

Case Report

Pelvic limb reconstruction failed by propeller flap resolved with microsurgery

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ABSTRACT

Reconstruction of lower limb defects is a constant challenge for surgeons, the etiology of the defect can be very variable from diabetic ulcers, traffic accidents, fall from height, oncological resections and many others. Free flaps have always been an important option because it has great results in complex reconstructions in lower limbs, it is a microvascular technique, so it has a higher level of complexity. This technique is usually reserved for extensive perilesional wide defects. On the other hand, the propeller flap, which is considered less invasive and easier as it does not involve microvascular surgery. An 18-year-old patient who had a fracture of the right tibial pylon due to a 7-meter drop, who after orthopedic treatment had a defect with exposure of osteosynthesis material of 3 cm in circumference in the medial malleolus. This defect was first managed with a propeller flap complicated with necrosis at 48 hours which was treated with sub atmospheric pressure system for 5 days and later with an ultra-thin anterolateral flap of the pelvic limb. Complete pedicled propeller flap failure is very rare but, because necrosis develops distally, even partial necrosis can expose bone, tendons, or other tissue. Some surgeons consider that propeller flap placement is risky in this location, especially the distal third of the lower leg a prefer to use free flaps. Whenever any pelvic member reconstruction plan fails in the distal third, the best and safest is the use of microsurgery even with the failure of a previous micro vascular flap.

Keywords: Flap loss, Fasciocutaneous flap, Island flaps, Lower limb reconstruction, Local flaps, Microvascular flap, Pedicled flap

INTRODUCTION

Skin defects in the distal third of the leg are difficult to treat, since the bones are very superficial and have poor

muscle coverage. This implies that it is very difficult to reconstruct by means of local flaps (rotation and/ or advance flaps), in addition on some occasions the bone and the osteosynthesis material are exposed. Two

therapeutic alternatives have been proposed for the recovery of skin defects in the distal third of pelvic limb: propeller flaps and microsurgery. Propeller flaps allow bringing proximal skin distally to cover average size defects that would otherwise require a free flap. Free flaps are still the gold standard for large defects, but propeller perforator flaps are an appealing option for small and medium defects.¹

Skin defects in lower limbs can be commonly managed with free flaps,² although due to the greater vascular anatomical knowledge, different strategies have been implemented such as the propeller perforator flaps that is commonly used in small wounds and compared to the free flap is less invasive, technically simple and effective.³ Hyakusoku et al. first used the term ‘propeller flap’ in 1991, describing two subcutaneous pedicled island flaps, vascularized by a perforator artery in the center and rotated 90°, for the reconstruction of skin scar contractures in burn patients.⁴

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.^{1,5} The ability to rotate the propeller perforator flaps up to 180°, which we performed in 82% of the cases, makes it extremely versatile to reconstruct defects of the middle and distal third of the leg, as has been reported in other series.^{4,7}

Reconstruction of lower limb defects has always been a challenge, since it is known for poor wound healing and scarce source of flaps for reconstruction. Nevertheless, it is a fundamental topic since it has lots of indications, such as reconstruction of traffic accident defects, fall from height, oncological resections, burns, post infection cellulitis debridement and many more. There are two main ways to reconstruct lower limb defects, free flaps and propeller flaps.⁸ Free flaps have been reserved for cases with extensive perilesional scarring and medium or large sized defects, as it requires microsurgical reconstruction this is a much more complex technique.⁹

Some of the flaps that can be used are: Latissimus dorsi, anterolateral thigh, rectus abdominis, gracilis and anterior serratus. The overall failure of free flaps is 3.9%.⁹ Propeller flaps requires microsurgical dissection but does not require vascular anastomosis, thus they can be defined as microsurgical no microvascular flap. Avoiding vascular sutures make the surgical act quicker in comparison with microvascular flaps. Some of the advantages of this technique include versatility as the flap may be selected on the perforary artery according to the defect type.⁸

Table 1: Comparison between free flap versus propeller flap.

	Free Flap	Propeller Flap
Indications	Extensive perilesional scarring Wide defects Sparse local tissue Important devascularization of tegument with subdermal and supra-fascial plexus injuries	Medium sized defects Small defects Local tissues in good conditions Elderly patients Patients who cannot undergo microsurgical procedure
Frequent Applications	Reconstruction of lower limb defects, knee, ankle and foot	
Complications	Partial necrosis 2.7% Infections 4.45% Hematoma 2.88% Wound dehiscence 2.38%	Partial necrosis 6.8% (p=0.001) Infection 1.22% (p=0.009) Hematoma 1.21% (p>0.05) Wound dehiscence 0.26% (p>0.05) Venous congestion Vascular insufficiency
Etiology of defect	Posttraumatic, oncological resection, chronic ulcer, postoperative complications, osteomyelitis, pressure sores, burn injuries, diabetic ulcer, unstable scar, burns	
Considerations	Shorter healing time Better global aesthetic results Less partial necrosis Needs microvascular anastomosis	Simpler Less invasive Preserves main vascular trunks, nerves and muscles Avoids need for micro anastomosis
Coverage Failure Rates	Partial necrosis is quite rare and does not develop above the elements for which coverage is most important	Failure is very rare but because necrosis develops distally, even partial necrosis can expose bone, tendons or other tissue

Indications for propeller flaps

Indications for propeller flaps are small or medium-sized defects located in a well-vascularized area with healthy surrounding tissues. This reconstructive technique can be performed with a single-stage approach. More than vascularity and traditional length/width ratios, the most important factors to consider are the quality and volume of the soft tissue transferred, scar orientation and, above all, proper planning of the flap, in order to allow direct donor site closure without tension in the area. When these indications were respected, propeller flaps showed great success rate with low morbidity, quick recovery, good aesthetic outcomes and reduced cost.¹⁰ Increased knowledge of vascular anatomy allowed for refinements in reconstructive strategy and flap harvesting techniques.¹¹⁻¹² Recently, propeller perforator flaps have gained popularity as a reconstructive tool for lower limb defects of average size; compared with free flaps, propeller perforator flaps are considered simpler and less invasive, although effective.^{5,13,14} Which option to choose? Both techniques have advantages and disadvantages, as well as indications, for which we have created a comparative table to pick the option that will

best fit outpatient (Table 1).^{6,8,9} Authors do not see it as a step treatment, we consider the concept of “reconstructive elevator” favoring the use of more complex reconstruction if it favors the patient context.

Complications

Partial or complete flap necrosis

The inclusion of scar tissue in the flap design may be associated with a partial necrosis. or excessive tension in the closure of the defect.¹⁵ This is why sometimes recommended the laminar skin graft for the donor site of the flap, which will always become a more common option as the defect is more distal, due to the lack of displacement of the tissues in the leg, as we did in 14.3% of the cases.¹⁶ Full flap loss rates appear to be approximately 5% with partial flap loss rates being approximately 11%.¹⁷ One option of treatment is delay technique, in which the flap is transferred to its initial position on day 1 postoperatively and retransferred to the defect on day 21 after the initial operation. The propeller flap complications are shown in Table 2.

Table 2: Propeller Flap complications.

Complication	Diagnosis	Treatment
Complete or partial flap necrosis	Color changes, clear signs of necrosis	Salvage surgery for poor circulation postoperatively using delay technique Debridement Healing by secondary intention Microsurgery
Infection	Systemic inflammatory response syndrome	Broad spectrum antibiotics
Venous congestion	Patency in distal venous anastomosis can be checked with acoustic Doppler	Negative pressure wound therapy Secondary Healing
Edema or swelling	Skin ischemia or flap congestion	Release the sutures

Venous congestion

It is the major postoperative complication and the primary cause of flap necrosis, the perforator venous wall is much thinner than the perforator arterial wall, so it has greater chance of venous congestion when rotated up to 180°. ^{8,18} Venous insufficiency should be distinguished from the temporary congestion that often characterizes perforator flaps and fades out with stabilization of flow.

True venous insufficiency worsens with time and should be promptly recognized and treated. A small number of cases evolve in necrosis, so that deep vital tissue is still present at the recipient site. Cases of mild venous congestions in thin flaps can be addressed with venous hygiene therapy.

A precise preoperative plan, proper pedicle processing, and flap design can reduce the rate of venous congestion.¹⁸ Depending on the degree of vein insufficiency, it can be solved with a conservative treatment and secondary healing, or if it is significant and worsens over time, reexploration an venous supercharging are the best option. Should venous supercharging not be feasible, an alternative option is to temporarily derotate the flap (a few days) to relieve torsion on the pedicle and let the circulation settle.^{1,9,13,19.}

Edematous and swollen flap

If the sutures are too tight within the first 24 to 48 hours the flap can become edematous and swell, at these time stitches can cause constriction. Physicians should check for any skin

ischemia or flap congestion caused by stitches and release the sutures in case of bad evolution.^{20,21}

Partial or complete skin necrosis

The proximal part of the flap which is used for defect coverage sometimes suffers from partial skin necrosis due to venous congestion. This can be prevented with adequate dissection, loose suturing, post-operative drainage and massage.²² An important part of distal necrosis can be managed by secondary intention healing.²¹ If it is severe it may need a second reconstruction.¹⁰

Arterial Insufficiency

This complication is extremely rare: accurate planning of the flap and choice of the perforator help preventing it. When, due to persistence of arterial spasm, the flap remains pale due to insufficient arterial inflow, the flap can be derotated to its original position for a few days before rotating it.^{1,13,19}

Propeller Flap Failure. What now?

Complete pedicled propeller flap failure is very rare but, because necrosis develops distally, even partial necrosis can expose bone, tendons, or other tissue. Bekara et al. 2018 reported a weighted coverage failure rate of 5.24%. Some surgeons consider that propeller flap placement is risky in this location, especially the distal third of the lower leg a prefer to use free flaps.⁹

D'Arpa et al. in their series of 85 patients, performed venous anastomoses on two forearm propeller perforator flaps when the flaps were complicated by venous congestion soon after surgery.¹³ Other rescue measures or procedures used in flap complication or total failure can be: stitches removal, leeches, puncture and dressing heparinization, and flap derotation. The election of the procedure will be based on the context of the patient as well as the available resources.²⁰

CASE REPORT

For 18-year-old male patient, lends a fracture of the right tibial pylon due to a 7-meter drop, was admitted to the National Rehabilitation Hospital by the Traumatology Department, division in microsurgery. For the treatment of the fracture, an open reduction with internal fixation was performed 10 days after hospitalization (due to the intense soft tissue damage). Skin defect was observed with exposure of osteosynthesis material, 3 cm in circumference in the medial malleolus. (Figure 1)

So it was decided to perform flap in propeller, which evolved satisfactorily but presented necrosis of the distal edge at 48 hours, reason why which was removed leaving sub atmospheric pressure system as temporary coverage for 5 days.

Subsequently, it was scheduled for reconstruction with an ultra-thin anterolateral flap of the left pelvic limb, Figure 2, which evolved satisfactorily Figure 3.



Figure 1: Propeller flap. (A) Propeller flap marking. (B) Approach of the cutaneous defect of the medial malleolus where bone exposure can be seen. (C) Cutaneous coverage through the rotation of perforating flap (propeller flap).

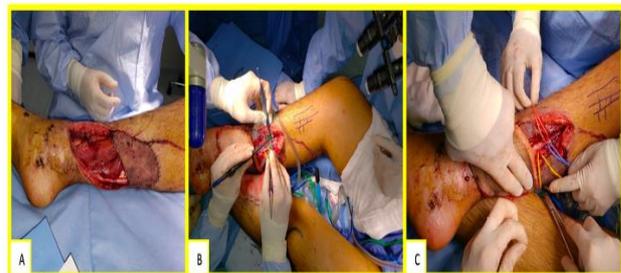


Figure 2: Residual skin defect, flap necrosis and new anastomosis. (A) Residual skin defect, after removal of flap necrosis, the adequate integration of the full thickness skin graft is observed in the proximal part of the skin defect. (B) and (C) Anastomosis of the anterolateral thigh flap thinned to the posterior tibial vascular package.



Figure 3: Final result 7 days after surgery. (A) Final result 7 days after surgery. (B) Adequate documented flows with acoustic doppler.

DISCUSSION

In lower limb reconstruction, defects of the lower third of the leg are a challenging problem, due to the paucity of local tissues available for reconstruction.¹⁹ In 2016, A. Sisti et al, performed a literature review based on clinical studies using propeller flaps as a reconstructing technique. Overall, 1,315 propeller flaps were reported in 1,242 patients. Complications were observed in 281/1242 patients (22.6%) occurring more frequently in the lower limbs (31.8%). Partial flap necrosis and venous congestion were the most frequent complications. The complications' rate was significantly higher in infants (<10 years old) and in the older population (>70 years old).²¹ It has been shown that propeller flap may be useful in the reconstruction of lower limbs but some groups do not consider it as the first treatment option since there are no differences between PPF and free flaps.³ Therefore, its use must be careful, selecting patients according to the size of the wound, location, contamination, type of wound, morbidity of the donor site, type of bone fixation and aesthetic results.^{22,23} The application of the pedicle perforator flaps and its propeller variant for leg reconstruction has many advantages. The main artery and underlying muscle are preserved, and the need to perform a microsurgical anastomosis is avoided.¹⁶

Dissection of the flap is relatively fast, and it has the thickness, texture, and pigmentation of the site that has been lost, replacing with the "like with like" principle.²⁴ Based on the results obtained in our study, we consider that perforator propeller flaps are ideal in reconstructing small-medium defects of the middle and distal third of the leg, being safe, easy to perform, providing similar tissue in texture and thickness of damaged tissues, with low donorsite morbidity.¹⁶ As reported by D'Arpa et al., free flaps are still the gold-standard for large defects in lower limb, but propeller perforator flaps are an appealing option for small and medium defects, especially at the level of the lower leg and foot.^{1,10}

CONCLUSION

As the anatomical/ vascular knowledge increases and the human resources and supplies in microsurgery increase, the concept of reconstructive elevator will be used more and the reconstructive ladder discarded. The main objectives in the reconstruction of the pelvic limb are: adequate skin coverage, stable coverage, use of footwear, less expensive, restore movement and sensory functions in less than 15 days.

Whenever any pelvic member reconstruction plan fails in the distal third, the best and safest is the use of microsurgery even with the failure of a previous micro vascular flap.

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