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Research Article

A CLINICAL STUDY OF PROPELLER FLAP – FOR RESURFACING OF LEG

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A R T I C L E I N F O

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A B S T R A C T

In the era of microvascular surgery, defects of distal third of leg still continue to be waterloo of plastic surgeons to provide a functional, durable and stable cover. Propeller flaps are a reliable source of 'like with like' soft tissue replacement. A prospective clinical study on propeller flaps was made between January 2020 to March 2021, in patients with soft-tissue defects of the middle and distal third of the leg. A total of 50 patients were studied and followed up for 12 months. During follow up, venous congestion was found to be the most common complication, observed in 12 patients (24%). Other complications were marginal necrosis of flap seen in 6% patients and suture line dehiscence was seen in 2% of patients. All the patients were followed up for 12 months post-operatively. Propeller flaps are pedicled flaps with a short learning curve, which are more reliable with better cosmetic appearance. They can be elevated based on all three major vessels of lower limb. They are excellent reconstructive option for coverage of leg defects and provide results comparable to that of free flaps.

INTRODUCTION

Soft tissue reconstruction of the middle and lower third of the leg is challenging. Inherent characteristics of the leg, paucity of the soft tissue, bony prominences, and biomechanics, makes even the simple defects is a major challenge. The cross leg flap popularized by Stark, has very high morbidity of donor site and prolonged immobilization was cumbersome to the patient. Although free microsurgical flaps have been the first choice for the reconstruction, microsurgical facility is not available for all the centres. The propeller flap is the good choice for resurfacing the leg. It is further modified and skeletonising perforator vessel helps in rotating 180 degrees on an eccentric pivot point. Easy of harvest, simpler technique, great freedom in design, avoid in sacrificing major limb vessel and lesser donor site morbidity makes propeller flaps are the attractive alternative for the free flaps for reconstruction of leg defects. Our overall experience in addressing soft tissue defects of mid and lower third leg with propeller flaps and its functional outcome are discussed in this article.

MATERIAL & METHODS

A prospective study was made between January 2020 to June 2021 of the propeller flaps done by the authors in IRRH & DPS Stanley hospital plastic surgery department, Chennai, in patients with soft-tissue defects of the mid-distal third of the leg. Patients with mid to lower third of leg defects as a squeal to trauma in the age group of 18 to 60 years included in our study. Post infective soft tissue defects, children and very old age population not included in our study. This study was approved in Institutional ethical committee. Proper informed consent was obtained and each patient was provided with the explanation of the procedure and post operative care. Follow up done for 6 months postoperatively.

- The process of selecting the vascular axis of the leg (anterior tibial artery, peroneal or posterior tibial artery), on which to base the perforating vessel of the propeller flap, was done by preoperative examination with a Nicolet handheld Doppler with a 8-Mhz probe, with an angulation of the probe of approximately 45degrees to the skin surface, according to the location of the defect to be covered. A provisional flap design can be drawn as follows, with the perforator as the pivot point of the flap.
- First, the distance between the perforator and the distal edge of the defect is measured. This value is then transposed proximally along the axis of the main source vessel, again measured from the perforator, and 1cm is added. This value forms the proximal limit of the flap. Next, the width of the proximal flap needed to cover the defect is determined by measuring the width of the defect. This value is then used to determine the proximal flap width, adding 0.5cm to allow for flap contraction and to facilitate its inset without tension. The lateral dimensions are equidistant to ensure that when the flap is eventually rotated around to fill the defect, there is no excessive sideways traction on the perforator during wound closure.

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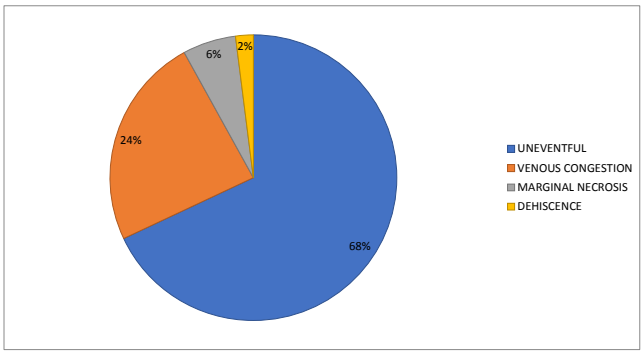
- We performed a first longitudinal skin incision on 1 of the margins of the flap to observe the perforator localized preoperative with the handheld Doppler. The distance of the perforator from the proximal edge of the defect determined the length of the minor paddle used to cover or partially cover the donor site. Donor site was closed with SSG.

RESULTS

A total of 50 patients were studied. Venous congestion was observed in 12 patients. Most of the venous congestion occurred in 3rd to 5th post-operative day which was treated with strict limb elevation, dependant drainage and removal of offending sutures. 1 case was treated with multiple punctures. Marginal necrosis of flap was seen in 3 patients. They were managed by debridement and secondary split-skin grafting. Suture line dehiscence was noticed in 1 patient due to bulky flap. It was managed conservatively. Subsequently settled on 15th post-operative day. All the patients were followed up for 6 months post-operatively. Flap settled well with better cosmetic appearance.

Complications



DISCUSSION

The term “propeller flap” was first used in 1991 by Hyakusoku, to describe an adipocutaneous flap based on a central subcutaneous pedicle, with a shape resembling a propeller that was rotated 90 degrees. In 2006, combining the concept of propeller flaps and perforator based flaps, Hallock reported a fasciocutaneous flap that was similar in shape to the one described by Hyakusoku but was based on a skeletonized perforating vessel and was rotated 180 degrees on an eccentric pivot point. Teo gave the greatest contribution to the surgical technique and the application of the perforator propeller flap. In the last years, the introduction of the propeller flaps gained great popularity; these flaps have been increasingly used for reconstruction of soft tissue defects of different parts of the body, especially in leg defects where paucity of tissue makes reconstruction is a challenging one.

Perforator propeller flaps have a reliable vascular pedicle and can undergo wide mobilization and rotation; their harvest is fast and easy and does not require microsurgery; however, accurate patient selection, preoperative planning, and dissection technique are mandatory to prevent complications
A clear definition of propeller flap was given in 2009 by the advisory panel of the first Tokyo meeting on perforator and propeller flaps, who defined it as an “island flap that reaches the recipient site through an axial rotation.” The difference between a propeller flap and other pedicled flaps is that the rotation in the case of a propeller flap is “axial”: this means that the flaps turn around a pivot that is made of the pedicle and this is similar to a propeller. According to the Gent consensus on perforator flaps and to the advisory panel of the first Tokyo meeting on perforator and propeller flaps perforator propeller flaps should be named after their nutrient vessels.

They can be classified according to the type of nourishing pedicle.

1. Subcutaneous pedicled propeller flap is based on a random subcutaneous pedicle and allows for rotations up to 90 degree.
2. Perforator pedicled propeller flap is based on a skeletonized perforator pedicle. This is the most commonly used type of propeller flap and can be rotated up to 180 degree.
3. Supercharged propeller flap is modification of the perforator pedicled propeller flap, in which a superficial or perforating vein of the flap is anastomosed to a recipient vein or an extra artery is anastomosed to a second arterial pedicle of the flap, to increase venous outflow or arterial inflow.

Surgical Technique

Anaesthesia

Spinal or Epidural

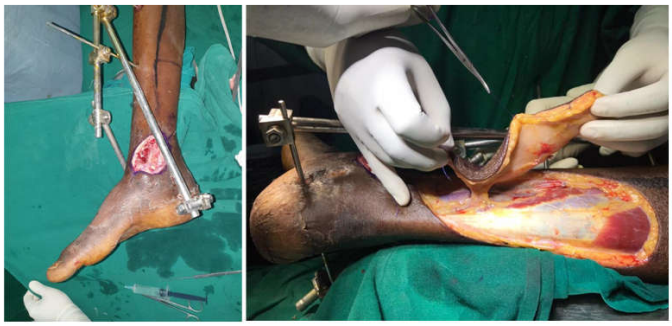
Preoperative Planning

A hand held Doppler probe is always sufficient for preoperative vascular assessment. The whole region should be investigated to have a clear preoperative picture of the location of all perforators or of the axial vessels. If a propeller axial flap is planned, identification of the vessel is easier because its position is mostly constant and well known. A flap is marked around the perforator with the best pulse and location (or around the axial vessel). Different options can be taken into account if more than one vessel is identified. An alternative flap is always planned as a “plan B.” An exploratory incision is planned without interfering with the alternative local flap(s) or such as to allow access to the recipient vessels, when plan B is a free flap. If possible, the skin incision is placed along previous scars or natural folds. Wide exploratory was made for accurate identification of perforators. The incision is our window to the perforator and must be wide enough flap Dissection.

Through the exploratory incision suprafascial or subfascial dissection under loupe magnification is used to identify all the perforators around the defect. Once all perforators have been identified, the best one is chosen based on caliber, pulsatility, course and orientation, number and caliber of accompanying veins, and proximity to the defect and to a sensory nerve (the biggest perforators usually accompany sensory nerves all over the body).Then, in cases of suprafascial dissection, the fascial opening is widened and the perforator is freed from any surrounding tissue and dissected as long as possible (up to the source vessel) in order to achieve an adequate length of the pedicle along which to distribute the torsion . Care should be taken in order to divide any attachment of the perforator to the surrounding tissues, like side branches (that must be ligated and not cauterized to avoid thermal damage to the perforator) or fibrous bands. As demonstrated by Wong , the risk of vessel buckling is decreased when, for a perforator of 1 mm diameter,

the vessel length is more than 3 cm. To prevent spasm, no tension must be placed on the perforator, which should be manipulated as little as possible. If needed, the flap is redrawn around the chosen perforator. Differently from traditional flaps, traditional length/width ratios do not apply to propeller flaps because the pedicle usually penetrates the flap around its central part: this means that a 25/5 cm flap should not be considered a 5/1 flap but rather a 3/1 plus a 2/1 flap. The possibility of achieving donor-site closure should be the main concern about flap size, rather than concerns about flap perfusion. If perfusion is deemed insufficient, the flap should be supercharged, whenever possible. For this reason, adequate length of superficial veins and of other perforators entering the flap must be preserved.

Flap Harvest



Flap Inset

Flap Insetting

A crucial step in warranting survival of these flaps is to wait for the circulation to settle before flap rotation for at least 20 minutes. After rotating the flap to its new position, its pedicle should be checked for twisting or buckling and further dissected if any limitation exists to an even distribution of the torsion. Clockwise and counterclockwise rotations are evaluated and the best one in terms of vessel rotation is chosen. The sense of rotation should be documented should the flap need to be re-explored. The flap is then secured in position and observed for color, capillary refilling, and bleeding. If insufficient arterial inflow is observed due to arterial spasm caused by surgical manipulation, the flap should be brought back to its original position until spasm resolution (usually about 20 minutes) and its pedicle rinsed with lidocaine. If the spasm persists after derotation, the flap should not be transferred anyway but rather left in place and delayed a few days before wound coverage.

Perforator Identification

Propelling the flap

Postoperative care

Limbs should be kept in a splint for the first postoperative days; compression on the flap should be avoided and elevation should be maintained for limbs flaps. Flaps are checked every second hour during the first postoperative days, to allow for prompt identification of eventual complications. Limb elevation maintained and POP maintained for 10 days. Suture removal on 10th post operative day.

CONCLUSION

Propeller flaps are pedicled flaps which are more reliable with fewer complications. Short learning curve. They can be elevated based on all three major vessels of lower limb. They are an attractive alternative to free flaps. In case of co-morbidities like malignancy and poor general condition, post excision defects can easily be covered with propeller flaps. These are good option flaps for defect extending from knee to foot of various sizes.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Author contributions

1. PSG – Forming the Concept, Participant recruitment, Surgical intervention, Outcome assessment, Final proof,
2. BS – Intervention / Surgery, Data collection, Abstract formation, Outcome assessment, Manuscript Preparation, Data analysis, final proof.
3. KB – Conceptualization, Data Analysis, Final proof.

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