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Original Research Article

A DESCRIPTIVE STUDY OF PROPELLAR FLAPS FOR THE RECONSTRUCTION OF LOWER TWO-THIRD LEG DEFECTS IN A TERTIARY CARE CENTRE

S. Ahamed Rafeeq Meeran[1], G.R. Balaji Sharma[2], S. Raja[3], Nandikonda Sathwik Reddy[4]

[1]Associate Professor, Department of Plastic and Reconstructive Surgery, Tirunelveli Medical College, Tirunelveli, Tamilnadu, India.
[2]Assistant Professor, Department of Plastic and Reconstructive Surgery, Tirunelveli Medical College, Tirunelveli, Tamilnadu, India.
[3]Assistant Professor, Department of Plastic and Reconstructive Surgery, Tirunelveli Medical College, Tirunelveli, Tamilnadu, India.
[4]Senior Resident, Department of Plastic and Reconstructive Surgery, Tirunelveli Medical College, Tirunelveli, Tamilnadu, India.

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Corresponding Author:
Dr. S. Raja,
Email: rajashanmugasundaram@gmail.com

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ABSTRACT

Background: Soft-tissue wounds and injuries of the middle and lower third of leg require dependable reconstruction because of limited local tissue and exposed vital structures. Propeller flaps provide a perforator-based, limb-preserving option with minimal donor-site morbidity, though outcomes may vary with pedicle length, rotation arc and patient factors. This study aimed to evaluate the clinical outcomes, complications and flap survival in lower leg reconstruction using propeller flaps. **Materials and Methods:** This prospective observational study included 50 patients who underwent propeller flap reconstruction for mid- or lower third of leg defects in the Department of Plastic Surgery, Tirunelveli Medical College, Tirunelveli, Tamilnadu. Preoperative Doppler identified suitable perforators, flaps were islanded and rotated up to 180°, and donor sites were closed primarily or with Skin Transplantation (split-skin grafts). Operative details, complications, and outcomes were documented with a six-month follow-up. **Result:** Most patients were 46–60 years (44%), male (64%) and sustained work-site injuries (54%). The mean flap size was 9.8 × 5.0 cm, pedicle length 1.2 cm, operating time 3.3 hours, and blood loss 75 mL. Venous stasis was the most common complication (24%), followed by marginal necrosis (6%), minor dehiscence (2%), and superficial partial flap loss (2%). No total flap loss occurred (0%). Overall complications were seen in 36%, and major reoperation in 2%. Complete flap survival was achieved in 98%, with 92% showing satisfactory functional results and 88% satisfactory cosmetic outcomes. **Conclusion:** Propeller flaps provide dependable coverage with high survival rates and manageable complications. They remain an effective reconstructive choice for middle and lower-third leg defects.

INTRODUCTION

Soft tissue defects in the lower extremity, particularly after trauma or infection, create considerable practical difficulty for surgeons managing lower-leg soft-tissue loss, thin skin coverage and the proximity of bone, tendons or neurovascular structures.[1] Traditional reconstructive options, such as muscle flaps or free tissue transfer, often involve donor-site morbidity, prolonged operative time, and require microsurgical expertise, which may not be feasible in all settings.[2] The development of perforator-based local flaps has provided a less invasive alternative, preserved major vessels and reduced donor-site sacrifice.[3]

The concept of the propeller flap, a local perforator flap rotated around a vascular axis, was introduced to allow surgeons to cover irregular defects while using nearby tissues that resemble the original area in texture and thickness.[4] Several studies have demonstrated that propeller flaps can show favourable survival rates in most reports, with complications typically remaining within manageable limits, particularly when anatomical perforators are well identified and preserved.[5,6] Previous meta-analysis of 619 propeller flaps, overall survival (after revisions) reached 97%, although

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distal necrosis and venous congestion continue to be among the recurrent concerns described.[6]

Despite these favourable outcomes, planning such flaps requires careful judgement and familiarity with the regional anatomy. Factors such as the distance between the perforator and the defect, the arc of rotation, flap dimensions and vascular pedicle integrity have been shown to influence complication risk.[7] A recent study found that the shortest safe distance of < 3 cm between the perforator and the wound significantly increased the risk of necrosis.[7] Moreover, outcome variability in different anatomical regions suggests that site-specific factors warrant further study.[8]

In the lower third of the leg, soft tissue reconstruction is particularly challenging due to the limited soft-tissue envelope and the increased vulnerability of flaps in this region.[5] Comparative research indicates that propeller flaps may lead to shorter operative times and reduced hospital stay compared to free fascio-cutaneous flaps in lower extremity reconstruction.[9] Still, complication rates continue to vary (8.3 - 42%) across patient populations.[10]

Given this background, the current study was to evaluate the clinical outcomes of propeller flaps in our setting and analyse complications. This study aimed to assess flap survival, complication rate, donor site morbidity, and the associations of patient, defect and flap design variables with outcomes in reconstructive procedures using propeller flaps.

MATERIALS AND METHODS

This prospective observational study was conducted on 50 patients who presented with soft tissue defects involving the middle and lower thirds of the leg in the Department of Plastic Surgery, Tirunelveli Medical College, Tirunelveli, Tamilnadu. All participants provided signed consent before being enrolled in the study.

Inclusion Criteria

Patients aged 18–60 years were included in this study.

Exclusion Criteria

Patients with post-infective soft tissue defects, children, elderly patients above 60 years of age, defects not suitable for propeller flap reconstruction and general conditions that prevented surgery were also excluded.

Methods

All surgical procedures were performed under strict aseptic conditions. Preoperatively, each patient underwent Doppler examination using a handheld Nicolet 8-MHz Doppler probe held at approximately 45° to the skin surface to identify the most suitable perforator arising from the anterior tibial, posterior tibial, or peroneal arteries. The flap was designed using the identified perforator as the pivot point. The distance between the perforator and the distal margin of the defect was measured and transposed proximally to determine flap length. An additional one centimetre was added to ensure a tension-free inset. The flap width was planned based on the defect width, with a small allowance added to accommodate flap contraction during rotation.

A longitudinal incision was made along one border of the planned flap to confirm the presence and quality of the perforator identified during the Doppler mapping. Supra-fascial or sub-fascial dissection was performed under loupe magnification to isolate the perforator, taking care to preserve the surrounding tissues and free the vessel enough to permit rotation of the flap without undue tension. Any side branches encountered during dissection were carefully ligated. Once the perforator was fully skeletonised, the flap was islanded and rotated up to 180°. Both clockwise and counter-clockwise directions were assessed and left briefly in position so that the circulation through the flap could be observed before final suturing. After rotation, the flap was allowed to rest for approximately 20 min to ensure stable perfusion before the final inset. The donor site was covered with split-skin grafting, and all wounds were closed after achieving haemostasis.

Postoperative care

After surgery, the leg was supported in elevation and protected with a splint to avoid any compression of the flap. The flap was checked regularly in the early postoperative period to detect any circulatory issues promptly and to identify the early signs of venous congestion or arterial insufficiency. The sutures were removed on the tenth postoperative day. All patients were followed up for a period of six months, during which flap survival, complications, donor-site healing and aesthetic and functional outcomes were assessed.

Statistical Analysis

The collected data were analysed using simple descriptive statistics. Categorical variables were expressed as frequencies and percentages and continuous variables were summarised as means and standard deviations.

RESULTS

Most patients were aged 46–60 years. 32 (64%) were male and 18 (36%) were female, 27(54%) had work-site injuries, 20(40%) had road traffic accident and 32 (64%) belonged to the lower socioeconomic class. [Table 1]

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Table 1: Baseline characteristics of study participants

Parameter	Category	N (%)
Age (years)	≤30	8 (16%)
	31–45	20 (40%)
	46–60	22 (44%)
	Mean ± SD	38.9 ± 10.8
Sex	Male	32 (64%)
	Female	18 (36%)
Aetiology / Cause of defect	Work-site injury	27 (54%)
	Road traffic accident	20 (40%)
	Train traffic accident	2 (4%)
	Onco-plastic reconstruction	1(2%)
Socioeconomic Status	Lower	32 (64%)
	Middle	15 (30%)
	Upper	3 (6%)

The mean flap size was 9.8 × 5.0 cm, with a mean flap area of 48.6 cm². The average pedicle length was 1.2 cm, mean operating time was 3.3 hours, and average blood loss was 75 mL. Most donor sites were closed with split-skin grafts (49 cases), while primary closure was performed in one case. The mean postoperative hospital stay was 5.2 days, and the patients were followed up for 6 months. [Table 2]

Table 2: Operative and postoperative parameters

Parameter	Mean ± SD	Range
Flap size (cm)	9.8 × 5.0 ± 2.1	4 × 4 – 16 × 9
Flap area (cm²)	48.6 ± 21.4	16 – 145
Pedicle length (cm)	1.2 ± 0.2	1.0 – 1.4
Operating time (hours)	3.3 ± 0.5	2.0 – 4.5
Blood loss (mL)	75 ± 25	40 – 150
Donor site closure by SSG	48 (98%)	
The donor site closed primarily	1 (2%)	
Mean postoperative stay (days)	5.2 ± 1.3	4 – 10
Mean follow-up (months)	–	6

The most common complication was venous congestion 12 (24%), followed by marginal necrosis 3 (6%). Other complications included suture line dehiscence 1 (2%), partial superficial flap loss 1 (2%), and donor-site partial graft loss 1 (2%). No complete flap loss occurred 0 (0%) and overall complications were observed in 18 (36%) patients. Only one (2%) patient required major reoperation. [Table 3]

Table 3: Postoperative complications

Complication	N (%)	Management / Outcome
Venous congestion	12 (24%)	Conservative (9), puncture (3); all flaps survived
Marginal necrosis	3 (6%)	Debridement + secondary SSG
Suture line dehiscence	1 (2%)	Conservative dressing
Partial flap loss (superficial)	1 (2%)	Debridement + graft
Donor site partial graft loss	1 (2%)	Regrafting performed
Complete flap loss	0 (0%)	–
Total complications (any)	18 (36%)	–
Major reoperation required	1 (2%)	Case abandoned; managed with alternate flap

Complete flap survival was achieved in 49 (98%) patients, with only 3 (6%) developing superficial partial necrosis, and no cases of total flap loss 0 (0%). Functionally satisfactory coverage was achieved in 46 (92%) patients, and cosmetic results were satisfactory in 44 (88%) patients. Donor sites healed without complications in 48 (96%) patients, and 4 (8%) required readmission. The mean time to complete healing was 18 ± 3 days. [Table 4]

Table 4: Flap outcomes and healing

Outcome parameter	N (%)
Complete flap survival	49 (98%)
Partial necrosis (superficial)	3 (6%)
Total flap loss	0 (0%)
Functionally satisfactory coverage	46 (92%)
Cosmetically satisfactory result	44 (88%)
The donor site healed without complication	48 (96%)
Readmission within 30 days	4 (8%)
Mean time to complete healing (days)	18 ± 3

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DISCUSSION

This study aimed to assess the outcomes and complications of propeller flaps in the middle and lower third of leg defect reconstruction. Our findings showed a 98% complete flap survival rate, with venous congestion being the most common but largely manageable complication. Overall, the patients achieved good functional and cosmetic results, indicating that propeller flaps remain a practical and dependable choice for managing lower third of leg defects.

In our study, most participants were middle-aged adults, with a predominance of males and individuals from lower socioeconomic status backgrounds. Work-related injuries were the leading cause of soft tissue defects, followed by road traffic accidents. Similarly, Benedetti et al. evaluated 13 patients with lower-limb soft-tissue defects managed using propeller flaps, with ages ranging from 21–79 years and a slight male predominance.[11] Tos et al. presented 22 patients reconstructed with perforator-based propeller flaps across an age range of 22–86 years, with mixed etiologies including oncological resections.[12]

Mendieta et al. treated 28 patients with trauma-related middle and distal leg defects using propeller perforator flaps, reporting ages of 19–65 years and a mean age of 32 years, with males comprising 75%.[13] Additionally, Mullah et al. studied 30 patients with lower leg defects reconstructed using propeller flaps, noting a mean age of 37.5 years, the largest age group being 31–40 years (36.7%), and a strong male predominance (90%). Trauma accounted for 63.3% of cases, followed by burns (26.7%) and malignancy (10%).[14] Overall, our study shows the same trend as earlier research: most propeller flap cases involve middle-aged men with injuries caused mainly by trauma.

In our study, the flaps were of moderate size with adequate pedicle length, and the operative procedure was completed within a reasonable duration with minimal blood loss. Most donor sites required split-thickness skin grafting, while only a single case achieved primary closure. The patients had a short postoperative hospital stay and were followed up for several months. Similarly, Ota et al. reported a mean flap size of 48 cm² (24–80 cm²) in the PPF group, comparable to ours, while free flaps were larger at 118 cm²; their mean operative time for PPF was 213 minutes (110–318 minutes), similar to our duration, whereas free flaps required 605 minutes, and donor-site grafting was needed in 8 PPF and 1 FF case.[15]

Mendieta et al. described flap sizes of 12–156 cm² with an average of 50 cm², with most requiring a 180-degree rotation (82%) and the rest 140–160 degrees, all based on a single perforatortypically from the posterior or anterior tibial arteries, and donor sites closed primarily in 85.7% of cases.[13] Also, Mullah et al. reported larger mean flap dimensions of 67.35 cm² (24–128 cm²), an average wound size of 27.8 cm², and flap measurements ranging from 6–16 cm in length and 4–8 cm in width.[14] Overall, these operative characteristics are broadly consistent with what earlier investigations have documented, suggesting that propeller flaps can be effectively applied to a range of defect dimensions.

In our study, venous congestion emerged as the most common complication, followed by minor issues such as marginal necrosis, suture line problems, and partial or superficial flap loss. Donor-site graft failure was rare, and no cases of complete flap loss were observed. Overall, complications were relatively limited, and only one patient required major reoperation.Similarly, Benedetti et al. identified venous congestion as the most frequent complication, occurring in four cases, along with postoperative infection and one complete graft loss.[11] In contrast, Ota et al. reported both complete and partial flap necrosis, including 2 cases of total necrosis in the PPF group and several partial losses, often associated with diabetes, hypertension, vascular calcification, or smoking.[15]

Mendieta et al. documented a 14% complication rate, comprising three partial necroses (each <15% of flap area) and one case of epidermolysis, mainly in posterior tibial–based flaps and more frequently in female patients; no complete flap losses or major reoperations were required.[13] In comparison, Artiaco et al. observed a higher overall complication rate of 33%, including superficial epidermolysis in four patients (19%) and partial necrosis in three patients (14%), two of whom required skin grafting, while one needed conversion to a free ALT flap due to extensive necrosis.[16] Thus, the distribution of complications in our series resembles what has been reported elsewhere, indicating that serious morbidity was uncommon and that venous congestion remained the main concern but was usually controllable.

In our study, flap survival was excellent, with only a few cases showing minor superficial necrosis and no cases of total flap loss. Most patients achieved satisfactory functional and cosmetic outcomes, and donor-site healing was largely uneventful. Most patients healed within a relatively brief time frame, and only a few required further hospital cares. Similarly, Benedetti et al. reported that most flaps survived successfully despite the presence of bone exposure and anatomically demanding defect sites.[11] Similarly, Mendieta et al. documented excellent outcomes, with all 28 flaps remaining viable and complications limited to minor partial necrosis or epidermolysis, both resolving with conservative care; donor-site healing was largely uneventful, particularly with primary closure.[13]

Mullah et al. rated final outcomes as good in 83.3% of patients, satisfactory in 10%, and poor in 6.7%, noting that although partial necrosis occurred in some cases, most flaps ultimately achieved adequate coverage.[14] In contrast, Artiaco et al. reported complete flap survival in 18 of 21 patients (86%), with superficial epidermolysis in 19% and partial necrosis in 14%; one case required conversion to a

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free ALT flap due to 50% flap loss.16Therefore, taken together, our findings and earlier work suggest that propeller flaps typically achieve good healing outcomes with limited major complications.

Limitations

This study was limited by its single-centre design and relatively small sample size, which may restrict generalisability. The short follow-up period of six months does not provide long-term insight into the functional or aesthetic outcomes.

CONCLUSION

Propeller flaps serve as a dependable method for addressing soft-tissue loss in the middle and lower one-third of leg defects. They showed a high rate of flap preservation in our study, with most postoperative issues being limited in severity. Venous congestion occurred most frequently, though it was generally controlled without major intervention. Overall, propeller flaps provided satisfactory functional and cosmetic outcomes, indicating that, when chosen for suitable cases, propeller flaps can provide a sound and practical reconstructive solution. Additional research involving larger patient groups and extended follow-up would help strengthen these observations and refine planning approaches.

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