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Original Research Article

# Prospective Analysis of Peroneal Perforator Based Propeller Flap –Single Centre Experience from Eastern India

**Biswajit Mishra[1], Deepak Kumar Sahu[2], Bibhuti Bhusan Nayak[3]**

[1]Associate Professor, Department of Plastic Surgery, SCB Medical College, Cuttack
[2]MCH Resident, SCB Medical College, Cuttack
[3]Professor and HOD, Department of Plastic Surgery, SCB Medical College, Cuttack

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**Corresponding Author: Dr. Biswajit Mishra**
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**Abstract:**

**Introduction:** Propeller flap is an ideal flap for small to medium size defects because it is harvested from local tissue, has similar color, texture. It obeys the principle of replacing like with like. It avoids the sacrifices of any nerve, muscle. It does not require microvascular anastomosis. When peroneal perforator flap is harvested with s propeller design, it avoids the drawbacks of pedicle peroneal perforator flap. There is no dog-ear formation and it has excellent cosmetic result.

**Primary Objective:** Evaluate the safety and efficacy of peroneal perforator flap in reconstruction of lower third of leg defects.

**Secondary Objective:**

1. Time taken for flap harvest.
2. Frequency of adverse effect i.e. Flap congestion, superficial necrosis, complete necrosis,
3. Donor site complication i.e. graft loss, infection, hematoma, seroma etc.
4. Perforator location relative to lateral malleolus.

**Study Design:** Prospective study undertaken in Dept. of Plastic Surgery of SCB Medical College, Cuttack from 2021march to 2022 November.

**Inclusion Criteria:** Small to medium size defects with non-healing wound on lower third of leg and ankle region

**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).

**Result:** 24 peroneal perforator flap were harvested during the study period. One flap had complete necrosis. There was one flap with superficial necrosis which was managed with vac therapy and skin grafted. The average location of perforator was 9.19 cm from lateral malleolus with SD of 1.3 cm. Age ranged from 15 to 48 years. Flap size ranged from 24 cm $^2$ to 180 cm$^2$. Male: Female ratio was 3:1. There was no donor site morbidity. All patients had satisfactory functional outcome. Time taken for flap harvest was 55.58 sec with SD 10.19.

**Conclusion:** Peroneal perforator artery based propelllar flap is safe and effective for coverage of small to medium size defect when used judiciously in appropriate time interval from injury. It can be harvested rapidly with minimal adverse effect. There is no donor site complications. It can be suitable alternative to free flap for small to medium size defects of lower limb.

**Keywords:** Peroneal Artery Flap, Perforator Flap, Propeller Flap, Lower limb trauma reconstruction.



## Introduction

Peroneal perforator flap was first identified by Yosumua [1]. Since then peroneal perforator based pedicle and free flap has been described for various uses [2] Peroneal perforator based flap can be raised as pedicle flap (perforator plus flap,) or perforator based propelllar flap. When raised as perforator plus flap there is significant dog ear formation which may necessitate secondary region [3]. This lead to cosmetic deformity and difficulty in wearing shocks. Perforator based propeller flaps avoids these problems. Since the flap is based only on perforator there is no sacrifice of sural nerve, no sacrifice of any muscle. It doesn't require microvacular anastomosis. [4] So it can be harvested even by junior plastic surgeons in resource contain areas. However, the perforator dissection require skill albeit less than microvacular anastomosis. Use of magnifying loupe adds to the safety and reliability of perforator iden-

tification. Perforator propeller flaps has fewer complication rate, low failure rate compared to free flap for low to medium size defects [5]. It is increasingly used now days for lower limb reconstruction. The concept of perforator flaps that was described in 1990s provided a better option to cover leg defects. Anatomical studies of the fibula osteoseptocutaneous flap showed that the peroneal artery perforator flap was reliable because it supplies a wider area and has a constant arterial blood supply [6].The lateral aspect of the leg, which is perfused by a number of perforators from the peroneal artery, is one of the most suitable areas for harvesting perforator flaps [7].

In addition, the peroneal artery is least likely to be affected by atherosclerosis [8].

**Aim and objective of the study**

**Primary Objective:** Evaluate the safety and efficacy of peroneal perforator flap in reconstruction of lower third of leg defects.

**Secondary Objective**

1. Time taken for complete wound healing
2. Frequency of adverse effect i.e. Flap congestion, superficial necrosis, complete necrosis,
3. Donor site complication i.e. grafts loss, infection, hematoma, seroma etc.
4. Perforator location relative to lateral malleolus
5. Functional outcome

**Study Design:** Prospective study undertaken in dept. of plastic surgery from 2021march to 2022 November

**Inclusion Criteria:** Small to medium size defects with non-healing wound on lower third of leg and ankle region.

Timing of surgery – Within 1 week or after two week of trauma

**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).

**Table 1:**

| Age | sex | Location | Defect size | Flap size | comorbidity | Complication | Perforator location in cm from lateral malleolus |
|---|---|---|---|---|---|---|---|
| 1. 14 | M | Tendoachilles | 4 cm X 3 cm= 12 $cm^2$ | 32 $cm^2$ | | Nil | 7 |
| 2. 22 | F | Lateral Malleolus | 8 cm X 4 cm =32 $cm^2$ | 10 cm X 5 cm =50 $cm^2$ | | Nil | 9 |
| 3. 18 | M | Lateral Aspect Of Lower Third Leg | 8 cm X 3 cm= 24 $cm^2$ | 45 $cm^2$ | | Superficial Necrosis | 9.5 |
| 4. 24 | F | Tendoachilles | 6cm X 4cm =24$cm^2$ | 40 $cm^2$ | | Nil | 9 |
| 5. 26 | M | Lateral Malleolus O | 8cm X 6 cm =48 $cm^2$ | 60 $cm^2$ | - | Nil | 8.6 |
| 6. 32 | M | Lateral Malleolus | 5cm X4 cm=20 $cm^2$ | 56 $cm^2$ | - | Graft Loss | 9 |
| 7. 36 | M | Tendoachilles | 5 cm X 5 cm=25 $cm^2$ | 48 $cm^2$ | HPTN | Nil | 7 |
| 8. 38 | M | Ankle | 5 cm X 2 cm =10 $cm^2$ | 48 cm 2 | - | Nil | 10 |
| 9. 40 | F | Posterior Aspect Of Heel | 4 cm X 4 cm =16 $cm^2$ | 52 $cm^2$ | DM | Suture Dehiscence | 8 |
| 10. 19 | M | Tendoachilles | 6 cm X 1.5 cm=9 $cm^2$ | 24 $cm^2$ | - | Suture Dehiscence | 11 |
| 11. 20 | M | Ankle | 4 cm X 3cm =12 $cm^2$ | 36 $cm^2$ | - | Nil | 8 |
| 12. 38 | F | Lateral Malleolus | 3 cm X 3 cm =9 $cm^2$ | 30 $cm^2$ | DM | Nil | 9 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13. 24 | M | Dorsum Of Foot | 10 cm X 8 cm =80 $cm^2$ | 180 $cm^2$ | - | Nil | 9 |
| 14. 29 | M | Ankle | 7 cm X 3 cm=21 $cm^2$ | 40 $cm^2$ | HPTN | Nil | 9 |
| 15. 31 | M | Ta | 5 cm X 2 cm =10 $cm^2$ | 33 $cm^2$ | - | Nil | 10 |
| 16. 23 | M | Ta | 3cm X 2 cm =6 $cm^2$ | 30 $cm^2$ | DM | Nil | 9 |
| 17. 43 | F | Lateral Malleolus | 4 cm X 2 cm=8 $cm^2$ | 33 $cm^2$ | - | Nil | 10 |
| 18. 28 | M | Ta | 5 cm X 3 cm=15 $cm^2$ | 36 $cm^2$ | HPTN | Nil | 11 |
| 19. 32 | M | Lateral Malleolus | 8 cm X 2 cm =16$cm^2$ | 35 $cm^2$ | - | Nil | 10.6 |
| 20. 35 | M | Ankle Posterior Aspect Heel | 4 cm X 4 cm =16 $cm^2$ | 32 $cm^2$ | DM | Nil | 7 |
| 21. 36 | M | Lateral Malleolus | 5 cm X 3 cm =15$cm^2$ | 27 $cm^2$ | - | Nil | 8 |
| 22. 40 | M | Posterior Aspect Of Heel | 5 cm X4 cm =20 cm | 55 $cm^2$ | - | Nil | 10 |
| 23. 45 | F | Fibula | 4 cm X 2.5cm=10 $cm^2$ | 39 $cm^2$ | - | Nil | 12 |
| 24. 44 | M | Lateral Malleolus | 7 cm X 3 cm =21 $cm^2$ | 44 $cm^2$ | HPTN | Nil | 10 |

**Surgical technique**

First step in the surgery involves wound debridement and defect creation. (Figure 1)

The second step involves identification of peroneal perforator. Bony landmark include head of fibula and lateral malleolus. The posterior intermuscular septum lies 1 to cm posterior to the posterior boarder of fibula. Peroneal perforator is identified with the help of 8 Hz hand held Doppler.

Doppler was kept at 45 degree to skin surface to avoid the bias of detecting source vessel. [9] (Figure 2)

Third step – Planning in reverse. Pivot point is the perforator location. From that point the distal edge of the defect is measured. 1 cm is added to it.

This length is transposed proximally which forms the proximal boarder of the flap. (Figure 2)

Forth step –Tourniquet is applied. Exploratory incision is given on the anterior aspect. The incision deepened up to deep fascia. Deep fascia is fixed to dermis with suture to prevent shearing of perforator. Peroneal muscles are retracted and perforator is identified. (Figure 3)

Fifth step –The position of perforator is matched with Doppler marked site. In case of discrepancy the flap is redesigned.

Sixth step –Proximal margin of the flap is incised. Flap is raised from proximal to distal. During the process of flap harvest any other proximal perforator if detected are divided.

Seventh step- If two perforator are found close to each other than soft clamp is applied and after 15 minutes, flap perfusion is checked. If perfusion is adequate, then that perforator is divided.

Eight step –Perforator is dissected free from the surrounding facial strands.

Ninth step –Flap is rotated and perfusion is checked. In case of congestion flap in setting is not contemplated and flap is loosely attached to margin with some sutures.

Tenth step – After edema subsided in setting is completed. Post operatively limb is elevated.

**Figure 1: defect over tendoachilles**

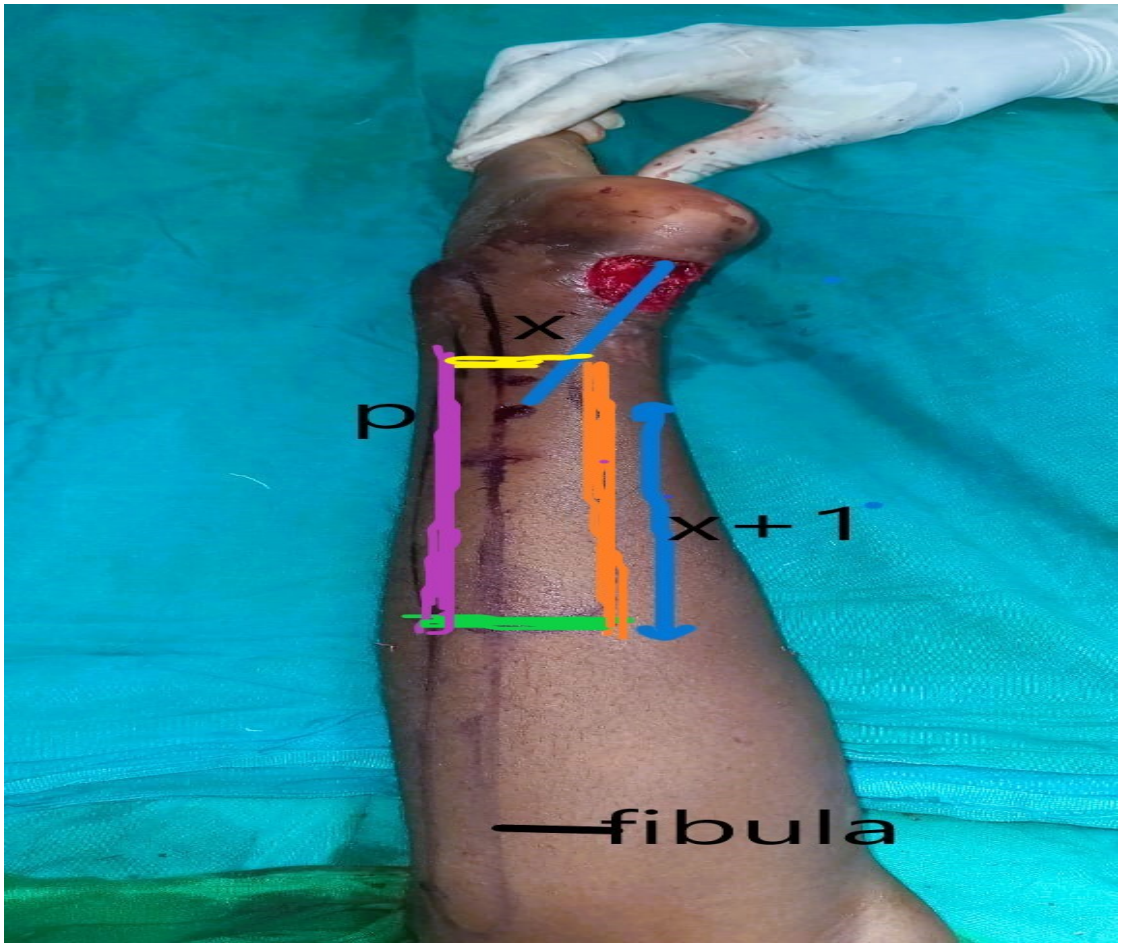


**Figure 2: x = distance from perforator to distal margin of the flap. p= pivot point. x+1= proximal limit of the flap**

Green border= proximal boarder of the flap which will be propelled to reach distal margin of the defect. Yellow border= distal border of the flap which will be rotated to upper side. Brown border= medial border of the flap purple= lateral border of the flap.

**Figure 3: skeletonisation of the perforator**

**Figure 4: intra operative picture after final inset**

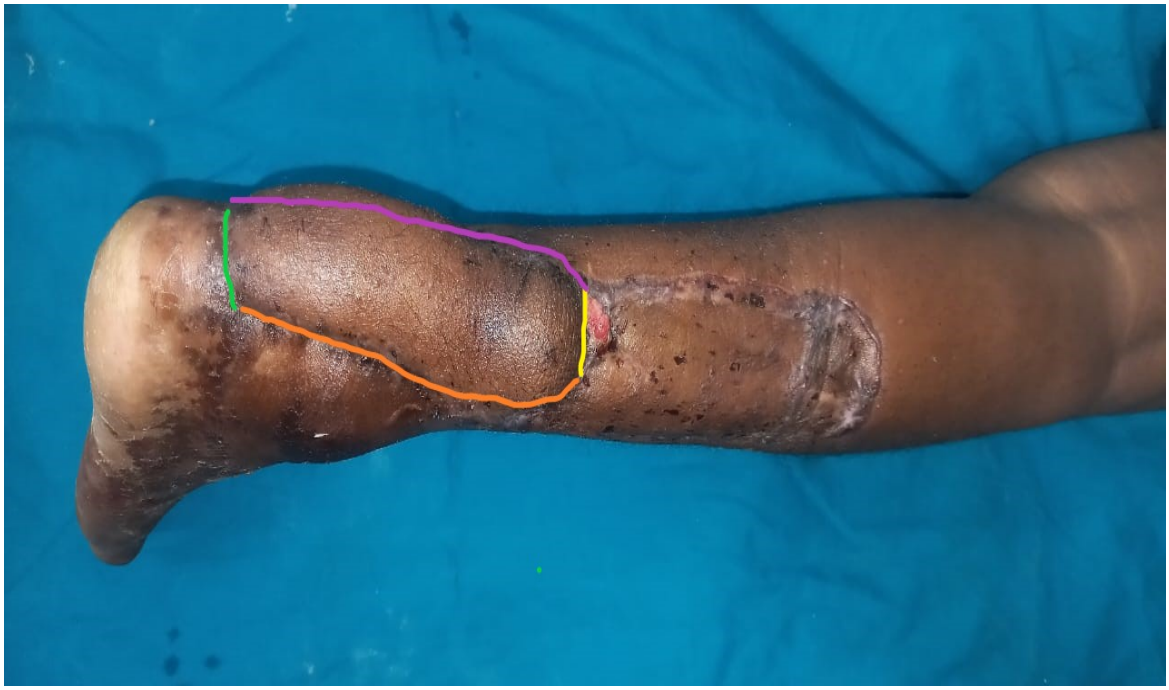

**Figure 5: Three month follow up. Note the green border now comes to lie at the distal end of the defect. Yellow portion has come to lie at proximal end of the defect. Lateral border of the flap finally occupies the medial border and medial border of the flap becomes the lateral border.**

**Result:**

There were 24 peroneal perforator flap harvested in the study period. Flap success rate 91.66 %. One flap had complete necrosis. One flap had superficial necrosis which was managed conservatively. The average location of perforator was 9.19 cm from lateral malleolus with SD of 1.3 cm. Age ranged from 15 to 48 years. Flap size ranged from 30 $cm^2$ to 180 $cm^2$. Male: Female ratios were 3:1. There was no donor site morbidity. Time taken for surgery was 55.58 minute with SD 10.19 second. All patients have satisfactory functional outcome.

**Discussion**

According to Tokyo consensus of propelllar flap, perforator flap is composed of skin or subcutaneous tissue that is supplied by one (or more) perforator blood vessels that branch from a deeper blood vessel. The isolated perforator is freely dissected from the surrounding tissue enabling the flap transposition. Simple transposition of the flap is sufficient in some cases, but when the flap needs to be rotated by more than 90°, it is usually deployed in the manner of a propeller with the perforator used as the axis of rotation, which is called a propeller flap [10] Venous congestion is the most common complication of propeller flaps, and is one of the main causes of flap necrosis. Necrosis mainly occurs at the distal end of the flap, but may lead to necrosis of the entire flap in severe cases. Flap necrosis rate ranges from 10.77% to 24.00 %. [11, 12, 13, 14] Propeller flap necrosis is mainly determined by flap size, pedicle length, and angle of rotation [10, 15]. After the flap is rotated, if the length of the large paddle is less than the desired dimension the flap is stretched resulting in excessive tension of the vascular pedicle. In addition, flap rotation and other factors increase the risk of venous return disorder.

Perforator position also affects the flap survival. Closer the perforator is to the wound, the greater is chance that perforator is surrounded by scarred tissue resulting from post-traumatic inflammation. This scarring prevents the skeletonisation and free rotation of perforator and increases the chance of venous congestion. [16]

Timing of surgery also affects flap survival. As inflammation peaks at 7–12 days after injury, optimal time for wound cover is either before or after this period. Once the wound enters to phase of chronic inflammation there is fibrosis of the surrounding tissue which obliterates the tissue planes. Flap harvest becomes difficult and chances of kinking of veins by scar tissue also increase.

Previous studies have also shown that the flap width affects the survival of the flap, as the anastomoses between the perforators of the main blood vessels in the calf are almost all choke anastomoses [17]. Therefore, the wider the flap, the farther the edge of the flap will be from the axis of rotation, and the greater the decrease in the diameter of the vascular network and the pressure of the blood flow; furthermore, due to the special anatomical structure of the lower leg, when the flap position is lower, the wider edge of the flap approaches or even surpasses the

midline of the front and rear of the calf, which directly leads to partial necrosis of the flap

The next factor affecting propeller flap necrosis is the length of the vascular pedicle. Length of the pedicle and tension on the pedicle are inversely related. When pedicle is short, there is excessive local tension due to traction, which impairs venous return. Perforator should be dissected for a length of at least 3 cm and a width of at least 1 mm [18] to reduce the risk of twisting and kinking of blood vessel.

The caliber of the blood vessel must also be considered. Preoperative Doppler examination must be performed to locate the perforator position and select a perforator with a suitable caliber as the direct nutrient vessel for the flap [19]

Next factor affecting propeller flap necrosis is the flap rotation angle. The chance of flap necrosis increases as the rotation angle increases from 90 degree to 180 degree. Perforating vessels, especially the perforating veins, are easily compressed by the surrounding deep fascia fiber bundles due to their thin wall and low pressure [20]. Complication rate of propeller flap reconstruction is higher in the extremities than in the trunk. This is because the trunk has relatively abundant perforators and large perforator areas connected by blood vessels, which may aid in the safe harvest of flaps, thereby reducing the incidence of complications [14]

Some authors have suggested that inclusion of two perforators may increase the chance of venous congestion as there is chance of twisting of pedicle. But release of perforator from surrounding facial stand and release of septum from fibula increase the flap mobility and in three of our cases we have retained the septum between the two perforator and flap was rotated. This has not adversely affect the flap survival. It has minor folding of skin at the marking which settled down after two weeks without much of cosmetic deformity. However, we have not statistically analyzed the effect of single perforator or double perforator on flap survival. Morris et al. [21] that a perforating vessel of 0.7 cm provides an approximate irrigation of 47 $cm^2$ and may even have a broader extension as described by Gir et al. [22] of 67.1 $cm^2$

The average location of perforator was 9.19 cm from lateral malleolus with SD of 1.3 cm. Our study result is similar to finding by Wei et al. [23]

In our study, we found complications 8.33 %, which is lower than that reported in the meta-analysis performed by Gir et al [22] reporting complications of 25.8%

In our series flap survival rate was 91.5 % which was comparable to other studies [22,]. Average time taken for flap harvest was 55 minutes. High success rate of flap survival in our series was due to multiple factors. We operated after week weeks in all cases. In our set up where patients are primarily treated by orthopedic surgeon, they refer the patients usually after 7 to 10 days. We assess the wound. Debridement is done whenever required. We think radical debridement avoid infection in the wound bed. All the cases were done in elective operation theatre. Perforator is identified by hand held Doppler. We meticulously dissect the perforators, skeletonize it. Post operatively we elevate the limb. While doing dressing we avoid pressure in the pedicle of the flap. Close monitoring of the flap is done for early detection of color change or marked edema. With early detection of brisk bleeding sutures are released from on the periphery and wound is left open for late secondary sutures after edema subsides will help to prevent progression of venous congestion. If congestion is established, flap massage from the periphery toward the center is described. Bleeding therapy by small incisions of 5 mm with application of heparin soaks will allow bleeding from the flap with close monitoring of blood pressure. Other methods to prevent flap necrosis involves early surgical exploration for further pedicle dissection, evacuation of any hematoma, and supercharging with microsurgical venous anastomosis to a recipient vein to increase venous drainage.

Wound infection remains a considerable complication although it does not directly endanger the flap viability. Proper use of perioperative aseptic techniques and culture based antibiotics will reduce the risk of surgery site infection.

## Conclusion

Peroneal perforator flap is safe and effective for small to medium size defect of the lower extremity. It can be harvested within one hour. It has fewer adverse defects, fewer complications. It should be considered in the reconstructive option for coverage of small to medium size defects of the lower extremity.

## References

1. Yoshimura M, Imura S, Shimamura K, Yamauchi S, Nomura S. Peroneal flap for reconstruction in the extremity: preliminary report. Plast Reconstr Surg. 1984; 74(3):402–409.
2. M. Innocenti, I. Dell'Acqua and M. Famiglietti et al., Free perforator flaps vs propeller flaps in lower limb reconstruction: A cost/effectiveness analysis on a series of 179 cases, Injury, https://doi.org/10.1016/j.injury.2019.10.039
3. Soltanian H, Garcia RM, Hollenbeck ST. Current concepts in lower extremity reconstruction. PlastReconstrSurg 2015; 136:815e–829e. .
4. Ribuffo D, Atzeni ML, Guerra M, et al. Clinical study of peroneal artery perforators with computed tomographic angiography: implications for fibular flap harvest. AnatClin. 2010; 32(4): 329–334.
5. Koh K, Goh TLH, Song CT, Suh HS, Rovito PV, Hong JP, Hallock GG. Free versus Pedicled

Perforator Flaps for Lower Extremity Reconstruction: A Multicenter Comparison of Institutional Practices and Outcomes. J Reconstr Microsurg. 2018 Oct;34(8):572-580.
6. [6] Koshima I, Moriguchi T, Ohta S, Hamanaka T, Inoue T, Ikeda A. The vasculature and clinical application of the posterior tibial perforator-based flap. PlastReconstrSurg 1992; 90:643–649. Back to cited text no. 2
7. [7] Chen YL, Zheng BG, Zhu JM. Microsurgical anatomy of the lateral skin flap of the leg. Ann Plast Surg 1985; 15:313–318. Back to cited text no. 8
8. [8] Hansen T, Wikstrom J, Johansson LO, Lind L, Ahlstrom H. The prevalence and quantification of atherosclerosis in an elderly population assessed by whole-body magnetic resonance angiography. Arterioscler Thromb Vasc Biol 2007; 27:649–654. Back to cited text no. 9
9. Khan UD, Miller JG. Reliability of handheld Doppler in planning local perforator-based flaps for extremities. Aesthetic Plast Surg. 2007;31:521–525.
10. Pignatti M, Ogawa R, Hallock GG, et al. The "Tokyo" consensus on propeller faps. PlastReconstr Surg. 2011;127(2):716–22.
11. Nenad T, Reiner W, Michael S, et al. Saphenous perforator fap for reconstructive surgery in the lower leg and the foot: a clinical study of 50 patients with posttraumatic osteomyelitis. J Trauma. 2010;68(5):1200–7.
12. Dai JZ, Chai YM, Wang CY, et al. Distally based saphenous neurocutaneous perforator fap for reconstructive surgery in the lower leg and the foot: a long-term follow-up study of 70 patients. J Reconstr Microsurg. 2013;29(7):481–6.
13. Hifny MA, Tohamy AMA, Rabie O, et al. Propeller perforator faps for coverage of soft tissue defects in the middle and distal lower extremities. Ann Chir PlastEsthet. 2020;65(1):54–60.
14. Gunnarsson GL, Jackson IT, Westvik TS, et al. The freestyle pedicle perforator fap: a new favorite for the reconstruction of moderate-sized defects of the torso and extremities. Eur J Plast Surg. 2015;38:31–6.
15. Bekara F, Herlin C, Mojallal A, et al. A Systematic Review and Meta Analysis of Perforator-Pedicled Propeller Flaps in Lower Extremity Defects: Identifcation of Risk Factors for Complications. PlastReconstr Surg. 2016; 137(1): 314–31.
16. Panse N, Sahasrabudhe P. Free style perforator based propeller faps: Simple solutions for upper extremity reconstruction! Indian J Plast Surg. 2014; 47(1):77–84.
17. Gascoigne AC, Taylor GI, Corlett RJ, et al. The relationship of superfcial cutaneous nerves and interperforator connections in the leg: a cadaveric anatomical study. Plast Reconstr Surg. 2017;139(4):994e–1002e.
18. Wong CH, Cui F, Tan BK, et al. Nonlinear fnite element simulations to elucidate the determinants of perforator patency in propeller faps. Ann Plast Surg. 2007;59(6):672–8.
19. Wong JKF, Deek N, Hsu C-C, et al. Versatility and "fapefciency" of pedicled perforator faps in lower extremity Reconstruction. J PlastReconstrAesthet Surg. 2017;70:67–77.
20. Demir A, Acar M, Yldz L, Karacalar A. The efect of twisting on perforator fap viability: an experimental study in rats. Ann Plast Surg. 2006;56(2):186–9.
21. Morris S, Tang M, Geddes CR. Bases anatómicasvasculares de los colgajosperforantescutáneos. Cir PlástIberlatinamerDic. 2006; 32:225–236.
22. Gir P, Cheng A, Oni G, Mojallal A, Saint-Cyr M. Pedicled perforator (propeller) flaps in lower extremity defects: A systematic review. J Reconstr Microsurg 2012; 28: 595–601.
23. TC L, Lin CH, Lin CH, Lin YT, Chen RF, Wei FC. Versatility of the pedicled peroneal artery perforator flaps for soft-tissue coverage of the lower leg and foot defects. J Plast Reconstr Aesthet Surg. 2011;64(3):386–393.