern of flap use in lower extremity.

An average of 93 perforators from 21 vascular territories supply the integument of the lower extremity. The average diameter and area supplied by a single perforator is approximately 0.7mm and $47cm^2$ respectively. Propeller flaps have become an important tool in lower limb reconstruction. This study was aimed to evaluate the role of propeller flaps in reconstruction of small to medium sized soft tissue defects of the lower limbs.

MATERIAL AND METHODS

20 Patients with traumatic lower limb defects of various sites and sizes treated in the Department of Plastic Surgery, Gandhi Hospital, Secunderabad, during the period 2010 – 2013 are included in the study.

In this study the patients are taken up for flap cover at various intervals after injury depending on the time of presentation to our Department. Most of the patients presented after orthopedic intervention for stabilization of bone fractures either by internal or external fixation.

Inclusion criteria

- Age group 10 – 60 years
- Small to medium sized soft tissue defects of leg.

[1]Consultant Plastic Surgeon, Mallareddy Narayana Multispeciality Hospital and Medical College for Women, Hyderabad, [2]Associate Professor, Department of Plastic Surgery, MNJIO and RCC, Red Hills, Lakdikapool, Hyderabad, [3]Ex-Resident, Basavataraka Cancer Hospital, Hyderabad. Plot.no. 244,245, Block -D, RNS Dream Homes, RNS Colony, Boduppal, Hyderabad, Telangana, India

Corresponding author: Dr. Rangaswamy Gurram, Sri Ranganatha Swamy Nilayam, Plot.no. 244, 245, Block -D, RNS Dream Homes, RNS Colony, Boduppal, Hyderabad.500092, India

How to cite this article: K. Raghuram Prasad, Rangaswamy Gurram, Manjula Gurram. A study of propeller flaps for the reconstruction of soft tissue defects of lower limbs. International Journal of Contemporary Medical Research 2019;6(1):A1-A7.

DOI: http://dx.doi.org/10.21276/ijcmr.2019.6.1.33

Exclusion criteria

- Patients with diabetes, hypertension, age more than 60 yrs. and smokers.

Pre-operative protocol

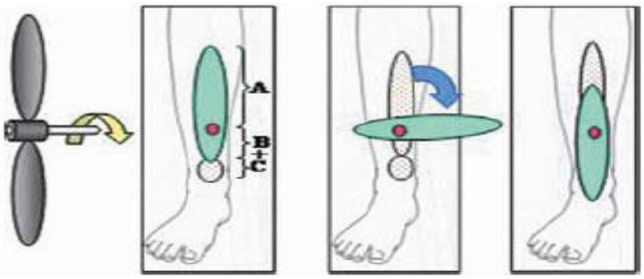
The following pre-operative criteria are fulfilled in all the patients-

- Hemoglobin – more than 11gms%
- Normal serum proteins, biochemical markers
- Limb elevation for 2-3 days, Pressure therapy with crepe bandage to reduce edema.
- Preoperative IV Dextran in patients with low perfusion pressure or weak Doppler signal in the affected limb

Preoperatively the true defect was assessed and perforator identification and marking by hand held Doppler with an 8Hz probe was done in all the patients along the vascular axis of posterior tibial or peroneal vessels. A provisional flap design is marked with this perforator as the pivot point.

Flap Design

Concept of propeller flap corresponds to 2 blades of propeller of unequal length and perforator forming the pivot point. When the 2 blades are rotated, the long blade fills the defect. The distance between proximal tip of the flap and the perforator should be equal to the distance between the perforator and the distal limit of the defect with 1 cm added to facilitate tension free closure when the flap is rotated. The width of the flap is equal to the width of the defect with 0.5 cm added.



Surgical technique

All flaps were dissected under loop magnification. An exploratory incision is given along posterior margin of the flap. Only one skin edge is incised to permit alteration of the skin paddle according to the feeding vessel selected. The dissection is performed in sub fascial plane. The perforators are easily identified in this plane because of 1. Avascular plane containing loose collagenous tissue and 2. Transparent epimysium.

A suitable sized perforator close to the defect was found. The size of the perforator is measured using a caliper. The dimension of flap is confirmed or changed to the extent, as required. Flap margins were then incised, so as to island it on selected perforator. Direct handling of the perforator is avoided during dissection to prevent vasospasm. Fat around the perforator is preserved.

The flap is rotated on the axis of this perforator for up to 90-180 degrees depending on the site of the defect and is sutured in its new position. The secondary defect is partially covered with the distal flap and the rest is closed primarily or covered by split skin graft

Only Vaseline gauze dressings are used to cover the flap, which can be monitored easily for any change in color. A posterior splint is used to keep the leg extended and immobilized postoperatively and the foot is kept elevated.

Postoperatively all the patients were put on IV fluids, IV antibiotics, Analgesics, IV Low Molecular weight Dextran 40 for 48 hrs. and thereafter the treatment was changed as per need.

After discharge the patients are followed up twice weekly for initial 15 days followed by once in a week for 1 month and once a month thereafter.

STATISTICAL ANALYSIS

Statistical analysis was conducted with the statistical packages for the social sciences system SPSS version.1.7. Continuous variables are presented as mean standard deviation and categorical variables are presented as absolute numbers and percentages. The shortest hospital stay was 5 days and longest stay was 60 days in our series.

RESULTS

This study is conducted on 20 patients admitted in the Department of Plastic Surgery, Gandhi Hospital, Secunderabad, during the period - August 2010 to March 2013.

The propeller flap method is used in all the 20 patients to cover the soft tissue defects of lower limbs.

1. Sex incidence: Males were commonly involved and age of these patients ranged between 13- 60yrs (Figure :1**)**

2. Site of the defect: The middle third of the leg was the most common site of the wound (13 out of 20) followed by lower third (6 out of 20) (Figure 2.)

3. Outcome in relation to site of defect: In our series the lower 1/3rd of leg was commonest site of leg defect (65%) followed by middle 1/3rd of leg (30%). Lower leg defects reconstructed with propeller flaps showed a survival rate of 33% and in middle 1/3rd defects a higher survival of 84% is observed (Figure: 3.) **(**Table: 1.)

4. Source Vessel: The source vessels in the leg are Posterior tibial perforators in 12 cases (60%) and the Peroneal artery perforators in 8 cases (40%). (Figure:4)

5.Outcome in relation to Source vessel: In our study the source vessels in the leg are posterior tibial perforators in 12 cases (60%) and peroneal artery perforators in 8 cases (40%). In 9 out of 12 cases (75%) based on posterior tibial perforators flap cover was successful. Whereas in flaps based on peroneal artery perforators only 5 out of 8 flaps (62%) survived**.** (Table:2) (Figure:5)

6. Reliability of Doppler: A hand-held Ultrasound Doppler scanner (Hunt leigh) is used preoperatively in all cases to detect perforator arteries in the donor site areas. (Figure: 6)

7. Proximally Vs Distally based: Most of the flaps are

Site	No. of cases	Flaps survived	Flaps lost
Upper 1/3rd	1	1 (100%)	0 (0%)
Middle 1/3rd	13	11 (85%)	2 (15%)
Lower 1/3rd	6	2 (33%)	4 (67%)
Total	20	14	6

Table-1: Outcome in relation to site of defect

Source artery	No. of cases	Flaps survived	Flaps lost
Posterior tibial	12	9 (75%)	3 (25%)
Peroneal	8	5 (62%)	3 (38%)
Total	20	14	6

Table-2: Outcome in relation to Source vessel

Base of the flap	No. of cases	Flaps survived	Flaps lost
Proximally based	6	5 (83%)	1 (17%)
Distally based	14	9 (64%)	5 (36%)
Total	20		

Table-3: Proximally Vs Distally based

Distal flap length	No. of cases	Flaps survived	Flaps lost
< 6 cm	11	9 (81%)	2 (19%)
6-10 cm	9	5 (55%)	4 (45%)
Total	20		

Table-4: Outcome in relation to distal flap length from the perforator

Size of the flap	No. of cases	Flaps survived	Flaps lost
<8x6cm	9	7(78%)	2(22%)
>8x6cm	11	7(63%)	4(37%)
Total	20		

Table-5: Outcome in relation to size of the flap

Angle of rotation	No. of cases	Flaps survived	Flaps lost
<120 degrees	18	13 (72%)	5 (28%)
120-180 degrees	2	1 (50%)	5 (50%)
Total	20		

Table-5: Outcome in relation to angle of rotation

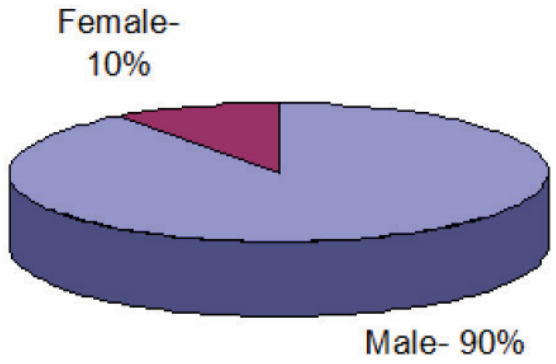


Figure-1: Sex incidence

distally based (70%) compared to proximally based flaps (20%) (Table: 3) and there outcome is show in Figure: 7

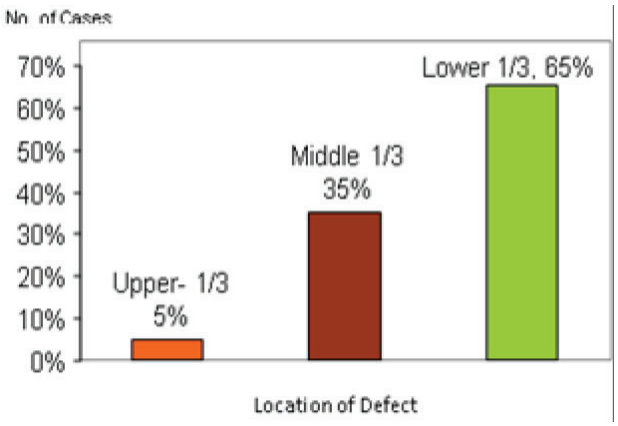


Figure-2: Site of the defect

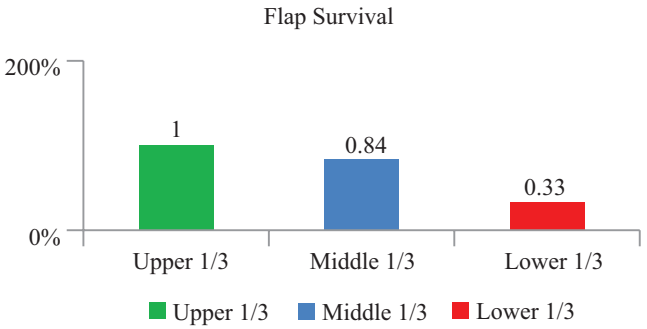


Figure-3: Outcome in relation to site of defect

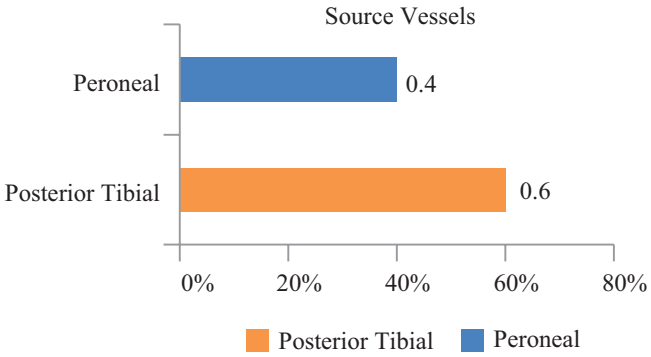


Figure-4:

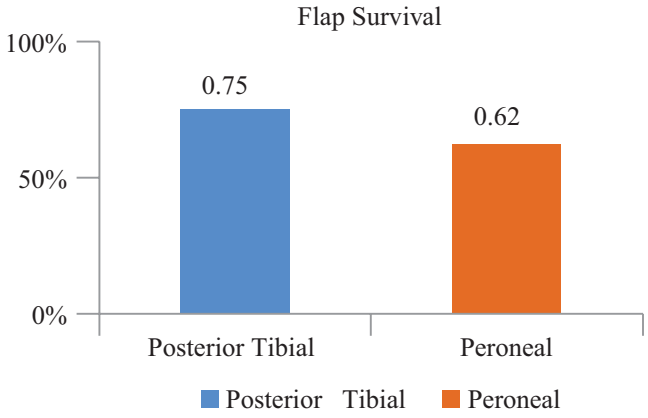


Figure-5: Outcome in relation to Source vessel

8. Distal flap length from the perforator: The distal flap length from the perforator varied from 4.5 – 10 cm in our study. It is observed that 81% flaps survived if the distal flap length was up to 6 cm and only 55% if it is ranges between

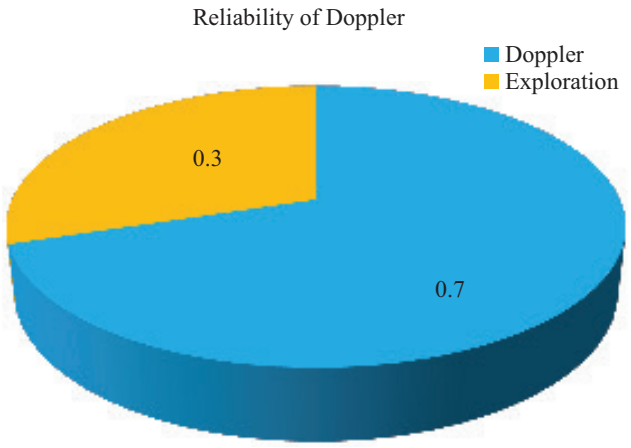


Figure-6: Reliability of Doppler

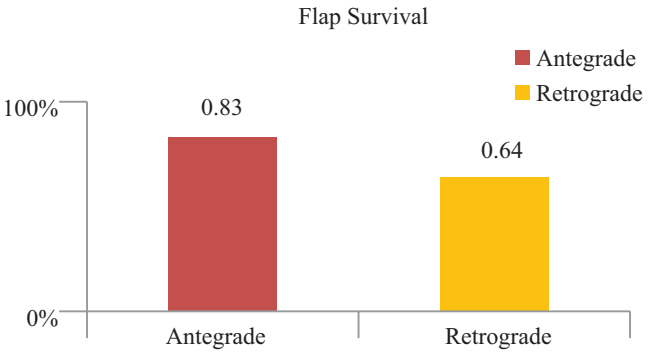


Figure-7: Outcome in Proximally and Distally based flaps

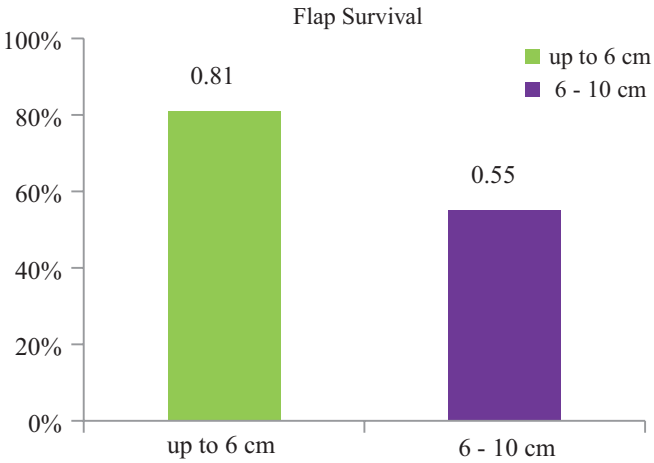


Figure-8:

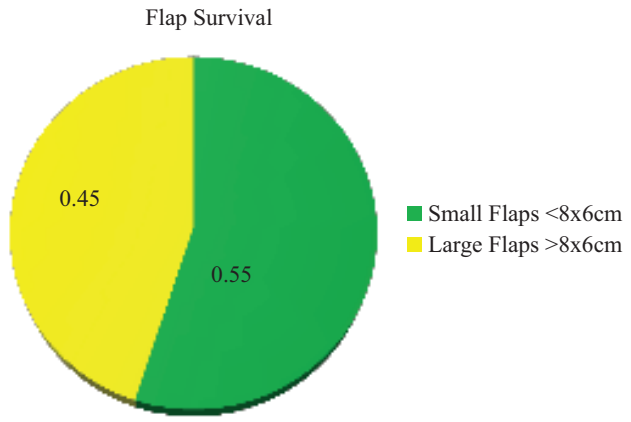


Figure-9: Size of the flap

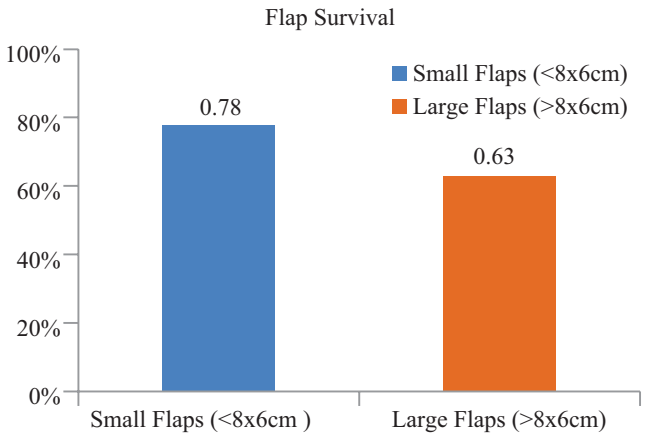


Figure-10: Outcome in relation to size of the flap

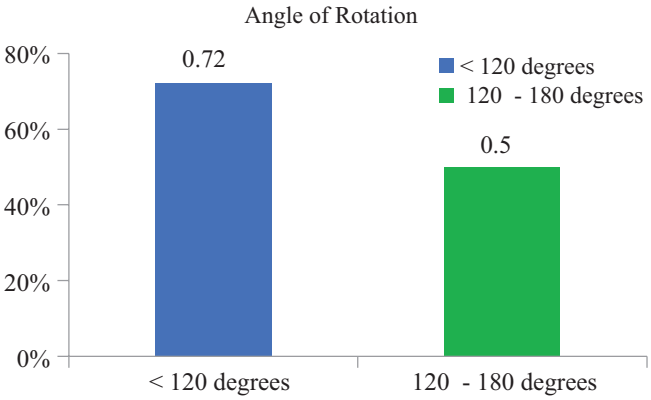


Figure-11: Outcome in relation to angle of rotation

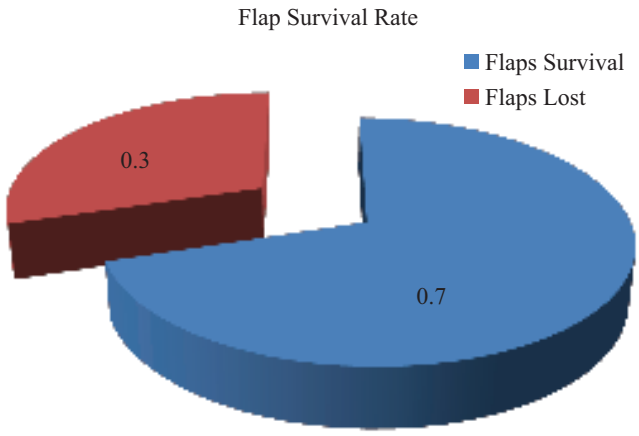


Figure-12: Flap survival in our study

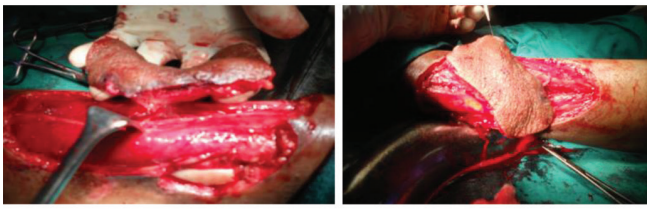
6 – 10 cm. The distal flap length from the perforator varied from 4.5cm to 10 cm. (Table 4)

9. Outcome in relation to distal flap length from the perforator: In our series the largest flap measured 12 x 6 cm and smallest flap 5 x 3 cm. Flap survival was 78% in smaller flaps (< 8 x 6 cm) compared to 63% when larger flap dimensions (> 8 x 6 cm) were used (figure-8).

10. Size of the flap: The size of the flap raised varied from 5x3cm (smallest) to 12x6cm (largest) (Figure: 9).

11. Outcome in relation to size of the flap: In our series the largest flap measured 12 x 6 cm and smallest flap 5 x 3 cm. Flap survival was 78% in smaller flaps (< 8 x 6 cm)

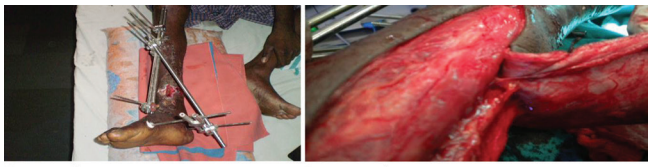
Preoperative



Intraoperative

Postoperative

Case-1: Upper third defect of leg



Preoperative Intraoperative

Postoperative

Case-2: Lower third defect of leg

compared to 63% when larger flap dimensions (> 8 x 6 cm) were used. In Ting chen lu et al[4] series the length of the flap ranged from 7.5 – 28cm and width from 3- 8cm, with a flap survival rate of 87% (Table-5) and (Figure-10).

12. Angle of rotation: The angle of rotation of the islanded flap varied from 90 to 180 degrees (Table-5).

13. **Outcome in relation to angle of rotation:** All the donor defects were partially covered with the flap and the rest of the area is covered with split thickness skin grafts (Figure-11).

14. Flap survival rate: Flap survival rate is 70% (14 out of 20 cases). Complete flap loss occurred in 6 cases (30%) (Figure-12).

DISCUSSION

We used propeller flap for soft tissue defects of lower limbs in 20 patients during the period august 2010 to march 2013. The age of the patients ranged from 13 - 60 years. Male patients dominated the study group as they are bread winners and so more prone to road traffic accidents.

All the flaps were Fasciocutaneous flaps. Though skin flaps have been described we chose Fasciocutaneous flaps as they have robust blood supply (supra and sub fascial plexus) which is desired in our study group with chronic wounds, late presentation and malnourished state.

All the defects were post traumatic due to road traffic accidents. Durga Karki and Narayan[7] in their series reported reconstruction with propeller flap in 20 patients and all the defects were post traumatic. Omar Quaba[8] in his series reported that majority of the flaps (53 out of 66) were used for post traumatic.

Out Come in Acute Vs Chronic Wounds

Nikhil et al.[8] reported a distally flap length ranging from 6 cm – 17 cm in their series. Pierluigi et al.[3] used flap sizes ranging from 3 x 5 cm – 25 x 15 cm with a flap survival rate of 90%. Ariel et al.[13] in their case report and literature review reported flap dimensions varying from 15 cm^2 – 135 cm^2.

In our study flap cover was given in 14 acute wounds and 6 chronic wounds. Flap survival in acute wounds is 85% and only 35% is chronic wounds. Schaverien et al[9] reported 88% flap survival rate in acute wounds and 50% in chronic wounds. Hallock[10] reported 90% survival in acute wounds and 63% is chronic wounds

Earliest flap cover we could give was on 2nd day after injury and longest was after 14 weeks. The reason for intervention at various intervals after injury was delayed referral by orthopedic department, time taken to control the metabolic disorders, illiteracy and poor socio-economic status.

Nikhil S Panse et al[11] reported an average time since trauma, when the patient was operated upon was 18 days. Ioannis et al.[12] reported earliest surgery after injury at 3 weeks and late intervention at 10 months. Early intervention yielded good results in our series. The flap survival rate is 82% (9 out of 11) in cases operated within 4 weeks after injury and only 55% (4 out of 9) in patients operated at any time after 4 weeks.

In delayed cases the reduced flap survival may be attributed to disuse atrophy of the affected limb, reduced size of perforator, atrophy of skin, fibrosis and scarring around the wound, wound infection, limb edema and overall poor general condition of the patient.

Site of the defect

In our series the lower 1/3rd of leg was commonest site of leg defect (65%) followed by middle 1/3rd of leg (30%). Lower leg defects reconstructed with propeller flaps showed a survival rate of 33% and in middle 1/3rd defects a higher flap survival of 84% is observed. Nikhil S Panse et al reported that lower 1/3rd was the commonest site of the wound in his series (65%) followed by middle 1/3rd (28%) with a flap survival rates of 40% in lower leg and 85% is middle 1/3rd defect.

Size of the defect

The size of the defect in our series varied from 3 x 2 cm (smallest) to 8 x 2 cm (largest). Flap dimensions up to 3 times the size of the defect were needed depending on the site of the perforator and the extent of the defect. Ting chen

lu[13] reported that the size of defect in his series ranged from 10 cm to 64 cm^2. Pignatti et al[14] reported defect sizes ranging from 7 x 9 cm to 24 x 10 cm. Nikhil et al concluded in his study that the perforator propeller flaps with maximum flap length equal to or less than 1/3rd of the limb length (lateral malleolus to fibular head) are safe flaps.

Outcome in relation to Source vessel

In our study the source vessels in the leg are posterior tibial perforators in 12 cases (60%) and peroneal artery perforators in 8 cases (40%). In 9 out of 12 cases (75%) based on posterior tibial perforators flap cover was successful. Whereas in flaps based on peroneal artery perforators only 5 out of 8 flaps (62%) survived. Greater percentage of survival of flaps based on the posterior tibial perforators is due to its constantancy in position and larger diameter of the perforators, than those of anterior tibial and peroneal vessels. Pierluigi et al[15] reported a flap survival rate of 92% (12 out of 13) with posterior tibial perforators and 66% (4 out of 6) with peroneal artery perforators. Only posterior tibial and peroneal perforators were used. Anterior tibial artery perforator-based flaps were not used as most of the injuries were in this zone (Table-2.)

Reliability of Doppler

Per operative perforator location correlated with the doppler marked site of Perforators in 14 cases (70%) out of 20. Khan et al[16] reported that the preoperative Doppler study could identify the perforators correctly in 82% cases with 8% false positives. They concluded that high false positive results due to small diameter perforator vessels.

Antegrade Vs retrograde

In our series most of the flaps (70%) are distally based (retrograde) compared to proximally based flaps (30% antegrade). Flap survival is more (83%) in proximally based flaps compared to distally based flaps (64%).

Outcome in relation to size of the perforator

In our study the size of perforators that supported the flaps varied from 0.9 – 2 mm. In vessels with a diameter < 1 mm the flap survival rate is 25% and in perforators between 1 – 2 mm diameter the survival rate of flaps increased to 75%. Alexandru[17] in his study identified the average size of perforators in leg as 0.8 +/- 0.2mm.

Outcome in relation to Distal flap length from the perforator

The distal flap length from the perforator varied from 4.5 – 10 cm in our study. It is observed that 81% flaps survived if the distal flap length was up to 6 cm and only 55% if the range is between 6 – 10 cm.

In our series the largest flap measured 12 x 6 cm and smallest flap 5 x 3 cm. Flap survival was 78% in smaller flaps (< 8 x 6 cm) compared to 63% when larger flap dimensions (> 8 x 6 cm) were used. Ariel et al[18] in their case report and literature review reported flap dimensions varying from 15 cm^2 – 135 cm^2.

Angle of rotation

In our study the angle of rotation about the perforator varied from 90- 180 degrees. In Flaps with pedicle rotation up to < 120 degrees the flap survival was 72% and in flaps with pedicle rotation from 120 to 180 degrees only 50% of the flaps survived. Nikhil et al reported 180 degrees pedicle rotation in all the 25 cases in their series with a complete flap loss in 3 cases (25%) and partial flap loss in 7 cases (28%) in Pierluigi et al series pedicle rotation angles varied from 80 – 180 degrees, with flap necrosis occurring in 2 cases (out of 22 cases) with 160 degrees flap rotations.

Final outcome

The survival rate of island pedicled propeller flaps in our study is 70%, 6 patients (30%) had complete flap loss. The cause of flap necrosis was venous congestion in 4 cases.

One case of flap necrosis occurred in diabetic patient with history of chronic smoking, and the cause of necrosis could be due to underlying small vessel disease.

One case of flap necrosis in a chronic case could be due to combination of atrophic limb, small perforator size and large flap dimensions.

Pierluigi et al reported flap necrosis in 2 cases (9%) out of 22 cases. Durga Karki and Narayan reported loss of 1 flap (5%) out of 20 patients due to venous congestion.

Outcome in Other series

S. No	Author	No. of Patients	Flap Loss (%)
1	Voche[19]	41	3 (7.3%)
2	Touam[20]	27	5 (18.5%)
3	Present study	20	6 (30%)

In our set, up the high rate of flap loss is due to:

Late presentation, Subclinical malnutrition, lack of preoperative physiotherapy to prevent muscle atrophy Lack of integrated trauma care system

The donor sites in our study were partially covered by the flap and the rest is skin grafted.

Complications

The most common complication in our series is venous congestion of the flap in 8 cases (40%) that lead to flap necrosis in 4 cases. In the rest of the 4 cases the congestion settled by 3rd or 4th postoperative day following massaging of the flap from peripheral margin towards center and most probably due to intravenous administration of Dextran 40 in these cases.

The incidence of venous congestion in other series Ting Chen Lu37.5%, Pignatti 33.5%

Superficial epidermolysis in 2 cases (10%), Wound infection in 3 cases and was due to underlying osteomyelitis of the bone.

Transient edema of the affected limb was recognized in 2 cases (10%). The leg edema in these patients disappeared in 6 months with compression stockings and limb elevation at rest.

Follow up in our study was up to 6 months in 6 cases and in the rest of the patients for not more than 3 months as most of these patients are poor and illiterate.

CONCLUSION

Propeller perforator flaps are best suited for small and

medium sized defects. These flaps based on perforators of all 3 main axial vessels of the leg are very useful in covering defects of the lower limbs and in well selected cases can provide a simpler alternative to the more sophisticated free flaps.

The propeller flap for the lower limb defects provides a valuable option in the reconstructive armamentarium. It is relatively easy and less time-consuming procedure which is beneficial in elderly, polytrauma patients, or with a compromised general status. Besides the fact that the reconstruction can replace like with like by using tissues of similar texture, thickness, pliability and colour, the source vessel and underlying muscle are preserved. The donor site morbidity is minimal and the hospitalization time is reduced. This flap avoids multiple surgical sites and the extra costs associated with free flaps and microsurgery and the flap being thin and pliable for soft tissue cover and its greater rotation arc makes it popular for lower limb reconstruction.

REFERENCES

1. Rad AN, Singh NK, Rosson GD. Peroneal artery perforator-based propeller flap reconstruction of the lateral distal lower extremity after tumor extirpation: case report and literature review. Microsurgery 2008; 28:663-70.
2. Koshima I, Soeda S. Inferior epigastric artery skin flaps without rectus abdominis muscle. Br J Plast Surg 1989; 42:645-8.
3. Kroll SS, Rosenfield L. Perforator-based flaps for low posterior midline defects. Plast Reconstr Surg 1988; 81:561-6.
4. Hyakusoku H, Yamamoto T, Fumiiri M. The propeller flap method. Br J Plast Surg 1991; 44:53-4.
5. Hallock GG. The propeller flap version of the adductor muscle perforator flap for coverage of ischial or trochanteric pressure sores. Ann Plast Surg 2006; 56:540-2.
6. Pignatti M, Ogawa R, Hallock GG, et al. The "Tokyo" consensus on propeller flaps. Plast Reconstr Surg 2011; 127:716-22.
7. Durga karki and R.P. Narayan. The versatility of perforator-based propeller flap for reconstruction of distal leg and ankle defects, Plastic surgery International: Vol 2012.
8. Quaba O, Quaba AA. Pedicled perforator flaps for the lower limb. Semin Plast Surg 2006; 20: 103-11.
9. Schaverien et al., Lower limb reconstruction using the islanded posterior tibial artery perforator flap, Journal of plastic and reconstructive surgery: 2010;125:1735-43.
10. Hallock GG. Lower extremity muscle perforator flaps for lower extremity reconstruction. Plast Reconstr Surg 2004; 114:1123-30.
11. Panse NS, Bhatt YC, Tandale MS. What is safe limit of the perforator flap in lower extremity reconstruction? Do we have answers yet? Plast Surg Int 2011; 2011: 349-357
12. Ioannis et al., Distal posterior tibial artery perforator flaps for management of calcaneal and Achilles tendon injury in diabetic and non-diabetic patients: Diabetic foot and Ankle: 2011; Vol 2: 1-4.
13. Ting Chen Lu et al. The peroneal artery perforator-based propeller flap for distal lower limb reconstruction, JTSPS: 2011;20: 196-201.
14. Pignatti M, Pasqualini M, Governa M, Bruti M, Rigotti G. Propeller flaps for leg reconstruction. J Plast Reconstr Aesthet Surg 2008;61:777–783.
15. Pierluigi Tos et al., Perforator based Propeller flaps treating loss of substance in the lower limb, Journal of Orthopedic trauma: 2011;12: 93-99.
16. Khan UD, Miller JG, Reliability of hand-held Doppler in planning local perforator-based flaps for extremities, Aesthetic Plastic Surgery: 2007;31: 521-5.
17. Alexandru v. Georgesca. Propeller perforator flaps in distal lower leg: Evolution and clinical application, Archives of Plastic Surgery: 2012;39: 94-105.
18. Ariel et al., Peroneal artery perforator-based propeller flap reconstruction of the lateral distal lower extremity after tumor extirpation: Case report and literature review. Microsurgery: 2005;28: 663-670.
19. Voche P, Merle M, Stussi JD. The lateral supramalleolar flap: Experience with 41 flaps. Ann Plast Surg 2005; 54: 49–54.
20. Touam C, Rostoucher P, Bhatia A, Oberlin 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. Plast Reconstr Surg 2001;107: 383–392.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 09-12-2018; **Accepted:** 04-01-2019; **Published:** 23-01-2019