Perforator Based Propeller Flap for Soft Tissue Reconstruction

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Branch III

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DEPARTMENT OF PLASTIC, RECONSTRUCTIVE, FACIOMAXILLARY AND COSMETIC SURGERY

Government General Hospital, Chennai – 600003.

CERTIFICATE

This is to certify that, this dissertation titled "Perforator Based Propeller Flap for Soft Tissue Reconstruction", submitted by Dr. Pradeoth K M appearing for M.Ch (Plastic Surgery) degree examination in August 2009 is a bonafide record of work done by him under my guidance and supervision.

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Title of the work : "perforator based propeller flap for soft tissue reconstruction

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The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 17 – 2 – 2009 at 2 P.M in Government General Hospital, Deans, Chamber, Chennai-3.

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DECLARATION

I solemnly declare that this dissertation ***"Perforator Based Propeller Flap For Soft Tissue Reconstruction"*** was prepared by me in the Department of Plastic, Reconstructive and Maxillofacial Surgery, Madras Medical College and Government General Hospital, Chennai under the guidance and supervision of Professor & HOD Department of Plastic, Reconstructive and Maxillofacial Surgery, Madras Medical College and Government General Hospital, Chennai between 2006 and 2009**.**

This dissertation is submitted to the TamilNadu Dr. MGR Medical University, Chennai in partial fulfillment of the University requirements for the award of degree of MCh Plastic Surgery.

Place: Chennai

Date :

Acknowledgement

I take this opportunity to express my sense of gratitude and thanks to all those who have been instrumental in the successful completion of the work.

I thank the Almighty God for his endless grace and showering his choicest blessings on me and helping me in each and every step of my life.

I would like to convey my heartiest gratitude and regards to my esteemed teacher Dr. **K. V. Allalasundaram**, Professor and head of the Department of Plastic, Reconstructive and Facio-Maxillary Surgery, Madras Medical College, Chennai, for his keen interest, invaluable suggestions and painstaking supervision throughout the period of this study. His continued encouragement, deep devotedness and guidance have always helped me to keep focus on my work in all stages.

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I sincerely thank **Dr. J. Palanivelu,** Professor, Department of Plastic, Reconstructive and Facio-Maxillary Surgery, Madras Medical College, Chennai, for his kind support and helpful attitude.

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Dr. K. M. Pradeoth

Dedicated

to

My parents

Contents

Introduction

Reconstruction of soft tissue defects is one of the difficult assignments for plastic surgeons. A framework from skin graft, to local flap, to regional flap, to microvascular free flap can be applied to any reconstructive situation. The challenge is to utilize a single stage reconstruction to seek a safe flap with functional restoration and less morbidity.

Skin grafts require a vascular bed and will seldom take on exposed bone, cartilage, or tendon devoid of their periosteum, perichondrium or paratenon.

Flaps are usually required for covering recipient beds that have poor vascularity, covering vital structures and padding bony prominences.

Local skin flap provide functional and cosmetic requirements for wound coverage but limited by its application in the face, particularly around the eyes, nose, and mouth.

Fascial and adipofascial flaps provide thin, pliable tissue which serve as a highly vascularized support for skin grafts but limited by post operative edema, contour deformity at the donor and recipient site.

Fasciocutaneous flaps are simple to elevate, quick, and fairly reliable in healthy patients. The flaps are elevated with the knowledge of orientation of the fascial plexus, the fasciocutaneous perforators, and the fascial septum. Fasciocutaneous flaps are less bulky with less functional loss. Limitation of the fasciocutaneous flaps includes donor site morbidity and difficulty in monitoring flap failure.

Muscle flaps are used primarily to provide a well-vascularized soft tissue that is relatively resistant to infection, revascularize bone and offer a vascularized surface for skin grafts. They provide superior closure of dead space compared with random pattern flaps and musculocutaneous flaps, and are more resistant to bacterial infection[1] The limitation of muscle flaps is donor site morbidity with functional impairment.

Myocutaneous flaps are harvested as a regional pedicled flap that allows greater rotation distances into a nearby defect than the local cutaneous flap, but donor site must be covered with a split-thickness skin graft resulting in donor site morbidity with functional deficit due to loss of muscle.

Advantages of free flaps include stable wound coverage, improved aesthetic and functional outcomes, with minimal donor site morbidity. Multiple flaps, chimeric flaps, and composite flaps that contain various tissue types can be transferred on a single vascular pedicle for complex three-dimensional tissue defects.[2] Microsurgery is technically demanding procedures and is often an option when local or regional flaps are not feasible.

Advantages of fasciocutaneous flaps in reconstructive plastic surgery are ease of elevation, less bulk, high reliability, and easier transfer than for either muscle or musculocutaneous flaps, without subsequent functional impairment. The vascular basis of this form of tissue transfer has been elucidated using dye injection techniques[3]. Like musculocutaneous flaps, the donor site must be covered with a split-thickness skin graft resulting in donor site morbidity. Rotation of these flaps results in elevated cones or 'dog-ear' deformities. Efforts to take advantage of these local flaps and improve on local aesthetics have resulted in the islanding of these flaps, thus eliminating the 'dog-ear' deformity.[4]

Perforator flaps, originally pioneered by Koshima[5] in Japan in 1989, provide an autogenous tissue reconstruction with reduced donor-site morbidity. Perforator flaps involve the dissection of terminal blood vessels into a tissue segment. The advantages of the perforator flap over the traditional flap include reduced bleeding, preservation of the muscle and its function, versatility of the flap design to yield a better match to the defect and increased movability of the flap. The perforator flap has proven to be effective as both a free flap and a pedicled flap in the reconstruction of a variety of regions.

The perforator based propeller flap is an island fasciocutaneous flap based on a single pedicle. The term propeller flap was first introduced in 1991 by Hyakusoku[6] to define a method of elevating and rotating a flap with a length largely exceeding its width and based on a central subcutaneous pedicle. The skin island design is peculiar, being made of two portions similar to the two blades of a propeller which necessarily differ in dimensions depending on the position of the perforator in relation to the defect location. The recipient sites are covered with the rotated flaps or skin grafts. The advantages of this flap compared to a fasciocutaneous flap are the presence of reliable vascular pedicle, wider mobilization and better rotation options with less donor morbidity.

Review of Literature

Standard reconstructive paradigms serve as a broad guide for planning that can be tailored to the demands of the situation. Simpler reconstructive options such as secondary intention healing, delayed primary closure or skin grafting have a role in smaller defects or where tissue loss has not left important or relatively poorly vascularized tissues exposed. Topical negative pressure dressings have extended the situations in which these simpler reconstructive procedures can be applied[7].

Skin grafts can be taken from anywhere on the body, but the color, texture, thickness of the dermis, vascularity, and donor site morbidity of body locations vary considerably. Frequently, however, a more durable and expedient soft-tissue coverage is required.

Flaps are used when a skin graft is unsuitable or would leave the defect with inadequate bulk. Flaps are more resistant to infection than grafts[8]. Flaps are preferable when it may be necessary to operate through the wound at a later date to repair underlying structures.

In 1965 Bakamjian[9] successfully elevated the medially based deltopectoral skin flap, which disregarded the rules for length-to-width and which did not need a delay procedure. In 1967 Fujino[10] applied Seitchik and Kahn[10] knowledge of vascular anatomy to assess the relative contributions of axial and perforator vasculature to skin flap circulation.

Fujino suggested that the generally accepted 3:1 length:width ratio of a flap may be less important to flap survival than the presence or absence of axial vasculature. In 1970 Milton[11] also disputed the length:width concept of flap viability, stating that “the surviving length of flaps made under similar conditions of blood supply is constant regardless of width. The only effect of decreasing width is to reduce the chance of the pedicle containing a large vessel.” Thus the survival of a long skin flap is increased by augmenting its blood supply and not by increasing its width.

Daniel and Kerrigan[12] discuss the survival patterns of skin flaps based on their vascularity. Although the surviving patterns are highly variable and impossible to determine preoperatively, a distal part of the skin—i.e. a random cutaneous border— always survives through perfusion from the dermal-subdermal plexus regardless of the type of flap pedicle.

The skin territory of a flap is determined by the vascular anatomy incorporated in that flap. The critical factor in survival of random cutaneous flap is the number and type of blood vessels located at the base of the flap. There are overlapping areas between musculocutaneous and direct cutaneous territories which remain clinically undefined in many instances. Hence the size of skin flap is limited by the angiosome concept.

Ponten[13] first described fasciocutaneous flaps in 1981. Previously, most lower limb flaps were based on the concept of random skin flap design, thus were limited by a certain length-to-width ratio (usually 1:1 in the lower extremity). Ponten flaps had length-to-width ratios ranging to 3:1. These flaps have been referred to as Ponten superflaps. Two years later Tolhurst and colleagues[14] confirmed the usefulness of the fasciocutaneous flap in lower leg reconstruction and expanded the concept to encompass reconstruction in other parts of the body, particularly the trunk and axilla. More recently Fix and Vasconez[15] described the blood supply of fasciocutaneous flaps and the principles of flap transfer in the lower extremity.

Investigations into the blood supply of the fascia[16] have shown that the fasciocutaneous system consists of perforating vessels that arise from regional arteries and pass along the fibrous septa between muscle bellies or muscle compartments. The vessels then spread out at the level of the deep fascia, both above and below, to form plexuses which in turn give off branches to the skin.

The identification of muscle flaps as a source of tissue offered tremendous flexibility and more optionsanatomically for wound coverage and defect reconstruction[17].Muscle flaps provide a functional motor unit or a means of controlling infection in the recipient area. Each superficial muscle provides vascular connections via musculocutaneous perforating vessels to the overlying skin. Identification of vascular connections to the skin made it possible to include a segment of skin with the muscle flap[17]. Because a skin paddle is provided, the musculocutaneous flap is generally preferred to the muscle flap alone because of its ability to provide a combined replacement of deficient tissue.

Initial studies by Mathes et al[19,20] showed that muscle flaps likely improved wound healing in infected wounds because of their enhanced bacterial clearance, tissue ingrowths, and vascular perfusion. As a result, most wounds at high risk for infection have been treated using pedicled or free muscle flaps. However, more recent retrospective studies by Wei et al[21] found no differences between musculocutaneous and fasciocutaneous flaps in wound healing following lower extremity trauma reconstructions. Both types of flap healed equally well with comparable infection rates. Unless a large, complex, 3-dimensional defect is present, muscle or myocutaneous flaps may not be necessary. Studies boast that fasciocutaneous flaps are easy to mobilize, very reliable and appropriate in areas with not as much soft tissue loss. However, many surgeons prefer to use muscle flaps in potentially contaminated wounds because studies have suggested a theoretical advantage in terms of bacterial clearance, flap perfusion, and flap ingrowth into the contaminated area. More recent publications have found no clinical differences in postoperative wound infections between fasciocutaneous and muscle flaps reconstructions, if wounds had been adequately debrided[21,22]. Calderon, Chang, and Mathes[19] found that fasciocutaneous flaps were less resistant to the effect of bacterial inoculation and exhibited less collagen deposition than musculocutaneous flaps.

Among the advantages of fasciocutaneous flaps in reconstructive plastic surgery are ease of elevation, less bulk, high reliability, and easier transfer than for either muscle or musculocutaneous flaps, without subsequent functional impairment. Like musculocutaneous flaps, however, the donor site must be covered with a split-thickness skin graft.

Knowledge of the vascularisation of the subcutaneous and cutaneous tissues was boosted by the studies of Taylor on the angiosomes of the body[23] and focused by recent anatomic studies[24].

Asko Seljavaara[25] in 1983 introduced the term ‘freestyle free flaps’ to describe the flap harvesting technique based on the direct visualisation of the main vessel, the identification of a perforator/cutaneous vessel, and the design of a skin island over it. Wide clinical application of this technique followed.

The fusion of the concept of freestyle free flaps and the discovery of the angiosomes, led to simpler reconstructive methods through the use of pedicled perforator flaps in different areas of the body[26].

The main advantage of a pedicled perforator-based flap compared to a fasciocutaneous flap is the certain presence of a reliable vascular pedicle. The key element in predicting the survival of any cutaneous flap is the nature of the blood supply that is included[11].

A perforator based propeller flap has the additional advantage of wider mobilization and rotation options. The term propeller flap was first introduced in 1991 by Hyakusoku[6] to define a method of elevating and rotating a flap with a length largely exceeding its width and based on a central subcutaneous pedicle. The flap was then rotated 90^0 on the central axis to release a post-burn skin contracture.

The perforator-based propeller flap is a ‘skeletonised perforator flap’ with several peculiarities, as described by Teo[27] and recently published by Hallock[28] and Masia[29].

The skin island design is peculiar, being made of two portions similar to the two blades of a propeller, which necessarily differ in dimensions depending on the position of the perforator in relation to the defect location. The two blades of the propeller rotate from 90^0 to 180^0, around the fixed point of the perforator vessel[30]. The donor site defect is partially covered with the tissue raised between the defect and the perforating vessel or with skin graft[26].

By planning the flap around predetermined and predictable perforator vessels the viability of the flap may be preserved whilst increasing the amount of movement. The technical problem of anatomic variations can be overcome by using Doppler USG to identify perforating vessels, which are then included in the flap design[31]. More recently an increased blood velocity in perforator flaps compared to normal skin blood supply was demonstrated. Further to these experimental and clinical series, perforator flaps have been shown to be well vascularised due to a structural haemodynamic enhancement described by Rubino et al[32] and used as free or pedicled flaps, they can provide an adequate functional covering in selected patients. Rubino and Coscia [33] have shown that there is an inversion of blood velocity between pedicle artery and perforator artery compared to normal circulation and that the proportion of flow entering the perforator artery and, hence, flap skin is significantly higher than flow entering the same perforator artery before flap elevation.

The advantages of the perforator flap over the traditional flap include reduced bleeding, preservation of the muscle and its function, versatility of the flap design to yield a better match to the defect and increased movability of the flap[34].

Due to the length of vascular pedicles in propeller flaps, there is no need to dissect the perforator vessel to its source vessel and it is not important to know the origin of the vascular trunk to perform the flaps. The operation time is short. Also a microvascular anastomosis is not needed. The surgical intervention can be performed under locoregional anaesthesia. This advantage makes it an interesting option for patients like elderly patients or with complicated metabolic disorders and when a free microsurgical flap is not advisable. The perforator based propeller flap overcomes the shortcomings of microvascular techniques for free tissue transfer like procedural complexity, duration, and demand on resources. The purpose of our present study was to evaluate the usefulness of perforator based propeller flap for soft tissue reconstruction and to study the reliability of the surgical algorithm in soft tissue defect reconstruction using this flap.

Aims

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Objectives

The aim of this study was to evaluate the usefulness of perforator based propeller flap for soft tissue reconstruction in various sites and to study the reliability of the surgical algorithm in soft tissue defect reconstruction using this flap.

Materials & Methods

The study was conducted in the Department of Plastic Surgery, Government General Hospital, and Madras Medical College over a period of 31 months September 2006 to March 2009. Twenty cases where a fasciocutaneous flap was used in the reconstruction of a soft tissue defect– either primarily or secondarily – were included in the study. The proforma for the collection of data was made. All the relevant details of the patient during preoperative, surgical, and postoperative and follow up periods were collected and analyzed. All patients in addition to routine investigation were submitted to Doppler examination of the perforators near the soft tissue defect.

Patient selection:

Inclusion criteria:

1. Post-excision defects in patients with malignancies.
2. Soft tissue defects in patients acute trauma.
3. Patients presenting with post traumatic soft tissue defects at a later date.
4. Patient presenting with a post-surgical defect.

Exclusion criteria:

1. Infected wound.

2. Patients with peripheral vascular diseases.
3. Irradiated patients.
4. Patients who cannot withstand prolonged anesthesia.

In infected cases, seen late, they were already on appropriate culture and sensitivity.

In acute situations were immediate cover was done the wound was debrided by plastic surgeon prior to planning of the flap.

Trauma wounds were debrided initially by orthopedic team or general surgery team and again during the cover by plastic surgeon.

Procedure:

- Dimensions of the skin defect were recorded.
- A handheld Doppler ultrasound scanner was used to locate the most promising perforator artery (8mhz probe).
- A provisional flap design was drawn.
- Distance between the perforator and the distal edge of the defect was measured. This value was then transposed proximally, again measured from the perforator, and one centimeter was added to it to form the proximal limit of the flap.
- The width of the defect was measured and half a centimeter was added to it.

- A tourniquet was used in case of upper or lower limb for emptying the blood but retains enough to allow for easier identification of perforator vessels during exploration.
- The perforator vessels were located through an exploratory initial incision.
- The approach to the pedicle was sub-fascial.
- With this initial incision, a number of potentially useful perforators, based on its position, size and presence of concealed injury to the pedicle, were exposed.
- A visual assessment of the perforators was then made to choose the best pedicle for the flap.
- Neither perforators that were within one to two centimeters from the wound nor far away from the defect were chosen unless there were no other suitable ones available.
- When the perforator was finally chosen, re-designing and adjustment of flap dimension was carried out, if necessary
- Careful dissection around the pedicle was done to clear of all muscular side branches from its vessel of origin to the point where

the pedicle penetrates the deep fascia of the flap or for at least 2 cm.

- Meticulous division of all the fascial strands using magnification that would potentially cause vascular embarrassment through kinking of the vessels was performed.
- Once the pedicle was secured rest of the flap will be raised.
- The flap was completely islanded left in its original position for 10 – 15 minutes to allow it to perfuse and to allow the spasm of the vessels to relax.
- Topical vasodilators were instilled around the pedicle at this point.
- Once the flap perfusion was satisfactory, the flap was carefully lifted from the wound bed and rotated around this pedicle into the defect.
- Rotation was anything from 90º to a maximum of 180º looking in particular for any sign of kinking by any residual fascial strands which may need further division.
- The flap was secured into position with the first two skin sutures placed on either sides of the axis of the pedicle ensuring that the pedicle was not put under any traction tension either in a proximal or distal direction.

- A suction drain was placed carefully under the flap and secured well away from pedicle.
- The rest of the flap inset and wound closure was completed.
- The donor defect was closed primarily or by skin grafting
- Over tight bandaging was avoided to prevent vascular embarrassment.
- A window was made in the dressing to observe the flap, especially the tip.
- Immobilization of the operated region was ensured.

All patients were retained in plastic surgery ward until the flap had healed. Patients with good general condition were then discharged and reviewed twice a week – if the patient lived nearby to the hospital – or once weekly – if the patients were from a longer distance. Follow up period varied with individual complaints.

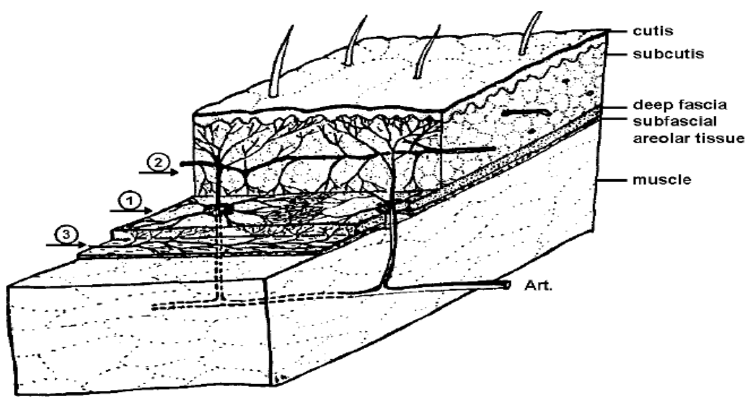
Statistical Analysis:

Data was analyzed using the statistical package at periodic intervals and at the end of study.

Surgical anatomy of perforator flaps

Investigations into the blood supply of the fascia have shown that the fasciocutaneous system consists of perforating vessels that arise from regional arteries and pass along the fibrous septa between muscle bellies or muscle compartments. The vessels then spread out at the level of the deep fascia, both above and below, to form plexuses which in turn give off branches to the skin.

Three major vascular systems in the deep fascia as found by Schafer are:



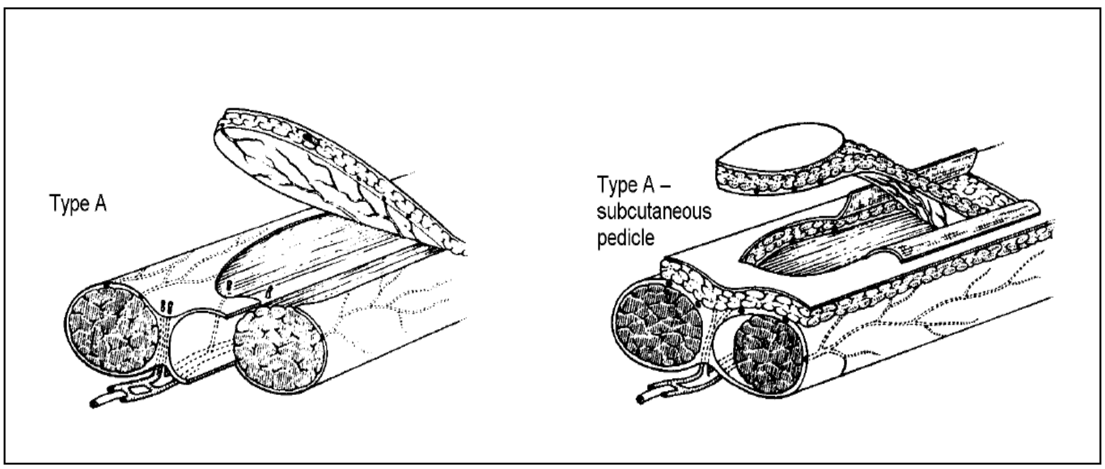
Arterial bloodsupply of the deep fascia ①②③

- *perforating* arteries from underlying muscle giving off several radiating branches which perforate the fascia before continuing to the subdermal plexus.
- *subcutaneous* arteries running in the fat and anastomosing frequently with the superficial plexus of the deep fascia and with each other.

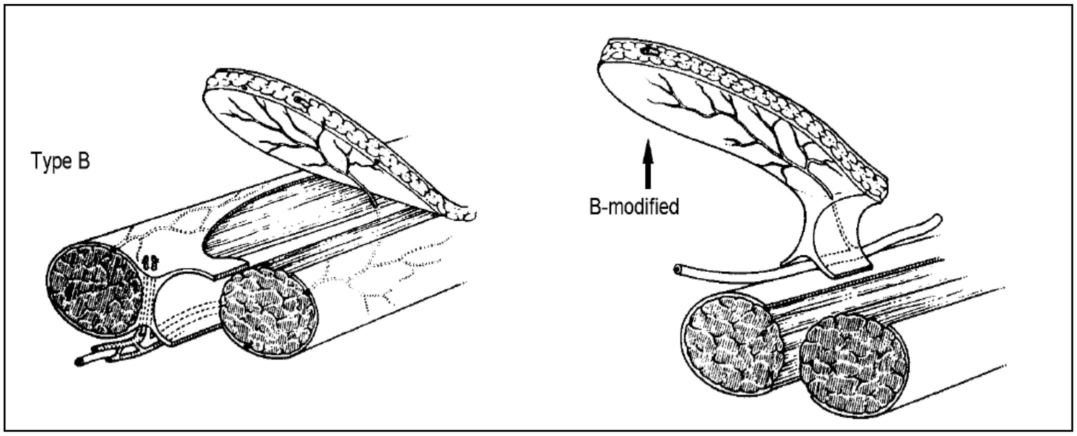
- *subfascial* arteries arising from the intermuscular septa and running in the loose areolar tissue beneath the deep fascia and adjoining the deep and superficial plexus.

On the basis of anatomic studies, Cormack and Lamberty proposed five categories of fasciocutaneous flaps according to their vascular patterns.

Type A is a pedicled flap supplied by *multiple* fasciocutaneous. Perforators at the base of the flap and oriented with the long axis of the flap in the predominant direction of the arterial plexus at the level of the deep fascia. The flap can be proximally or distally based and the skin can be removed to create an island flap.

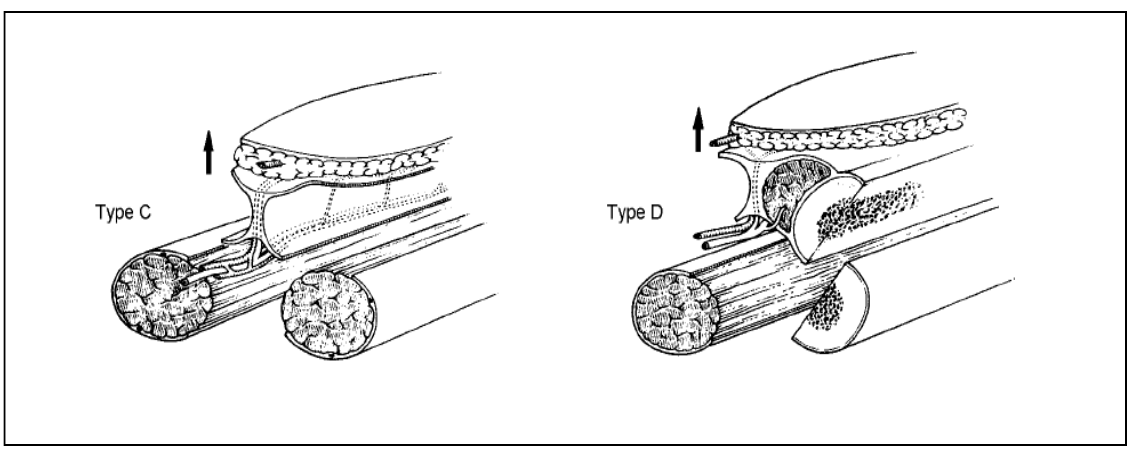


Type B is based on a *single* fasciocutaneous perforator of moderate size which is consistent both in its presence and its location. It may be used as either a pedicled or free flap.



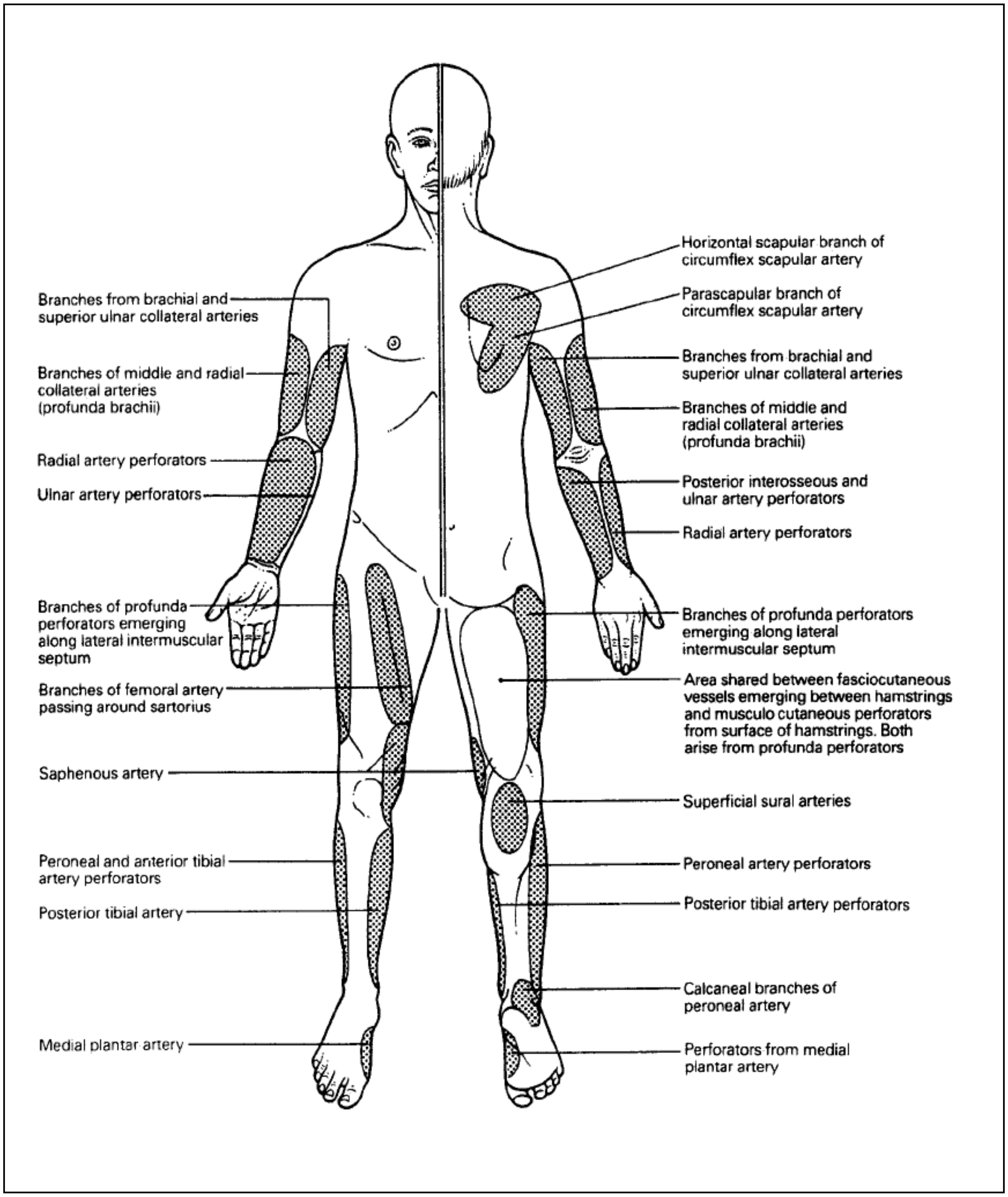
Type B modified is fed by a *single* perforator but differs in that the perforator is removed in continuity with the major vessel from which it arises. It is intended for use as a free flap.

Type C flap supports its skin by *multiple* small perforators along its length. These perforators reach it from a deep artery by passing along a fascial septum between muscles. Its main use is as a free flap.

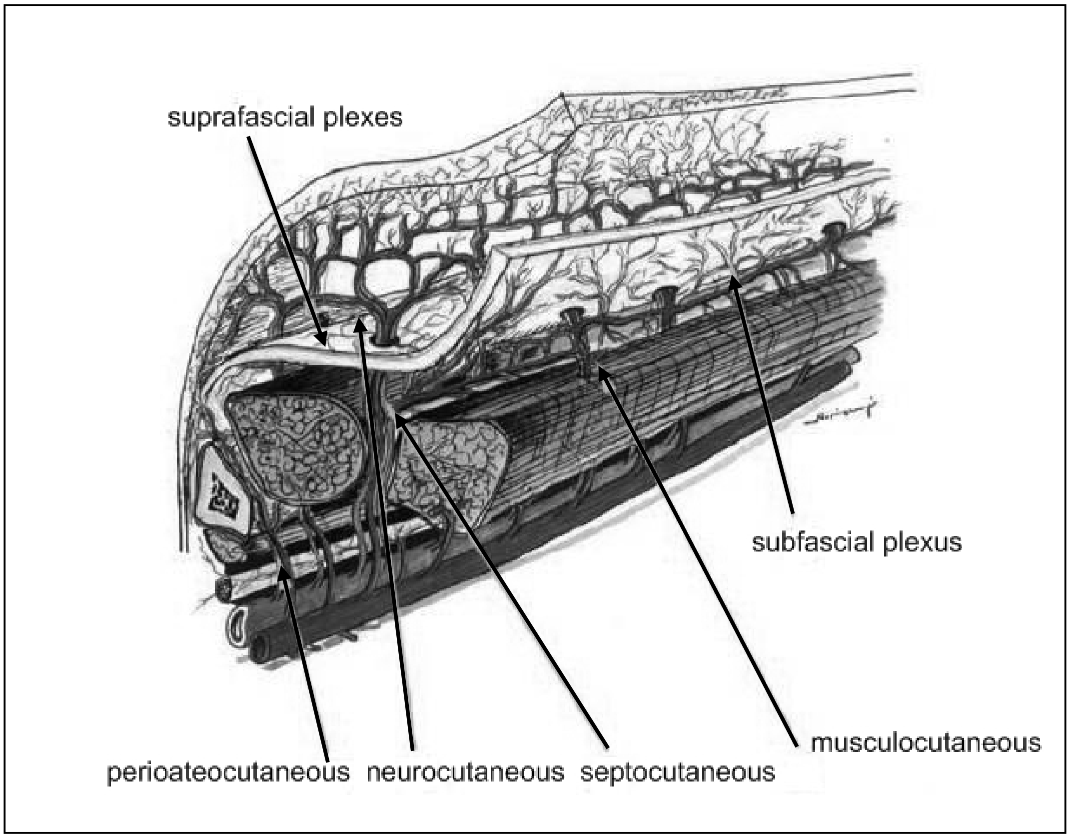


Type D consists of an *osteomusculofasciocutaneous* free tissue transfer.

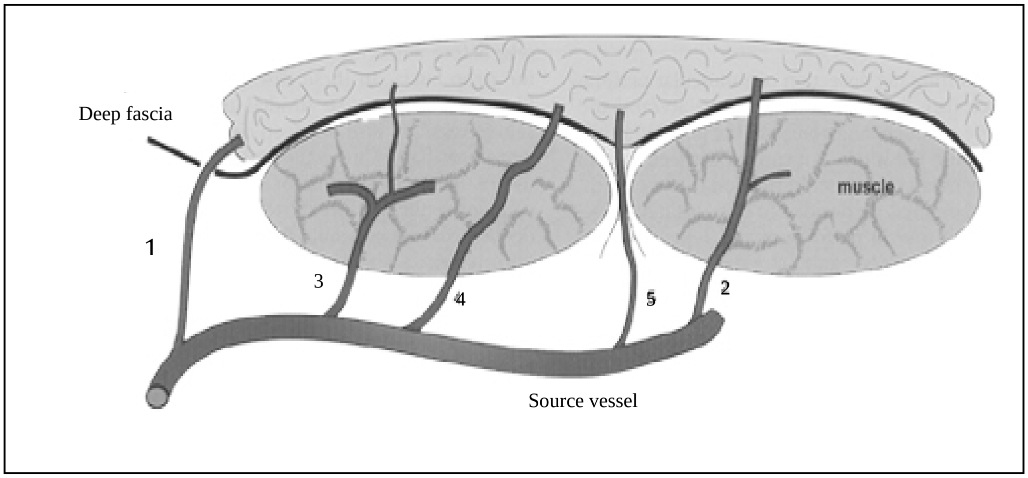
Cormack and Lamberty described potential donor areas of fasciocutaneous flaps according to the vascular pattern as shown in the diagram:



The perforating vessels arise from the main vessel or muscles and enter the suprafascial plane through defined openings in the deep fascia. There are smaller vessels which terminate at the subfascial level and form the subfascial plexus. The circulation between the subfascial and suprafascial plexi communicates through the intrafascial plexus and thus renders the fascia extremely vascular.



A perforator flap is a flap consisting of skin and/or subcutaneous fat. The vessels that supply blood to the flap are isolated perforator (Type B Cormack and Lamberty). These perforators may pass either through or in between the deep tissues (mostly muscle).

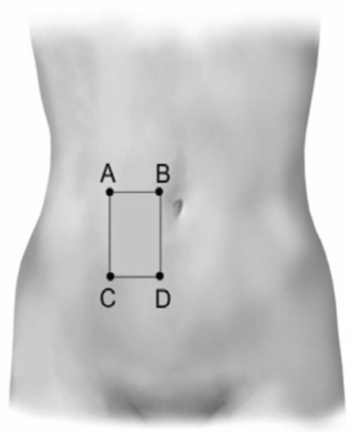


Schematic drawing of the different types of direct and indirect perforator vessels with regard to their surgical importance.

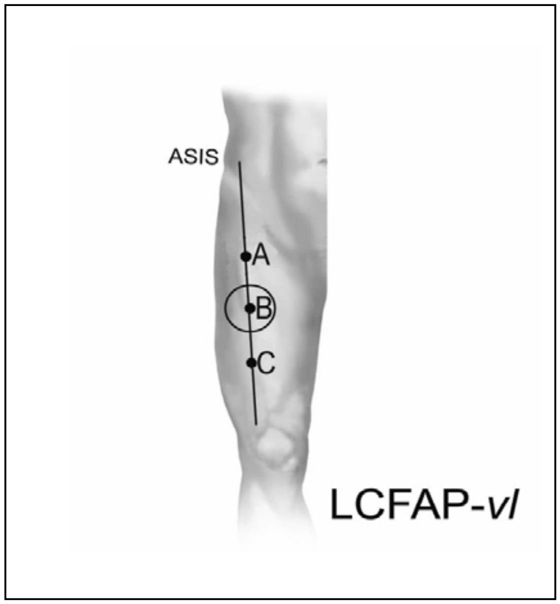
1. Direct perforators perforate the deep fascia only.
2. Indirect muscle perforators predominantly supply the subcutaneous tissues.
3. Indirect muscle perforators predominantly supply the muscle but have secondary branches to the subcutaneous tissues.
4. Indirect perimysial perforators travel within the perimysium between muscle fibers before piercing the deep fascia.
5. Indirect septal perforators travel through the intermuscular septum before piercing the deep fascia.

Geoffrey G. Hallock and David C. Rice[35] recently described a primer of schematics for facilitating the design of the common muscle perforator flaps by body region as follows:

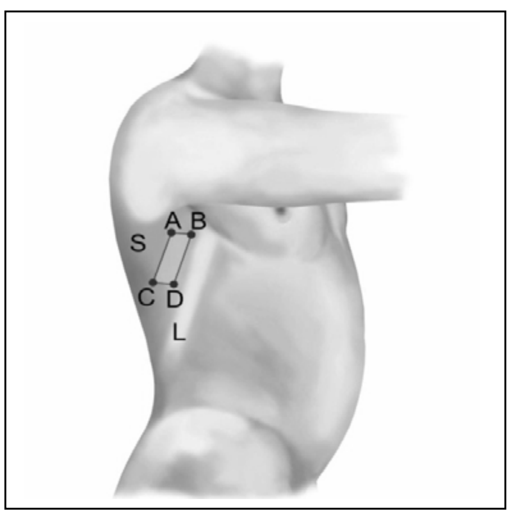
In case of deep inferior epigastric artery perforators, the paraumbilical perforators will be found in rectangle ABCD overlying the ipsilateral rectus abdominis muscle. ABCD extends vertically 2 cm. above the umbilicus to 6 cm. below. Horizontally, ABCD will be 1 cm. lateral to the midline, then to the lateral border of the muscle, approximately 6 cm. in width.



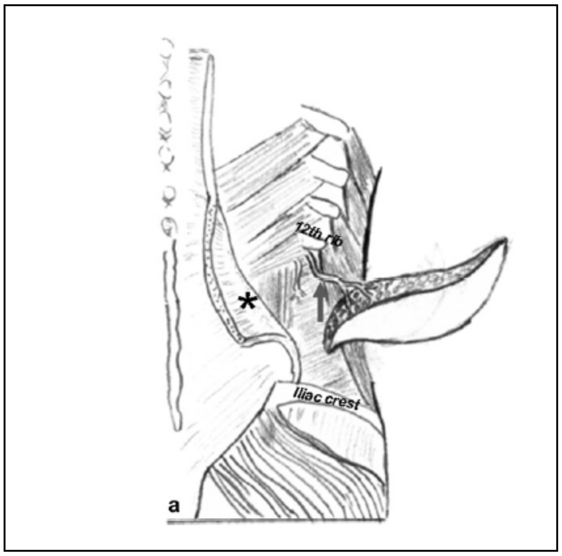
For anterolateral thigh perforator (lateral circumflex femoral artery perforator—*vastus lateralis*) a line is drawn from anterior superior iliac spine [ASIS] to superior lateral border of patella. Perforator “A” is found 5-8 cm. proximal to “B”. “B” is at midpoint of LINE within circle of radius 3 cm. “C” is found 5-8 cm. distal to “B”.

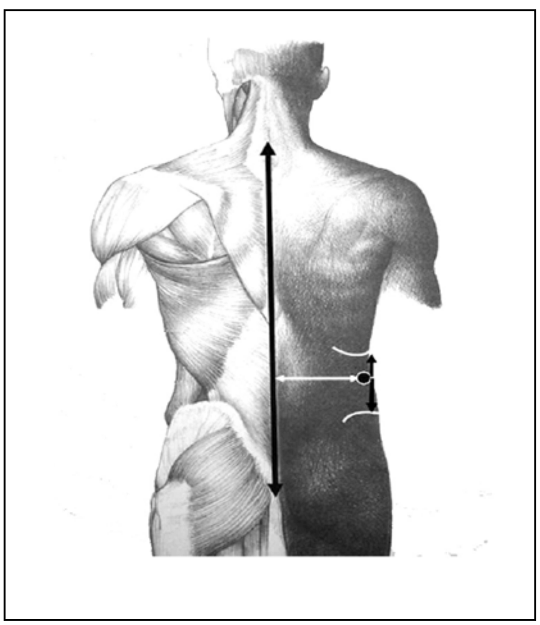


In dorsal thorax (TDAP = thoracodorsal artery perforator), the anterior border of the latissimus dorsi muscle [L] and scapular tip [S] are readily palpable. The 1st perforator of the descending branch of the thoracodorsal will lie in a rectangle ABCD extending from 5 to 15 cm. below the posterior axillary fold. The width of this rectangle will extend from 0.5-3.0 cm. inward from latissimus dorsi muscle.



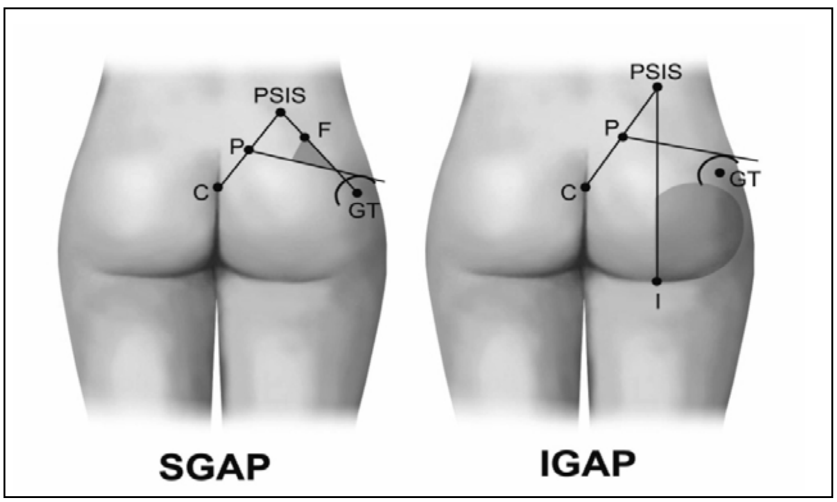
Topographic and schematic overview of the anatomy of subcostal artery perforator flap done by Feinendegen et al[36].The reflected latissimus dorsi muscle with the arrow pointing the perforator located caudal to the end of the 12th rib at the edge of the external oblique muscle.





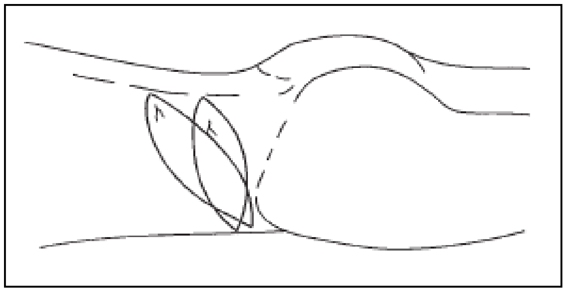
In gluteal region (SGAP -superior gluteal artery perforator) lines are drawn from the posterior superior iliac spine [PSIS] to the coccyx [C], and to the apex of the greater trochanter [GT].

A line from the midpoint [P] of PSIS-C to the superior edge of the greater trochanter corresponds to the course of the piriformis muscle. Point F at the proximal third of the line PSIS-GT corresponds to the exit of the SGA from the pelvis. Perforators will be located in shaded area above the piriformis muscle.

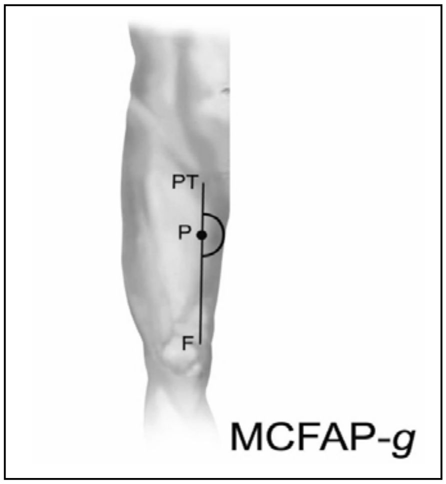


For IGAP [inferior gluteal artery perforator] lines are drawn from the posterior superior iliac spine [PSIS] to the coccyx [C] and to the ischial tuberosity [I]. A line from the midpoint [P] of PSIS-C to the superior edge of the greater trochanter corresponds to the course of the piriformis muscle. Perforators will be located in shaded area below piriformis muscle and above inferior gluteal crease, lateral to the vertical line PSIS-I.

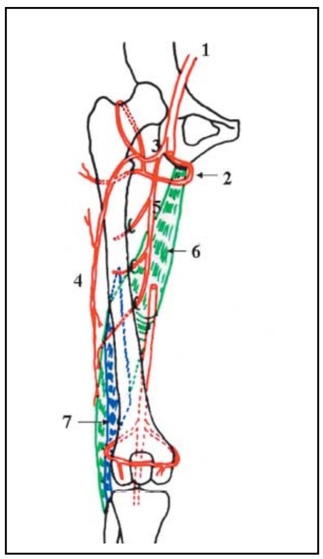
Design of lumbar artery perforator based island flap:



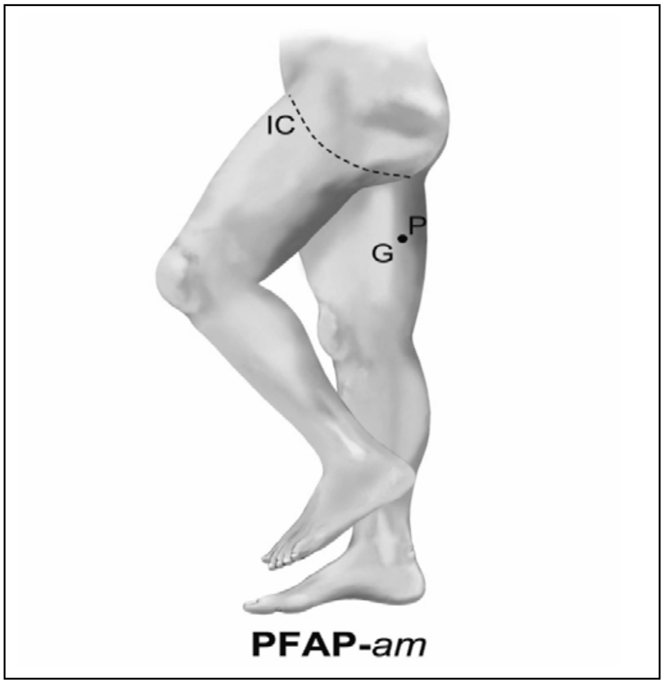
In medial groin [MCFAP—*g* = medial circumflex femoral artery perforator—*gracilis]* a line is drawn from the pubic tubercle [PT] along the medial thigh to the medial condyle of the femur [F], corresponding to the posterior border of the adductor longus muscle. The vascular hilum to the gracilis muscle will be at about point P, 10±2 cm. below PT on this line. A semicircle of radius 7 cm. centered at P, overlying the gracilis muscle, will encompass most usable perforators. The major axis of any flap, which should include these perforators, must parallel the groin crease.



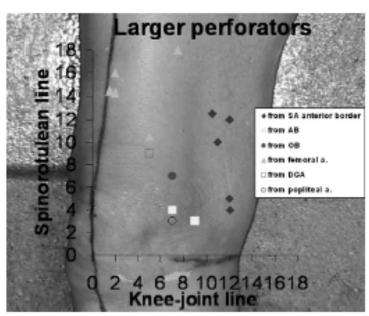
Schematic representation of perforators from short & long head of biceps femoris.



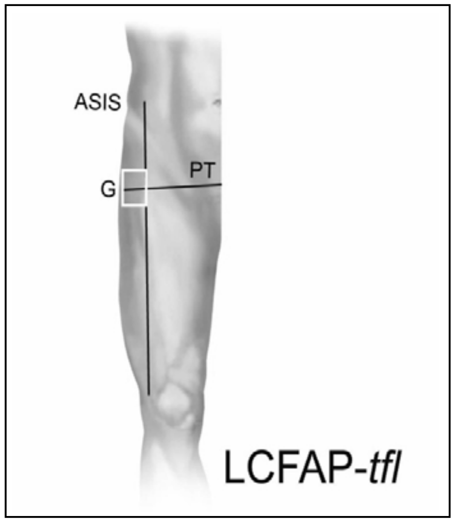
In posterior Thigh [PFAP—*am* = profunda femoris artery perforator—*adductor magnus] a* line drawn along the inguinal crease [IC] is extended to the medial aspect of the posterior thigh. The posterior border of the gracilis [G] muscle is identified. The perforator [P] will be found about 8 cm. below the extended IC line, and 2 cm. posterior to the gracilis muscle.



Location of perforator vessels of the distal anteromedial thigh from knee joint line and spinorotulean line, a study done by Fabrizio Moscatiello et al[37].



Tensor Fascia Lata [LCFAP—*tfl* = lateral circumflex femoral artery perforator— *tensor fascia lata]*.



A line “y” was drawn from the anterior superior iliac spine [ASIS] to the superior lateral border of the patella. Another line “x” was drawn from the pubic tubercle [PT] to the most prominent point of the greater trochanter [G], perpendicular to line “y”. A rectangle was formed within which perforators would be found, with horizontal sides 4 cm. above & below the “x’ axis. The vertical sides of the rectangle correspond to the encompassed portion of the “y” axis, and a parallel line tangential to the anterior border of greater trochanter.

In Calf (medial sural artery perforator) line was drawn from midpoint of popliteal crease [PC] along medial leg to apex of medial malleolus [M].First perforator sought within semicircle of 2 cm. radius centered on line 8 cm. below popliteal crease. Sometimes 2nd perforator found within circle of radius 3 cm. centered on line 15 cm. below popliteal crease.

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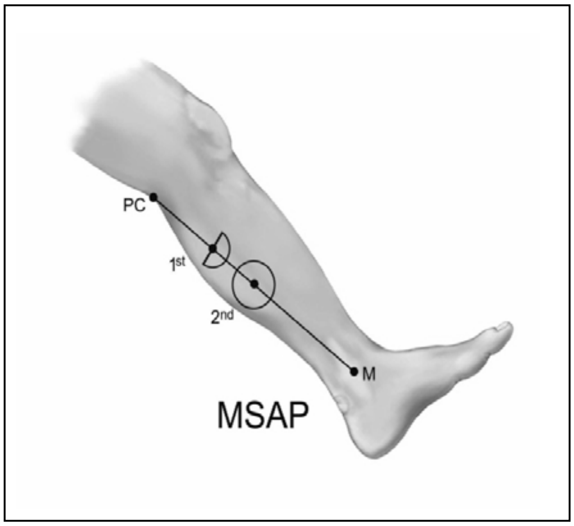
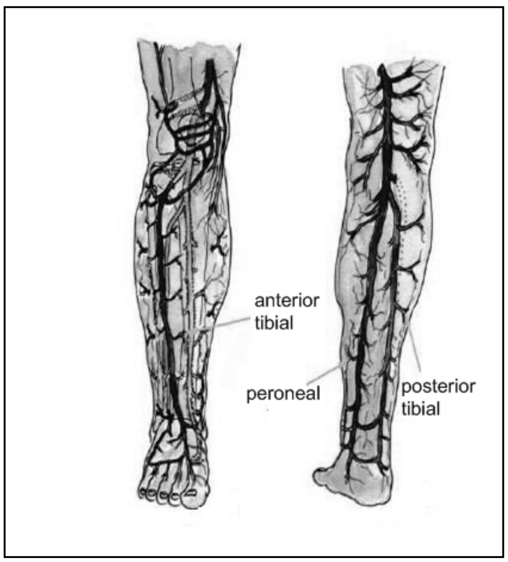
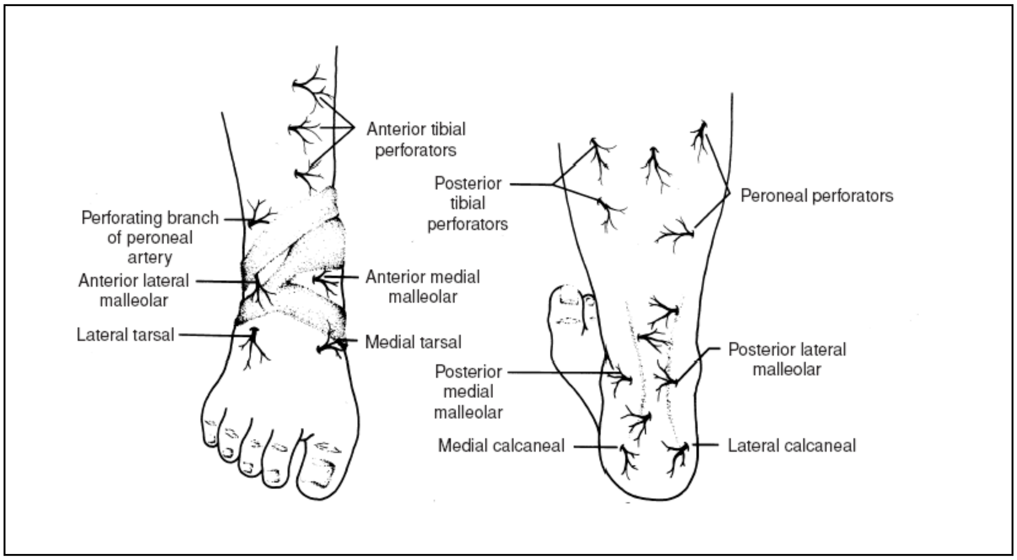


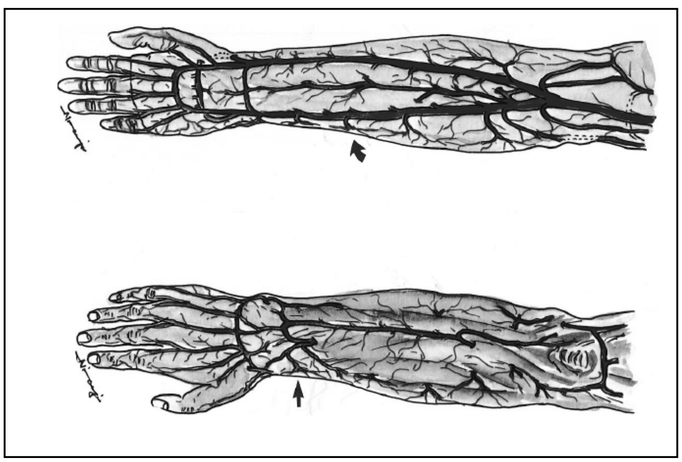
Perforating vessels from anterior tibial, posterior tibial and peroneal vessels were represented in this diagram as explained by Niranjan et al[38].



Location of the cutaneous perforators was shown as they emanate from the posterior tibial artery, peroneal artery, and anterior tibial artery by Hallock et al[39]. A flap designed with one of these perforators at its base, located by Doppler ultrasound probe, can encompass the territory fed by an adjoining perforator. To extend the flap successfully beyond those boundaries requires a delay procedure.



Schematic diagram showing the fascial feeders ('perforators') arising from the forearm and hand as described by Niranjan et al[40].



Surgical Techniques

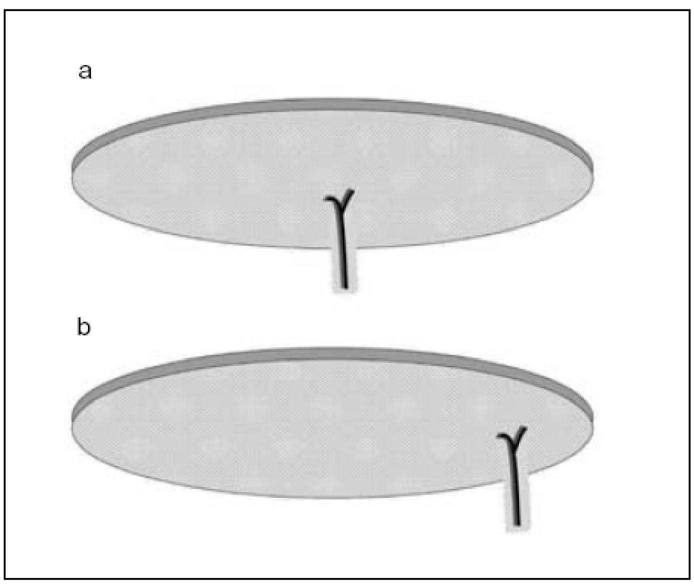
- Dimensions of the skin defect were recorded.
- A handheld Doppler ultrasound scanner was used to locate the most promising perforator artery. A provisional flap design would then be drawn. Scheme of propeller flap may be

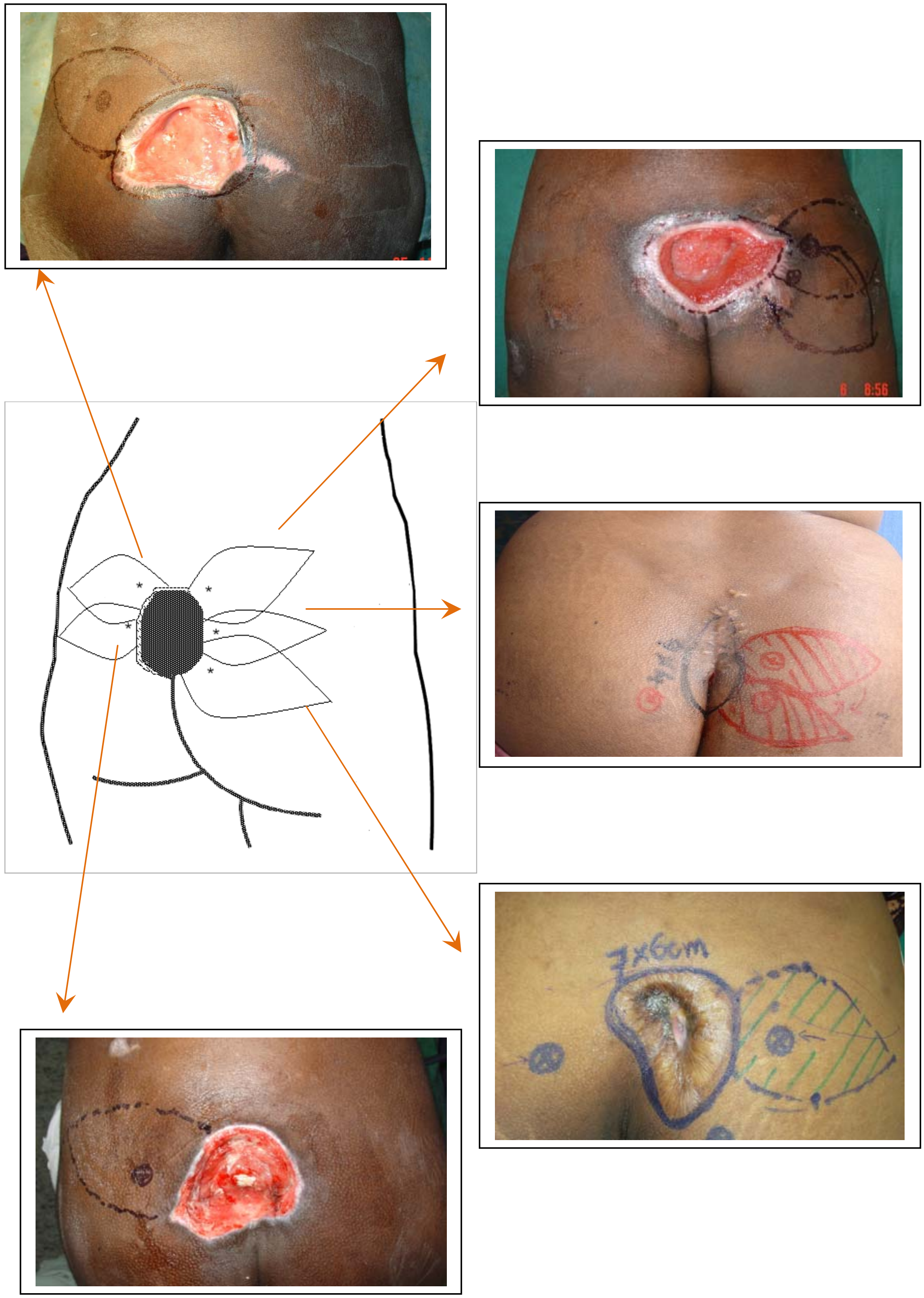
  a: Central axis type

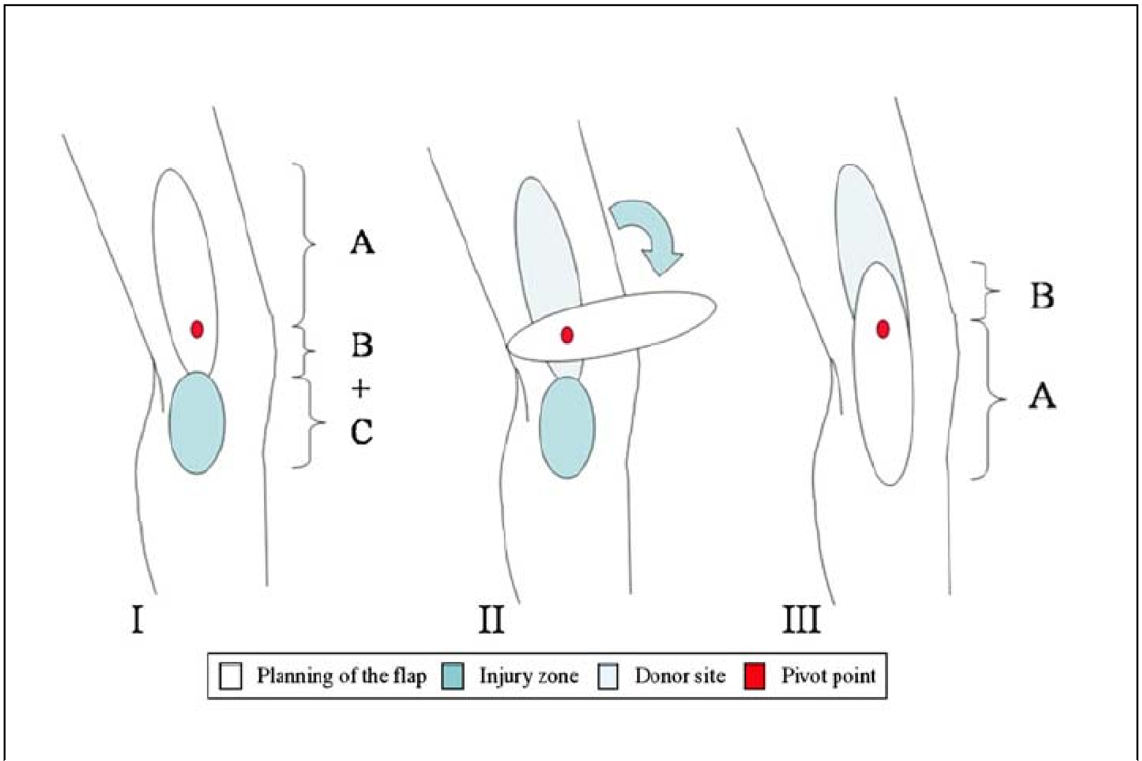
  The pedicle was located in the center of the flap. This type of flap can rotate 90 degrees to release contractures or cover skin defects.

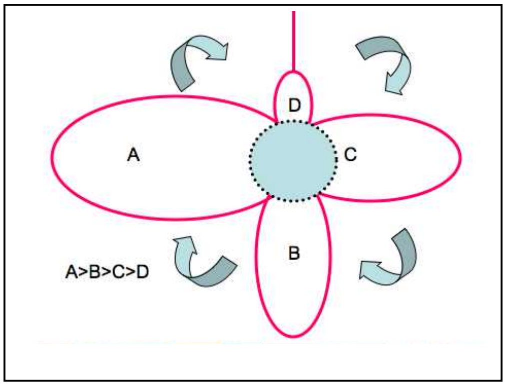
  b: Acentric axis type

  The pedicle was located on an acentric portion of the flap. This type of flap can rotate 180 degrees and cover skin defects at some distance



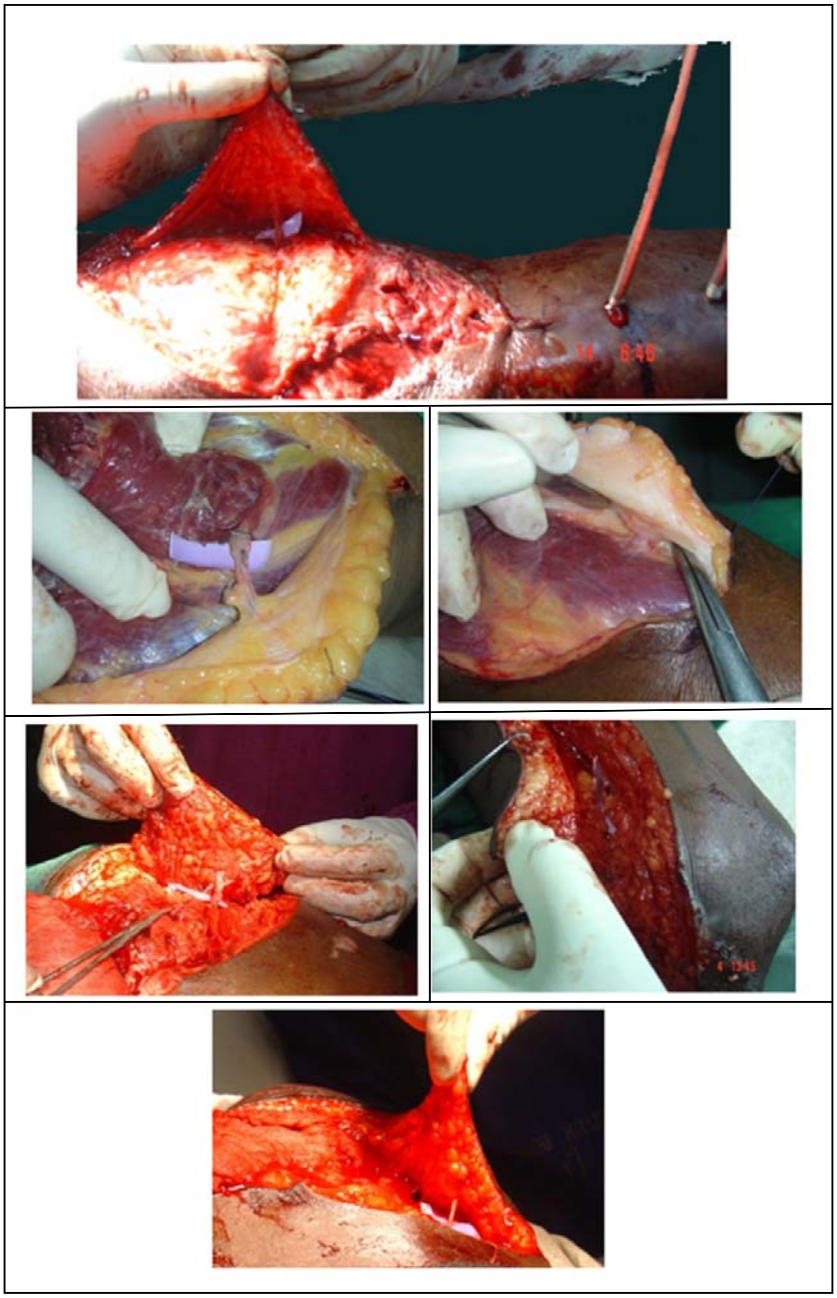

7x6cm


A
B
+
C
B
A
I
II
III
Planning of the flap
Injury zone
Donor site
Pivot point



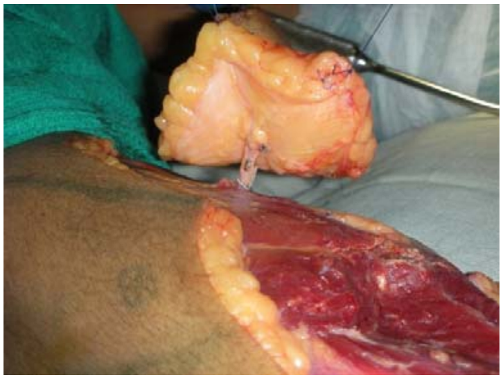
- Distance between the perforator and the distal edge of the defect was measured. This value was then transposed proximally, again measured from the perforator, and one centimeter would be added to it to form the proximal limit of the flap.
- The width of the defect was measured and half a centimeter was added to it.
- A tourniquet was used in case of upper or lower limb for emptying the blood but retains enough to allow for easier identification of perforator vessels during exploration.

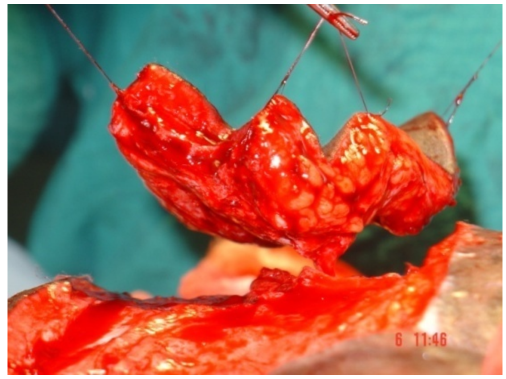
- The perforator vessels were located through an exploratory initial incision.



- The approach to the pedicle would be sub-fascial.

- With this initial incision, a number of potentially useful perforators, based on its position, size and presence of concealed injury to the pedicle, were exposed.
- A visual assessment of the perforators was then made to choose the best pedicle for the flap.
- Neither perforators those were within one to two centimeters from the wound nor far away from the defect were chosen unless there were no other suitable ones available.
- When the perforator was finally chosen, re-designing and adjustment of flap dimension was carried out, if necessary.
- Careful dissection around the pedicle was done to clear of all muscular side branches from its vessel of origin to the point where the pedicle penetrates the deep fascia of the flap or for at least 2 cm.
- Meticulous division of all the fascial strands using magnification that would potentially cause vascular embarrassment through kinking of the vessels was performed.

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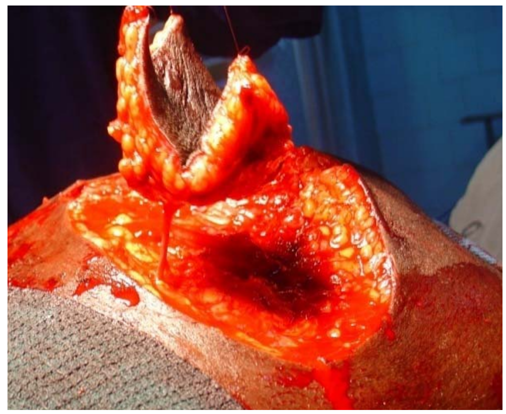
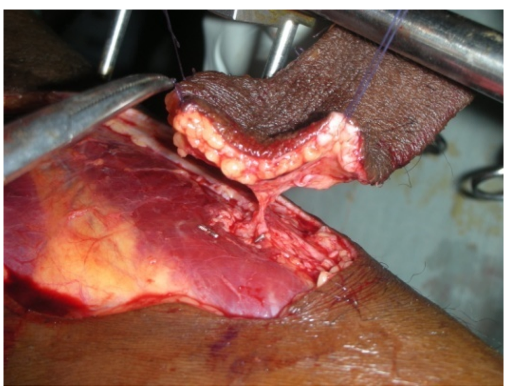





5 2:03

- Once the pedicle was secured rest of the flap would be raised.
- The flap was completely islanded left in its original position for 10 – 15 minutes to allow it to perfuse and to allow the spasm of the vessels to relax.
- Topical vasodilators were instilled around the pedicle at this point.
- Once the flap perfusion was satisfactory, the flap was carefully lifted from the wound bed and rotated around this pedicle into the defect.
- Rotation can be anything from, say 90^{o} to a maximum of 180^{o}looking in particular for any sign of kinking by any residual fascial strands which may need further division.

- The flap was secured into position with the first two skin sutures placed on either sides of the axis of the pedicle ensuring that the pedicle was not put under any traction tension either in a proximal or distal direction.
- A suction drain was placed carefully under the flap and secured well away from pedicle.
- The rest of the flap inset and wound closure was completed.
- The donor defect was closed primarily or by skin grafting

- Over tight bandaging was avoided to prevent vascular embarrassment.
- A window was made in the dressing to observe the flap, especially the tip.
- Immobilization of the operated region had to be ensured.

All patients were retained in plastic surgery ward until the flap had healed. Patients with good general condition were then discharged and reviewed twice a week – if the patients' lived nearby to the hospital – or once weekly – if the patients were from a longer distance. Follow up period varied with individual complaints

Observations

&

Results

Clinical profile:

Twenty patients with soft tissue defect were included in the study for a period of 31 months from September 2006 to March 2009. Mean age at presentation was 37 (range 21-54 yrs). A total of 14 male patients and 6 female patients were included in this study group.

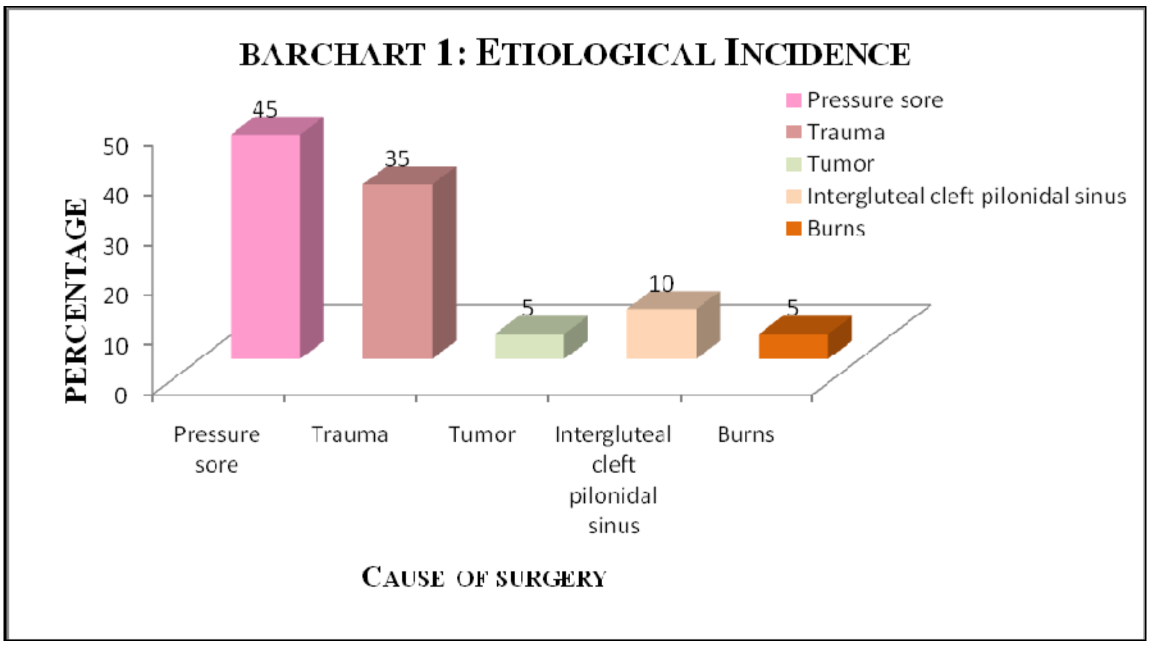
Table 1: Patients characteristics

Number of patients	20
Age range	21-54 yrs
Male	14
Female	6

Among twenty cases, 11 cases were soft tissue defects in the gluteal region (55%) and 9 cases were soft tissue defects in the lower extremity. Most common cause of soft tissue defect in the lower extremity was trauma (77.7%). Data on etiological incidence of soft tissue defects included in the study is shown in table 2.

Table 2: Etiological Incidence:

Pressure sore	9
Trauma	7
Tumor	1
Intergluteal cleft pilonidal sinus	2
Burns	1

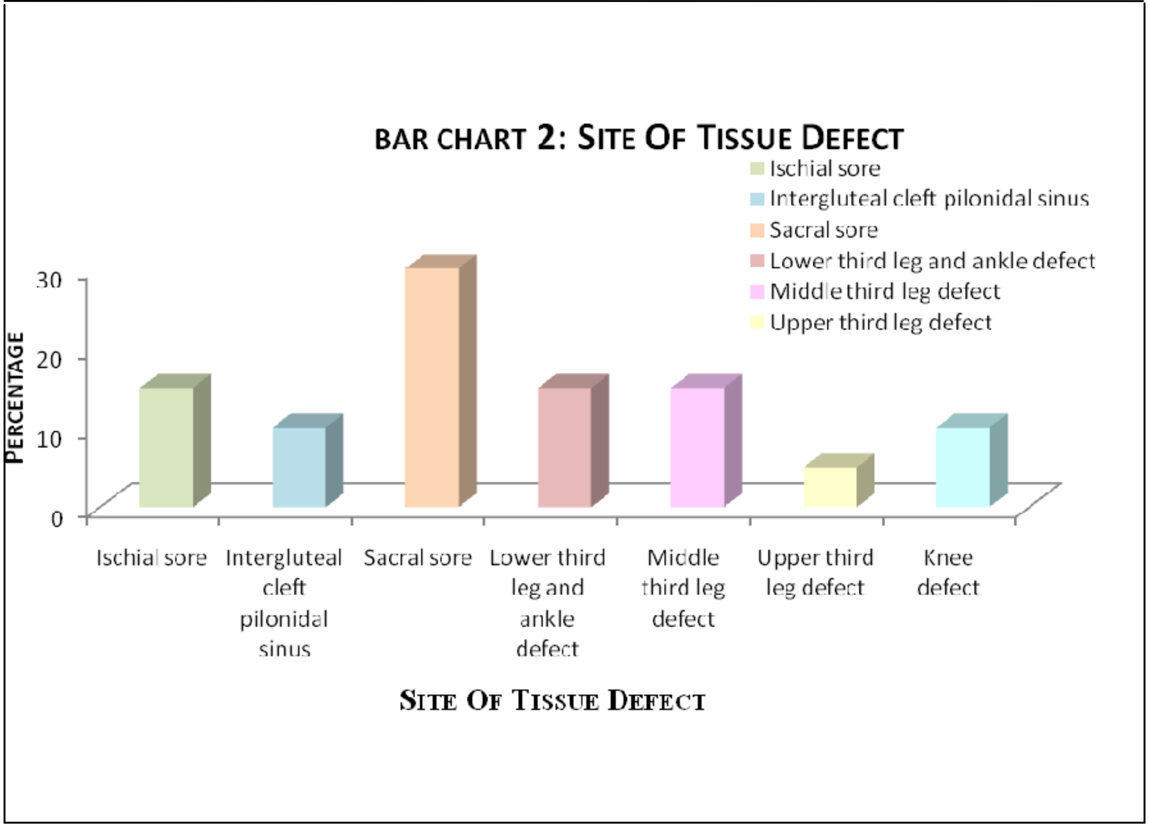


Site of tissue Defect:

Most common site of soft tissue reconstruction using propeller flap method in our study was sacral region which constitutes about 30% among the total cases. Data on site of tissue defects were shown in table3.

Table 3: Site of Tissue Defect

Ischial sore	3
Intergluteal cleft pilonidal sinus	2
Sacral sore	6
Lower third leg and ankle defect	3
Middle third leg defect	3
Upper third leg defect	1
Knee defect	2



Co-morbidity and habits:

Among twenty patients, four patients had the habit of smoking, one patient was diabetic on regular medication, one patient had the habit of consuming alcohol and one patient underwent treatment for tuberculosis before fifteen years. [Table 4]

Table 4: Co-morbidity and habits

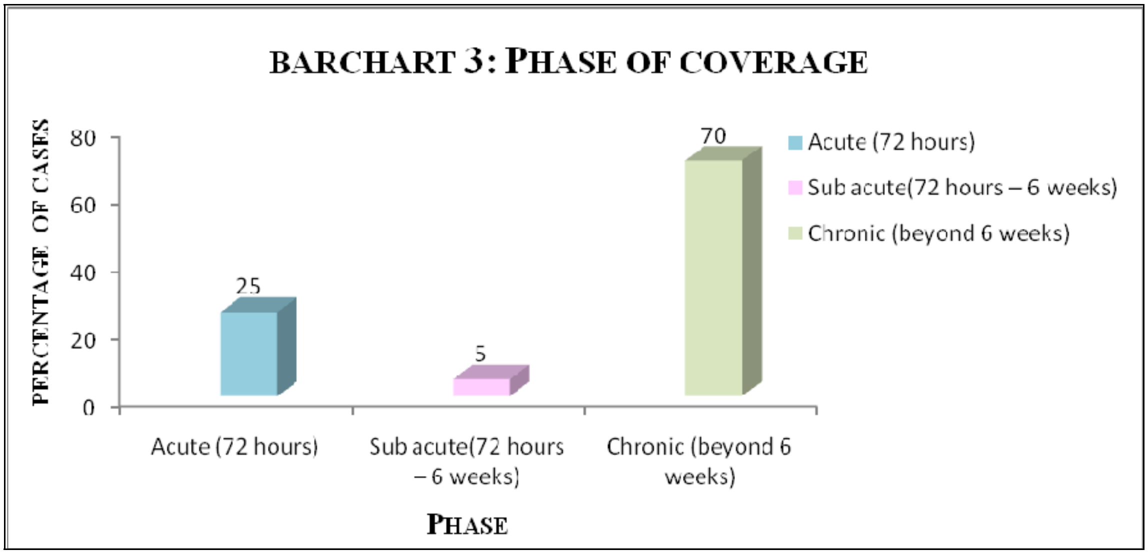
Diabetic	1
Smoker	4
Alcoholic	1
Tuberculosis (treated before 15 years)	1

Phase of coverage:

In this series maximum number of flaps were done in the chronic phase (70%) and least in the subacute phase (5%).[Table 5]

Table 5: Phase of coverage

Acute (72 hours)	5
Sub acute(72 hours – 6 weeks)	1
Chronic (beyond 6 weeks)	14



Flap characteristics:

Soft tissue defects dimensions were ranging from 3x3 cm to 13x 10 cm. Flap design utilized for reconstruction were shown in table 6.

Table 6: Flap design

Longitudinal propeller	16
Multilobed propeller	3
Bilobed propeller	1

Rotation degrees of the flap was ranging from 40^0 -180 ^{0}. In the gluteal region, perforators chosen for defect reconstruction were from inferior and superior gluteal artery. Anteromedial thigh perforators, medial leg perforators from posterior tibial artery & perforator from medial gastrocnemius were chosen for lower extremity soft tissue defect coverage. (Table 7)

Table 7: Perforator emerging sites

Medial leg perforator	5
Superior gluteal partery perforator	8
Inferior gluteal artery perforator	3
Medial gastrocnemius perforator	1
Anteromedial thigh perforator	3

Perforators were detected preoperatively by Doppler and intraoperatively by visual assessment. Location of perforators from the lesion was approximately 3 -8 cm from the defect. Total duration of surgery was ranging from 2hours 30 minutes to 4 hours

Results:

Flaps with dimension of 7x5 cm to 14 x 11 cm were elevated for soft tissue reconstruction. The number of perforator used as pedicles were 1 Arteriovenous perforator in 19 cases and 2 Arteriovenous (black arrows) perforator in a single case of sacral sore (fig.1).

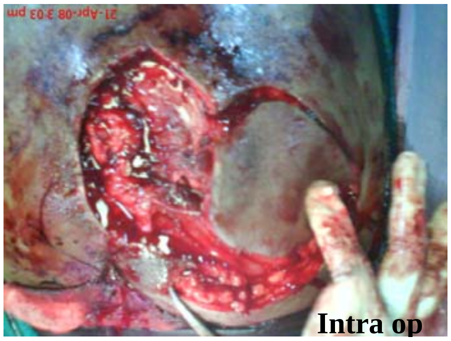

Fig 1

Six patients with sacral pressure sore were reconstructed with longitudinal propeller flap method based on superior gluteal artery perforator. Five among these six flaps survived completely (case 1-4).

Case 1:

Case 2:

Case 3



Case 4

Donor area was closed primarily in 5 cases. One case with flap dimension of 14x 11 cm, donor area could not be closed primarily necessitating a local rotation flap for closure of the donor defect (case 5).

Case 5:

Three cases of ischial pressure sore were reconstructed with longitudinal propeller flap cover based on inferior gluteal artery perforator. Two among these three flaps survived completely (case 6). Donor area was closed primarily.

Case 6:

Two cases of pilonidal sinus after thorough debridement were reconstructed with longitudinal propeller flap based on superior glutreal artery perforators. Both the flaps survived without any complications. Donor sites were closed primarily (case7, 8).

Case 7:

Case 8:

Two cases of knee defect and one case of upper thirds leg defect was reconstructed with anteromedial thigh perforator. Two flap designs were longitudinal propeller while one flap was bilobe design. Two flaps survived completely (case 9, 10). Donor sites were covered with skin grafting.

Case 9:

Among three cases of middle third defect, one was dermatofibrosarcoma with residual tumor. Reexcision done and perforator emerging from medial gastrocnemius muscle was utilized for reconstruction of the defect. (Case 10) Donor area was closed by skin grafting.

Case 10:


Pre Op


Immediate Post op


Late post op

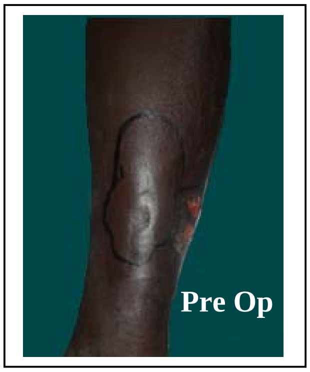
Among three cases of lower third leg defect two flaps were multilobed design and one was longitudinal propeller. All the flaps survived completely donor area was closed primarily in one case (case 11, 12). Skin grafting was needed in other two cases.

Case 11:


Pre Op


Immediate post op

Case 12:



Donor area of most of the flaps were closed primarily (60%) and if needed by skin grafting (35%). Table 7 provides the data on donor area management.

Table 7: Donor area management

Closed primarily	12
Skin grafting	7
Rotation flap	1

Complications:

In our study, five out of twenty patients presented with complications of wound dehiscence, partial and total flap loss. Analysis of complications based on region of soft tissue defect, phase of coverage and perforator types are depicted in the table 8, 9 and 10 respectively.

Table 8: Complications Based On Region of Soft Tissue Defect

No	Region	Flap type	Infection, wound dehiscence	Partial flap loss	Total flap loss
1	Sacral sore	Longitudinal propeller			1
2	Ischial sore	Longitudinal propeller	1		
3	Knee defect	Longitudinal propeller		1	
4	Middle third leg defect	Longitudinal propeller		1	
		Multilobed propeller			1

Table 9: Complications during Various Phases of Cover:

Phase	Infection	Partial loss	Complete loss
Acute		1	
Sub acute			1
Chronic	1	1	1

Table 10: Relation of Complications with Perforator Types:

No	Perforators	No: of cases	Complication	Percentage
1	Superior gluteal perforators	8	1	12.5%
2	Inferior gluteal perforators	3	1	30%
3	Anteromedial thigh perforators	3	1	30%
4	Medial leg perforators	5	2	40%

One case of sacral pressure sore reconstructed with longitudinal propeller flap developed respiratory distress in the immediate post operative period and was managed on mechanical ventilator. Patient developed alterations in metabolic parameters and difficulty in maintaining the prone position post operatively. Flap showed persistent congestion (case 12) and later total flap loss

Case 12

A case of Ischial pressure sore reconstruction with longitudinal propeller showed infection and the wound dehiscence managed by local rotation flap (case13).

Case 13

Case of knee defect reconstruction with anteromedial thigh perforator showed 20% necrosis in the distal part of the flap (case 14). Wound debridement with removal of underlying osteomyelitic patellar bone fragments done. Resultant soft tissue defect was reconstructed with medial gastrocnemius muscle flap and skin grafting.

Case 14

Pre Op

Intra Op

Immediate Post Op

Distal necrosis

Wound debridement

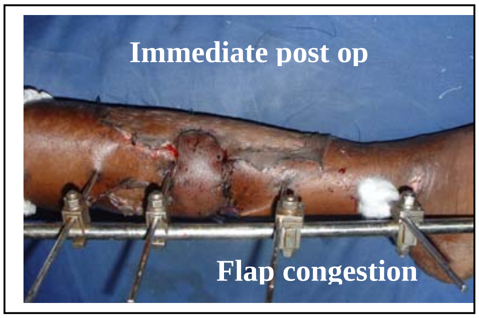
Gastrocnemius flap

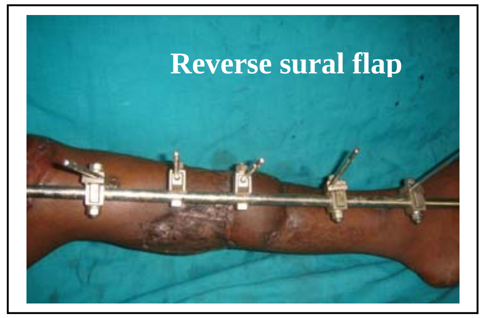
One case of middle third leg defect reconstructed with longitudinal propeller showed distal 30% necrosis which was managed by wound debridement and skin grafting (case 15).

Case 15

Other case of middle third leg defect reconstructed with multilobed propeller showed flap congestion during immediate post operative period which later resulted in total flap loss (case 16). This was managed by wound debridement and reverse sural artery flap

Case 16





Relation of comorbidity with complications:

Out of the five cases with complications three cases had a history of smoking. Among these three cases two cases showed partial flap necrosis while the other showed total flap loss. In the midst of the four patients with history of smoking three cases showed flap related complications.

Discussion

The ideal method for the soft tissue reconstruction should be reliable, relatively easy to perform, offer viable tissues similar in skin texture and thickness to the lost ones ('replace like with like'), leave the most inconspicuous donor site defect possible, and be performed without compromising other body regions.

Even if, experimentally, muscle flaps provides better blood flow, increased antibiotic release, increased oxygen tension and decreased bacterial count at the recipient site, provided the flap is well vascularised and the concepts of radical debridement and obliteration of dead space are respected, fasciocutaneous flaps did not demonstrate significant differences in the outcomes compared to muscle flaps. Further to these experimental and clinical series, perforator flaps have been shown to be well vascularised due to a structural haemodynamic enhancement described by Rubino et al[32] and, used as free or pedicled flaps, they can provide an adequate functional covering in selected patients. Nevertheless, there are instances where debridement of the bone tissue does not leave a deep cavity along the leg bones and fasciocutaneous flaps can be used to cover the defect and to restore function without recurrence of the disease.

The current study included twenty patients with soft tissue defect for reconstruction. Mean age at presentation was 37 (range 21-54 yrs). A total of 14 male patients and 6 female patients were included in this study group. 11 cases were soft tissue defects in the gluteal region (55%) and 9 cases were soft tissue defects in the lower extremity. Soft tissue defects dimensions were ranging from 3x3 cm to 13x 10 cm.

All patients in addition to routine investigation were submitted to doppler examination of the perforators near the soft tissue defect. As stated by Taylor [23] the position and calibre of cutaneous perforators are highly variable between individuals and often asymmetric even in the same individual. Pre-operative Doppler flowmetry is often used to rapidly identify the perforating vessels in the anatomical area of interest. However, the procedure is operator dependent, time-consuming, and not always accurate in localising the perforating vessels. False-positive results for unidirectional doppler sonography can be 50%. Therefore, Doppler evaluation could be limited to confirm intraoperatively the choice of the perforator vessel performed under direct visualization during the dissection. Other imaging methods such as Doppler ultrasound and multislice CT angiography are used worldwide to preoperatively localise the vessels in perforator flap surgery. However, in our small series, we did not feel the need for such investigations.

Perforator-based propeller flaps were planned. Direct visualisation of the vessels to choose the pedicle with the best characteristics for position and calibre, was done to increase the chance of a successful reconstruction. The dissection plane was subfascial. We believe that there is no big difference in flap survival between the fasciocutaneous and adipocutaneous propeller flaps. A difference can be seen in the ease of dissection. Sub-fascial flap raising is faster and the perforator is more clearly localised and freed. Supra-fascial dissection leaves a less consistent donor site defect and makes flap dissection easier at the sites where the muscular septa join the muscular fascia. Microsurgical xpertise needed in the vessels' dissection phase which was carried out under loupe magnification, in order to preserve the small perforating vessels and to follow the chosen nourishing vessels for a short tract into the muscle belly or inside the septa. Special care was needed to accurately release all the fascial adhesions around the perforating artery and vein to prevent the torsion of the pedicle during flap rotation. Due to the fact that the propeller perforator-based flap is a local flap, the characteristics of skin texture and thickness of the subcutaneous tissue are very similar to the missing ones, debulking and thinning of flap was unnecessary. The morbidity of the donor site was limited to the same area of the body already affected and it was cosmetic, the muscle being completely preserved during the flap harvesting. The donor site was partially covered by the flap (minor blade of the propeller). The conditioning factors in planning the flap design were the position and the size of the defect, the exact location of the perforator found during dissection, the presence of external fixator pins, the pre-existing scars and the need to preserve other useful local flaps for salvage procedures.

In the present study, six cases of sacral pressore sore, two cases of intergluteal pilonidal sinus, and three cases of ischial pressure sore and nine cases of lower limb defects were reconstructed. Flaps with dimension of 7x5 cm to 14 x 11 cm were elevated for soft tissue reconstruction. Five out of twenty patients presented with complications of wound dehiscence, partial and total flap loss.

Pressure-sore defects present a difficult challenge because of the high rates of wound complications and recurrence. Myocutaneous advancement flaps have been considered the standard first-line treatment for pressure sores that fail conservative therapy. Muscle sparing should be considered in paraplegic patients as well. Limitation of sliding gluteus maximus muscle cover as described by Ramirez et al[41] in 1984 are increased blood loss, the increased operating time and the tension on the edges of the flaps, sacrifice of gluteus maximus muscles which results in loss of the future reconstructive possibilities. The preservation of muscle integrity and muscle function is one of the greatest assets of the perforator flap principle. Especially in non-paralysed patients who will need full function of the gluteal muscles for recovery of ambulation, the knowledge that function is kept intact may significantly lower the threshold towards decubitus reconstruction with good-quality tissue.

Sacrifice of underlying muscle is required in the inferior gluteal myocutaneous rotation flap, a commonly used means of ischial reconstruction in these patients. The donor-site dissection requires closure over the dead space created by the disinserted muscle. We have observed that this site is a common site of postoperative wound breakdown after this reconstruction. The perforator counterpart permits tension-free donor-site closure over an intact muscle bed. Myocutaneous flaps for ischial reconstruction often leave readvancement of the failed flap as the only means of addressing recurrence. The inferior gluteal artery perforator flap spares all muscle and myocutaneous flaps for future use, if required. A myocutaneous flap has been used routinely for reconstructing pressure sores in the pelvic regions on account of its good vascularity.

The advantages of the perforator flap over the traditional flap include reduced bleeding, preservation of the muscle and its function, versatility of the flap design to yield a better match to the defect and increased movability of the flap. However, a myocutaneous flap is still a better choice when filling an extensive cavity with adequate bulk is indicated.

In 1993, Koshima et al[41] published their early results with gluteal perforator-based flaps for repair of sacral pressure sores. Majority of Koshima's patients received a flap based on several perforators, which needed to be rotated over $60–180^0$ to cover the defect. Four of our initial flaps were based on gluteal perforators in the parasacral region. Two or more arteriovenous perforators could be included in the flap designed with rotation of lesser degrees. The flaps taken from the parasacral area have a risk of perforators nearer to the injured zone.

As described by Blondeel et al [41] it is possible to raise large skin–subcutaneous flaps, based on one single muscle perforator, at a distance from the injured area. Four of our flaps to cover sacral sores were based on superior gluteal perforator. The dissection of the pedicle takes some time, but is straightforward as it lies in an avascular plane. This gives the additional advantage that the blood loss is kept to a minimum, compared to any gluteus flap of which the dissection of the sacral origin can be quite bloody. Although Meltem et al [31] harvested gluteal perforator flap with maximum dimension of 16x20 cm successfully, the largest flap based on gluteal perforators in our study was 14x11 cm in dimension. The conservative approach to the flap makes it a safe procedure, even at the beginning of the learning curve. If no perforators had been found at the expected sites, salvage would have been possible with bilateral rotation flaps. The rotation flap suture lines, however, always show some tension and the tip of the flap is less reliable and less bulky than the perforator flap would be. The superior gluteal artery perforator flap provides us with a large, bulky and safe skin–subcutaneous flap to cover sacral pressure sores. There is no significant donor site morbidity, no bridges are burned and neither muscle nor muscle function is sacrificed.

As described by Moscatiello et al[37] in the distal anteromedial third of the thigh, perforators arises from descending genicular artery (DGA), saphanous artery, femoral artery or popliteal artery. The SA can arise from the DGA or the femoral artery. Perforator vessels, that nourish the distal anteromedial thigh, can come from each of the deep vessels which are widely variable in location and diameter.

In our study, out of three perforators, one septocutaneous perforator arose directly from the femoral artery and the other two were musculocutaneous perforators. One of these patients suffered a partial distal necrosis of 20%. He was taken up for surgery in the acute phase after injury and had the habit of smoking. Flap dimension was about 18x7 cm. We were not able to understand if the necrosis was due to the smoking habit, underlying osteomyelitis or the excessive length of the flap. Moscatiello et al [37] had similar complication when flaps were extended beyond the proximal half of the thigh. In the midst of the four lower limb reconstruction patients with history of smoking, three cases showed flap related complications. Smoking as a factor for flap necrosis needs to be further evaluated. The distal anteromedial thigh provides soft tissue with adequate qualities such as texture, colour and pliability that make it a very useful donor site for knee and leg reconstructions. The operation time is short; a microvascular anastomosis is not needed. The surgical intervention can be performed under locoregional anaesthesia. This advantage makes it an interesting option for all patients and above all when a free microsurgical flap is not advisable (e.g. elderly patients, complicated metabolic disorders). The donor site can be closed in a V-Y shape or with a skin graft.

A flap based on the perforator can be designed whenever a cutaneous perforator can be identified with an audible doppler probe adjacent to a defect. In our study, we utilized multilobe design for three flaps in leg defect reconstruction, bilobe design for one flap in knee reconstruction and the rest were longitudinal propeller design. Although this design was only applied to the sacral and lower leg reconstruction, it can be applied in other locations such as a defect on the back or thigh region created after tumor excision when a large flap is needed and problematic donor closure is anticipated. This design has the following

Advantages of incorporating designs to perforator flap are:

- a larger flap could be transferred to the defect
- direct closure of the donor defect was easier;
- an extensive pedicle dissection was unnecessary; and
- Other potential donor sites could be saved by using a single donor site.

On comparison with free flaps, perforator flap design is constrained by local anatomy and available local perforators. Utilizing two perforators could be problematic in local perforator flaps. Short Pedicle and the need for radical dissection of perforator are other limitations of perforator flap when compared to free flap. Local perforator flaps and particularly the propeller flap could be a safer and lesser invasive reconstructive option than free flaps. The propeller flap can be a time-saving procedure, can reduce the risk of total flap failure, can reduce the donor site morbidity and can avoid the use of the main vessels that supply the foot, as recipient vessels in the lower leg. Extended Applications of perforator based propeller flaps include “Free Style” perforator local flap.

Summary

&

Conclusion

Vascularised tissue in the form of muscle or non-muscle flaps are currently the option for wound coverage following adequate surgical wound debridement. Twenty patients with soft tissue defect in the age range of 21-54 yrs were prospectively studied by reconstruction with perforator based propeller flaps. The following findings were observed from the study:

- The pedicle perforator propeller flaps offer viable tissues similar in skin texture and thickness to the lost ones ('replace like with like').
- Propeller flaps allows the surgeon the freedom to select, tailor or compose the flap independent of the limited indications of conventional flaps.
- Pedicle perforator propeller flaps of the refined design can be used effectively in various reconstructions when difficult wound reconstruction is anticipated.
- Propeller flaps are relatively easy to perform while allowing the coverage of wide defects.
- Propeller flaps leave the most inconspicuous donor site defect possible, preserving muscles both with their functions and sparing the main vascular trunks.

- Local perforator flaps and particularly the propeller flap could be a safer and lesser invasive reconstructive option than free flaps.
- Propeller flaps saves on operating time and does not rely on expensive microsurgical facilities without compromising the reconstruction.
- Propeller flaps provides better aesthetic results and higher patient satisfaction.

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Appendices

Appendix 1

Consent Form

PATIENT CONSENT FORM

Study Title : **Perforator based propeller flap for soft tissue reconstruction**

Study Centre : **Department of Plastic Reconstructive & Maxillofacial Surgery**

Patient's Name :

Patient's Age :

Identification No:

Patients may check (✓) these Boxes

I confirm that I have understood the purpose of procedure for the above study. [ ]

I have the opportunity to ask the questions and all my questions and doubts have been answered to my complete satisfaction. [ ]

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving any reason, without my legal right being affected [ ]

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethics committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from study. [ ]

I agree to this access, however, I understand that my identity would not be revealed. In any information released to third parties or published, unless as required under the law. [ ]

I agree not to restrict the use of any data or results that arise from this study. [ ]

I agree to take part in the above study and to comply with the instructions given during the study and to faithfully to cooperate with the study team, and to immediately inform the study staff if I suffer from any deterioration in my health or my well being or any unexpected or unusual symptoms. [ ]

I hereby give consent to participate in this study. [ ]

Signature / Thumb Impression ....
of the patient:
Place : ....
Patient's name and address : ....
Signature of the Investigator :..................................Place ....Date ....
Name of the Investigator : ....

Appendix 2
Proforma

PROFORMA

NAME:

AGE:

SEX:

ADDRESS:

Ph no:

PS No:

ADM No:

D.O.Adm:

D.O.Surg:

D.O.Dis:

PRESENTING COMPLAINTS:

HISTORY OF PRESENT ILLNESS

PAST HISTORY:

Co morbidity:

PERSONAL HISTORY

Smoker/ non-smoker

TREATMENT HISTORY

GENERAL EXAMINATION

CLINICAL EXAMINATION

PROVISIONAL DIAGNOSIS:

OPERATION : Date:

(photographs)

FOLLOW UP:

Appendix 3

Master Chart

Key to Master Chart

LP	LONGITUDINAL PROPELLER
MP	MULTILOBED PROPELLER
BP	BILOBED PROPELLER
U1/3	UPPER ONE THIRD
M 1/3	MIDDLE ONE THIRD
L1/3	LOWER ONE THIRD
L	LEFT
R	RIGHT
PT	POST TRAUMATIC
#	FRACTURE
D	DORSAL VERTIBRAE
BB	BOTH BONE
C	CERVICAL VERTIBRAE
A-V	ARTERIO VENOUS

Slno	Name	Adm No	PS No	Age	Sex	Aetiology	Co Morbidity	Habits	Site
1	S	23104	655/08	26	Male	Pressure Sore	Nil	Nil	R Gluteal Region
2	KD	26307	178/08	27	Male	Trauma	Nil	Smoker	Lower 3rd Leg & Ankle Region
3	M	25410	177/08	43	Male	Trauma	Nil	Smoker	Middle 3rd R Leg
4	R	24894	1211/08	45	Male	Pressure Sore	Nil	Alcoholic	Sacral Region
5	A	28145	1157/08	50	Male	Pressure Sore	Diabetic	Nil	Sacral Region
6	C	24763	932/08	45	Female	Residual Soft Tissue Sarcoma	Nil	Nil	L Leg Middle 3rd Calf
7	SJ	35787	3030/06	50	Female	Pilonidal Sinus	Nil	Nil	Intergluteal Cleft
8	K	21893	1605/08	45	Male	Pressure Sore	Nil	Nil	Sacral
9	P	41500	655/97	37	Male	Pressure Sore	Nil	Nil	L Gluteal Region
10	MB	44980	1574/08	30	Female	Pilonidal Sinus	Nil	Nil	Intergluteal Cl
11	SH	56642	2030/08	36	Female	Bullgore Injury	Nil	Nil	L Upper 3rd Leg
12	D	42887	1894/04	45	Male	Pressure Sore	Nil	Nil	Sacral Region
13	AD	59382	2513/08	40	Female	Trauma	Nil	Nil	Lower 3rd Leg
14	G	55568	1400/08	28	Female	Pressure Sore	Nil	Nil	R Gluteal Region
15	KK	57902	3176/08	22	Male	Pressure Sore	Nil	Nil	Sacral Region
16	JR	76206	3380/08	54	Male	Trauma	Nil	Smoker	R Knee Anterior Aspect
17	RD	56257	3223/08	25	Male	Pressure Sore	Nil	Nil	Sacral Region
18	SR	337109	3762/08	45	Male	Trauma	Nil	Smoker	Middle 3rd L Leg
19	KS	6830	3890/08	21	Male	Post Burns	ATT 15 Years Ago	Nil	L Knee Lateral Aspect
20	VM	9631	428/09	26	Male	Trauma	Nil	Nil	Lower 3rd L Leg

Slno	Name	Defect Dimension	Impression	Flap Design	Flap Dimensions In Cm	Rotation Degrees
1	S	5x5 Cm	Ischial Pressure Sore(R Side)	L P	6x7	40
2	KD	9x8 Cm	PT Soft Tissue Defect L Leg (L 1/3 & Ankle Joint)	L P	14x9	180
3	M	9x4 Cm	PT Soft Tissue Defect R Leg	L P	10x5	180
4	R	11x8 Cm	Grade IV Sacral Pressure Sore	L P	12x9	90
5	A	6x5 Cm	Grade IV Sacral Sore	L P	7x6	90
6	C	11x8 Cm	Residual Dermato Fibro Sarcoma	L P	12x9	180
7	SJ	7x6 Cm	Intergluteal Pilonidal Sinus	L P	8x7	90
8	K	5x6 Cm	Sacral Sore(L Side)	L P	6x7	90
9	P	7x6 Cm	Grade IV Ischial Pressure Sore	L P	8x7	90
10	MB	9x4 Cm	Intergluteal Pilonidal Sinus	L P	10x5	90
11	SH	7x7 Cm	PT Upper Third L Leg Defect	L P	8x8	180
12	D	13x10 Cm	Gradeiv Sacral Sore	L P	14x11	180
13	AD	3x3 Cm	PT Soft Tissue Defect L Leg(L 1/3)	M P	7x5	90
14	G	7x4 Cm	Grade IV Ischial Pressure Sore	L P	8x5	90
15	KK	9x7 Cm	Grade IV Sacral Sore	L P	10x8	110
16	JR	10x6 Cm	Grade III B Fracture Patella With Knee Defect	L P	18x7	180
17	RD	9x7 Cm	Grade IV Sacral Sore	L P	10x8	110
18	SR	4x3 Cm	PT Soft Tissue Defect L Leg (M 1/3)	M P	7x5	90
19	KS	9x5 Cm	Unstable Scar L Knee	B P	10x5	90
20	VM	4x3 Cm	Grade III B Fracture Tibia With Soft Tissue Defect L Leg(L1/3)	M P	7x5	90

Slno	Name	Details	No Of Perforators	Perforator Emerging Sites
1	S	Iumbar Meningomyelocele Operated At 40 Days Of Age	1 A-V	Inferior Gluteal Artery Perforator
2	KD	Ankle Stabilization By K Wire	1 A-V	Medial Leg Perforator
3	M	Nonunion # Both Bone R Leg	1 A-V	Medial Leg Perforator
4	R	Seizure Disorder Anterior Decompression Cervical Spine	2 A-V	Superior Gluteal Artery Perforator
5	A	#D12 With Paraplegia Anterior Decompression Done	1 A-V	Superior Gluteal Artery Perforator
6	C	Dermatofibrosarcoma With Residual Tumor	1 A-V	Medial Gastrocnemius Perforator
7	SJ	Discharging Sinus Intergluteal Cleft	1 A-V	Superior Gluteal Artery Perforator
8	K	C4C5 Subluxation With Quadriplegia	1 A-V	Superior Gluteal Artery Perforator
9	P	Healed Sacral Sore ,Rotation Flap For Ischial Sore With Remnant Sore	1 A-V	Inferior Gluteal Artery Perforator
10	MB	Discharging Sinus Intergluteal Cleft	1 A-V	Superior Gluteal Artery Perforator
11	SH	Bullgore Injury Upper Third Leg	1 A-V	Antero Medial Thigh Perforator
12	D	# D12 With Paraplegia - Anterior Decompression Done	1 A-V	Superior Gluteal Artery Perforator
13	AD	Post Infective Rawarea L Leg	1 A-V	Medial Leg Perforator
14	G	# D12 Anterior Decompression, Posterior Thigh Falp Done For Contralateral Ischial Sore	1 A-V	Inferior Gluteal Artery Perforator
15	KK	Multiple Punctate Contusion L Parietal Region	1 A-V	Superior Gluteal Artery Perforator
16	JR	# Lateral Femoral Condyl	1 A-V	Antero Medial Thigh Perforator
17	RD	#D1 D8 Paraplegia	1 A-V	Superior Gluteal Artery Perforator
18	SR	# Patella # BB L Leg On External Fixator	1 A-V	Medial Leg Perforator
19	KS	Non Healing Ulcer Medial Aspect Knee	1 A-V	Antero Medial Thigh Perforator
20	VM	Undisplaced # Tibia Lower Third Leg On Cast	1 A-V	Medial Leg Perforator

Slno	Name	Location Of Perforator From Defect	Duration Of Surgery	Donar Area Management	Complications	Salvage	Hospitilization Days
1	S	3-4 Cm	2hours 30 Min	Primary Closure	Nil		10
2	KD	7-8 Cm	3 Hours	Skin Grafting	Nil		23
3	M	3- 4 Cm	2 Hours 30 Min	Skin Grafting	30% Necrosis	Skin Grafting	38
4	R	3- 4 Cm	3hours 30 Min	Primary Closure	Nil		7
5	A	3- 4 Cm	2 Hours 30 Min	Primary Closure	Nil		10
6	C	3- 4 Cm	2 Hours 30 Min	Skin Grafting	Nil		9
7	SJ	3- 4 Cm	2 Hours 30 Min	Primary Closure	Nil		5
8	K	3- 4 Cm	2 Hours 30 Min	Primary Closure	Nil		10
9	P	3- 4 Cm	2 Hours 30 Min	Primary Closure	Wound Dehiscence	Rotation Flap	28
10	MB	3- 4 Cm	2 Hours 30 Min	Primary Closure	Nil		9
11	SH	6-7 Cm	3 Hours	Skin Grafting	Nil		8
12	D	3-4 Cm	3 Hours	Rotation Flap	Nil		12
13	AD	3-4 Cm	2 Hours 30 Min	Primary Closure	Nil		5
14	G	3-4 Cm	2 Hours 30 Min	Primary Closure	Nil		7
15	KK	3-4 Cm	3hours 30 Min	Primary Closure	Total Flap Loss	Wound Debridement	15
16	JR	5-6 Cm	4 Hours	Skin Grafting	20% Necrosis	Gastrocnemius Flap	31
17	RD	3-4 Cm	2 Hours 30 Min	Primary Closure	Nil		5
18	SR	3-4 Cm	3 Hours 30 Min	Skin Grafting	Total Flap Loss	Reverse Sural Flap	30
19	KS	3-4 Cm	2 Hours 30 Min	Primary Closure	Nil		20
20	VM	3-4 Cm	3 Hours 30 Min	Skin Grafting	Nil		12