

Bipedicle flaps - A Simple & Effective Mode of Coverage of Defects in the Leg and Foot: A Retrospective Case Study

Dinesh Chaudhary¹, Ashutosh Soni^{2*} and Kumawat JL³

¹Final Year General Surgery Resident, Geetanjali Medical College and Hospital, India

²Professor and Head, Department of Plastic and Reconstructive Surgery, Geetanjali Medical College and Hospital, India

³Professor, Department of General Surgery, Geetanjali Medical College and Hospital, India

*Corresponding author: Ashutosh Soni, Professor and Head, Department of Plastic and Reconstructive Surgery, Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India, Tel: 0294 250 0000; E-mail: dravsoni@yahoo.co.in

Received: June 27, 2023; Accepted: July 24, 2023; Published: July 31, 2023

Abstract

The bi-pedicle flap is designed adjacent to the defect and is advanced into the defect. This leaves a secondary defect that usually must be repaired with a split-thickness skin graft. The bi-pedicle technique in limbs has been refined to a single stage procedure. The commonest uses in limbs are trauma, tumor resection, peripheral vascular disease and diabetes. The objective of this study was to show the use and effectiveness of bipedicle flaps for coverage of defects in the leg and foot, their utility, advantages and merits. The bi-pedicle flaps are random flaps with blood supply from both ends of the flap. These flaps are safe, simple to raise and provide an effective coverage with lesser donor site morbidity or defects. Moreover, there is no need to delay these flaps or there are requirements of any special instruments like a microscope or deep skills as in microsurgical free flaps. The final appearance of these bipedicle flaps is also very acceptable due to use of adjacent local tissues.

Keywords: *Bipedicle flaps; Coverage; Defects; Exposed bone*

1. Introduction

Open wounds with exposed bones and fracture sites or exposed implants like plate and screws in lower and upper limbs are common problems requiring the intervention of the plastic and reconstructive surgeon for its coverage with a large plethora of available flaps and methods that include fasciocutaneous, muscle, myocutaneous and free flaps [1].

Citation: Chaudhary D, Soni A, Kumawat JL. Bipedicle flaps - A Simple & Effective Mode of Coverage of Defects in the Leg and Foot: A Retrospective Case Study. Clin Case Rep Open Access. 2023;6(3):265.

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Complex, lower extremities, soft tissue defects pose a significant challenge to the reconstructive surgeon and often require the use of free flaps, which puts significant demands on the patient, the surgeon and the health-care system. Bipedicled flaps are random but receive a blood supply from two pedicles, allowing the surgeon to use local tissue with an augmented nutrient blood flow. They are simple to elevate and economical in operating time. This study describes our experience with lower extremities wound reconstruction using the bipedicle flap as an alternative to pedicled flaps, free flaps [1].

The reconstruction of open tibia fracture accompanied by bone and soft tissue defects is difficult because such regions have poor circulation and insufficient local surplus skin, making reconstruction options limited. For the reconstruction of these defects, various local fasciocutaneous muscle flap and free flap options are available. Because of short operation duration, not involving multiple surgical areas, and low cost, local flaps are simple and favorable. In addition, local flaps can be alternatively used in older patients with co-morbidities for whom free flaps are not suitable. Among these local flap options, bipedicle flaps provide sufficient tissue for small- and medium-sized defects, have a constant circulation, are easy and rapid to harvest, and have reasonable donor site morbidity [2].

The commonest causes of large open wounds in the lower limbs are trauma, tumor resection, PVD and diabetes and cellulitis. The indications for the use of this flap have not been well defined and with the advent of more complex modes of tissue transfer this simple technique is often overlooked [3].

Moreover, these flaps are simple easy to raise and don't require any sophisticated instruments or technique as in free flap coverage and this simplicity adds more to their routine induction in the augmentation of the reconstructive surgeon as a preferential choice of flap [4,5].

2. Material and Methods

Our study shows result of 43 patients who underwent bipedicle flaps for reconstruction in leg and foot defects with exposed bone, fracture site or exposed tendons, implants in the leg and foot region were operated by us in our institute during January 2017 to December 2020.

Most of patients 39 were referred to us by the orthopedicians and surgeons, 4 patients came by self on exposure of bone, implants or fracture sites.

All patients were evaluated and underwent routine preoperative investigations.

A course of broad-spectrum antibiotics was started 1-3 days prior to all surgeries as majority of our patients had these defects for more than a week and were potential sources of infections.

The patients were preoperatively planned and in operation rooms, plans were successfully put into effect.

The size (length) of the defects ranged 22 mm to 118 mm in length and from 7 mm to 52 mm in width.

In 3 of our 43 patients a double bipedicle flaps from midline posterior leg was raised when the patient had very large defect exposed shin bones.

2.1 Aims

To study the role of bipedicle flaps for covering of leg and foot defects, their indications and usefulness.

2.2 Objectives

1. To study bipedical flaps for coverage of various leg and foot defects with progression and flaps outcomes.
2. To study various complications after local flap coverage for defects.

2.3 Study- design

A Retrospective cohort Study.

2.4 Inclusion criteria

1. All patients admitted from January 2017 to December 2020 having leg and foot defects.
2. Patients who were operated elsewhere with lower limb defects for revision surgery.

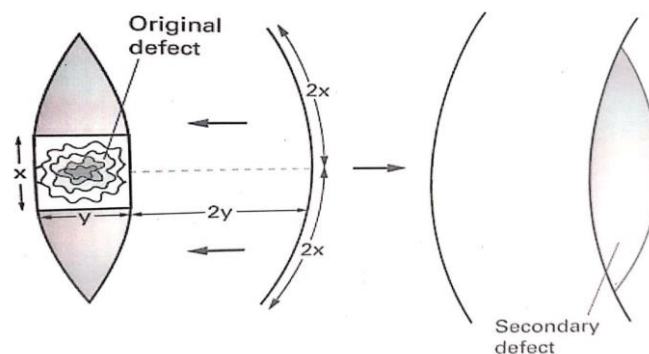
2.5 Exclusion criteria

1. Patients underwent reconstructive surgery other than bipedicle flaps.
2. Bipedicle local flaps of various body parts except leg and foot.

2.6 Statistical analysis used

NIL.

2.7 Surgical procedure



The length of the primary defect is measured using a scale and the bipedicle flap is marked in the adjacent tissue whose length is double of the primary defect length (image-left). The incision for raising the bipedicle flap is made parallel to the side of defect in a curvilinear fashion parallel to the primary defect lateral margin (image- right)

The flap is then mobilized and raised along with the underlying deep fascia making it more robust preserving the blood supply intact on both ends of the flap. Bipedicle advancement flap was planned. The measurement for the bipedicle is done initially. If the primary defect length is considered as X. To be adequate, the length of the incision should be twice that of the primary defect 2X. The width of the flap should be at least half the length of the primary defect X/2. The incision is curved parallel to the primary defect, which is a relaxing incision. Then mobilize the flap with the underlying fascia and its blood supply. A flap prepared with these dimensions can be moved easily into the new position and sutured to the primary defect.

Many times, the underlying fascia may be damaged and so a pure skin flap was planned but in smaller defects. The flap is raised and moved over the defect whose margins had been freshened and is sutured over the defect. The donor site of the bipedicle flap is covered with a split thickness skin graft harvested from elsewhere in the body. Complete and rapid coverage of the defect was achieved in all our cases with acceptable and minimal donor site appearance.

3. Results

3.1 Case 1

A patient of road traffic accident with tibial fracture and wound with exposed bone over shin area of right leg middle 1/3rd, external fixator was applied by orthopedics. Immediate coverage with bipedicle muscle flap was done to coverage the defects and secondary defects covered with SSG. After 1 month exposed wound totally covered with same skin color & contour. Patient fully satisfied and doing normal activities.



FIG. 1. A. Preoperative photo of defect with exposed bone middle 1/3rd of leg. B. Picture of Flap raised intra operatively with raw are on donor site. C. Defect fully covered with bipediced flap. D. Donor site grafted area.

3.2 Case 2



FIG. 2. A. Image of defect with exposed Tendoachilles region (lower back 1/3rd of leg region). B. Image of flap incision measured. C. Image shown flap insert with defect fully covered & also shown defect site after 3 months of follow up.

3.3 Case 3



FIG. 3. A. Image show defect in left ventral surface of sole with exposed bone. B. Incision for flap measured. C. Donor site covered with SSG & defect fully covered with BP flap. D. Image show defect site after 10th postoperative days.

3.4 Case 4



FIG. 4. A. Image of defect in middle 1/3rd of leg with exposed bone. B. Image of Bipedicled flap raised with donor site. C. Image show defect fully covered with Bipedicled flap. D. Defect of BP flap covered with SSG.

3.5 Case 5



FIG. 5. A. Defect in lower 1/3rd of leg antero-medial aspect. B. BP flap raised & defect covered. C. Defect fully covered. D. Defect site after 20 days post operatively.

3.6 Case 6



FIG. 6. A. Preoperative image of defect middle & lower 2/3rd of leg with exposed bone. B. Incision for BP flap measured posteriorly. C. Donor site covered with SSG. D. Defect fully covered with BP flap & Image of 10th postoperative days.

A total of 43 flaps of leg and foot defects were operated in the 'Department of Plastic & Reconstructive surgery' at Geetanjali Medical College and Hospital, Udaipur between the period of January 2017 to December 2020. All 43 patients of this series were covered using bipedicle flaps for exposed bone, tendons, implants or fracture sites.

In our series, 4 patients had complications from these 43 patients out of which 2 had partial superficial necrosis of the flap margin which healed with dressings and didn't require any subsequent surgeries, one had infection that was controlled with

antibiotics and only one had major necrosis in the patient with damaged deep fascia with diabetes in whom another local flap had to be done to cover the defect and fully survived. Unhealed partial graft zones in the donor site were observed as postoperative minor complications.

The follow up of these patients ranged from 6 weeks to 1 year post op.

All patients tolerated the surgical procedures well with no anesthesia related complications. All flaps survived. Cosmetically, there were some color mismatches.

TABLE 1. Site of defect.

| S No | Site of defect | No of cases | Percentage |
|-------------|-----------------------|--------------------|-------------------|
| 1 | Upper third of leg | 5 | 11.63% |
| 2 | Middle third of leg | 12 | 27.91% |
| 3 | Lower third of leg | 9 | 20.93% |
| 4 | Tendoachilles region | 6 | 13.95% |
| 5 | Dorsum of foot | 7 | 16.28% |
| 6 | sole | 4 | 9.30% |
| 7 | Total | 43 | 100% |

TABLE 2. Sex of patients.

| S No | Sex | No of cases | Percentage |
|-------------|------------|--------------------|-------------------|
| 1 | Males | 29 | 67.44% |
| 2 | Females | 14 | 32.56% |
| 3 | Total | 43 | 100% |

TABLE 3. Size of defect in length.

| S No | Size of defect in mm | No of cases | Percentage |
|-------------|-----------------------------|--------------------|-------------------|
| 1 | 20-40 | 6 | 13.95% |
| 2 | 41-60 | 14 | 32.56% |
| 3 | 61-80 | 15 | 34.88% |
| 4 | 81-100 | 6 | 13.95% |
| 5 | 101-120 | 2 | 4.65% |
| 6 | Total | 43 | 100% |

TABLE 4. Size of defect in width.

| S No | Size of defect in mm | No of cases | Percentage |
|------|----------------------|-------------|------------|
| 1 | 5-10 | 3 | 6.97% |
| 2 | 11-20 | 15 | 34.88% |
| 3 | 21-30 | 13 | 30.23% |
| 4 | 31-40 | 10 | 23.26% |
| 5 | 41-50 | 2 | 4.65% |
| 6 | Total | 43 | 100% |

TABLE 5. Age groups of patients.

| S No | Age group in years | No of cases | Percentage |
|------|--------------------|-------------|------------|
| 1 | 10-20 | 4 | 9.30% |
| 2 | 21-30 | 5 | 11.63% |
| 3 | 31-40 | 9 | 20.93% |
| 4 | 41-50 | 12 | 27.91% |
| 5 | 51-60 | 10 | 23.26% |
| 6 | 61-70 | 2 | 4.65% |
| 7 | 71-80 | 1 | 2.33% |
| 8 | Total | 43 | 100% |

3.7 Site of the defect

In our series, leg region defects, the middle 1/3rd of leg was commonest site of leg defect followed by lower 1/3rd of leg. Lower leg defects reconstructed with bipedicle flaps showed non complications rate 97.67% and in middle 1/3rd defects a higher flap survival of 100% was observed.

3.8 Size of the defect

The size of the defect in our series varied from 3 cm × 2.2 cm (smallest) to 11.8 cm × 5 cm (largest). Flap dimensions up to 2 times the size of the defect were needed depending on the site and the extent of the defect. A one study concluded that the bipedicle flaps with maximum flap length equal to or less than 1/3rd of the limb length are safe flaps.

The donor sites in our study were partially covered by the flap and the rest skin grafted. 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 1 year.

4. Discussion

Advantages of bipedicle flaps are: Shorter operating time, Limitation of scarring to one site, Reconstruction of defects with tissue of similar quality. Preservation of local sensation. It gives a better cosmetic result than transposition or rotation flaps by

avoidance of Dog Ears. Bipedicled flaps cover the large defects by providing improved blood supply due to bipedicle nature of the flap [3].

The limited mobility of the flap with design restricted by local anatomy and the requirement of a skin graft for the donor defect are the disadvantages of the flaps [4].

The bulky free or local flaps often destroy the anatomic shape of the region and cause persistent and long-term discomfort in patients so that additional surgical interventions are often required [5].

The disadvantage of the bipedicle flap includes that the skin of foot region is very tight, as well as the limited rotation of the flap. Undermine the flap widely and twist it to distribute the tension in a wide area along the suture line. Sometimes, poor design of the flap will lead to compromise the circulation. Close the secondary defect always needs a skin graft [2].

Lower limb defects with exposed bones, tendon, fracture site or implants are common problems faced by the plastic and reconstructive surgeon with the common causes being trauma and infection [1].

Lower extremity trauma with open soft tissue and tibial injuries, frequently occurs due to road traffic accidents and usually requires a plastic surgery involvement. The relatively unprotected anatomy of tibia leads to frequent bone exposure, which require soft tissue coverage [4].

Tibial defects are common due to its unprotected anatomy and deficiency of soft tissues covering it which in turn lead to its exposure requiring flap coverage. Also, in cases of compound fractures of the tibia a faster and rapid flap coverage will ensure less incidence of infection and malunion and faster healing [3].

The injured limbs are even more difficult to salvage when they face failure of free flap [6,7].

Complex soft tissue defects of limbs pose a significant challenge to the plastic surgeon in reconstruction. It requires the use of flaps, which is demanding on the patient as well as the operating surgeon [4,8].

The reconstructive strategies differ depending on underlying condition [9].

Bipedicled flaps are random pattern flaps with no specific named artery giving their vascular supply but random blood supply from its two ends hence the name bipedicle [1,4].

It is well known that a pedicled skin flap permits survival of longer flaps due to secondary recruitment of vascularity, inclusion of deep fascia with such a flap, obeying the principles of the single pedicled fascio-cutaneous flap, provide even greater security for the immediate transposition of yet larger or riskier flap without the need for delay maneuvers [5].

The injured limbs are even more difficult to salvage when they face failure of free flap [7,10,11].

This simple technique is often not used due to the advent of more complex modalities of tissue transfer [3,12].

The reconstructive surgeon has thus a greater chance of flap survival due to its double and augmented blood flow.

As a result of above procedure full tissue closure, marked functional recovery and good cosmetic results are achieved with the least damage to the donor site due to dual blood supply [4].

Also, the technique to elevate these bipedicle flap is simple and rapid [13].

The use of underlying deep fascia within the flap makes the flap more robust [14].

Bipedicled flaps being simple flaps take lesser operating time than other conventional muscle or free flap and hence there is lesser anesthesia time, no advanced equipment or instruments as in microvascular free flaps is required and hence proves more economical to the patient [6,15].

In 1996 Schwabegger [8] reported 12 cases of successful wound closure on the lower leg with the versatile bipedicle flap, showed the low incidence of minor complication, whether it was used as cutaneous, fascio-cutaneous or as a myo-fascio-cutaneous flap they concluded that though it is an old method it is an invaluable and less complicated one. If it is applied to selective indications and appropriate patients, the bipedicle flap is certainly a reliable alternative to the other common more sophisticated modern methods of tissue transfer [11].

Granzow et al [1] in 2013 concluded that bipedicle flaps provided a safe fast and relatively easy alternative for coverage of certain complex wounds of the lower extremity although their use does not preclude the use of more traditional options of pedicled muscle and free flaps.

D G dujon et al [3] in 1997 said that bipedicle flaps have been used to provide good quality soft tissue cover for defects in many anatomical sites. The indications for the use of this flap have not been well defined and with the advent of more complex modes of tissue transfer this simple technique is often overlooked.

Hillock in 1992 said that bipedicle skin flap permit survival of longer flaps due to secondary recruitment of vascularity [5]. Hence, they remain one of the useful methods of skin cover for the lower extremity defect [10,16,17].

5. Conclusion

Coverage of defects of leg and foot still pose a challenge to the reconstructive surgeon despite the availability of a large spectrum of flaps including free flaps. The best choice for any defect coverage would be a flap which is safe, easy to raise,

provides effective coverage does not require long periods of surgery or sophisticated instruments and equipment and also provides an aesthetic appearance matching with surrounding tissues. With the use of Bipedicled flaps full coverage of the defect is attained and the dual blood supply from both ends of the flap provides a more surety of flap survival even in large bipedicled flaps. Although it is a very basic random flap, the authors advocate their use more broadly in general practice and keeping them on the priority of the reconstructive plans and put into effect whenever and wherever feasible.

6. Declaration of Patient Consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

7. Financial Support and Sponsorship

Nil.

8. Conflicts of Interest

There are no conflicts of interest.

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