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Efficacy of Perforator based flap in Reconstruction of soft tissue defect of lower leg

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Abstract- *Soft tissue defect of the lower leg has been a difficult proposition since its inception because of proximity of skin to the bone and tendon , shortage of local tissue and poor local circulation. Perforator based flaps are based on local perforators and this has been well taken for repair of soft tissue defects of lower leg. This prospective study on 15 patients was conducted in Dept. of Surgery in NetajiSubhash Chandra Bose Subharti Medical College, Meerut. There were 13 males and 2 females in the study. The patients age varied between 15-55 years, Flap selection was done according to site, size, shape of the defect and status of the surrounding tissue. After proper pre-operative workup surgery was done under anaesthesia and perforators were identified by a hand-held Doppler (8MHz). Road traffic accident was the most common cause of the defect in 13 (87%) patients and post-infective chronic ulcer in 2 (13%) patients. 4(27%) patients had defect in the middle one-third of leg and 11(73%) patients had defect in lower one-third of leg and foot. Post-operative results were good with minimum complication. It was concluded that the perforator based flap is a reliable option for reconstruction of lower leg soft tissue defect with low post-operative morbidity, good daily function and satisfactory cosmetic results. Perforator flap also spares major vessels and muscles, gives stable coverage with good contour, colour match and less operative time. It is a single staged procedure, cost-effective, can be done under loupe magnification and with the use of simple device like a hand-held Doppler.*
Key words- *Perforator based flap, Reconstruction , Soft tissue defect, lower leg.*

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I. Introduction

Soft tissue defect of lower limb has been a difficult problem because of proximity of skin to bone and tendons and shortage of local tissue and poor local circulation.

The choice of reconstruction often ranges from simple to complex.Direct closure represents the simplest and straight forward technique.Simple technique includes skin grafts and local flaps, which may allow defect closure.

Circulation of fasciocutaneous flap is based on prefascial and subfascial plexus. There are also arterial plexus at the subdermal and subcutaneous level.

These plexuses are supplied by regional arteries that enter the deep fascia through following branches,Musculocutaneous branches (perforators)–through underlying muscle,Septocutaneous branches (perforators)–through the septum between underlying muscle and Direct cutaneous branch (perforators)

These perforators are quite significant in size and number and can be identified with Doppler, then raised and rotated for perforator based flap to cover small to medium sized adjacent defects.

Aims And Objectives

- To identify the perforator nearest to the defect with the help of hand held Doppler.
- To see the size of flaps based on different perforators.
- To see distribution of flaps based on different perforators.
- To see the degree of rotation of different flaps to cover defects.
- To see the outcome of raised perforator based flap in covering the defect.

II. Materials And Methods

This prospective study was conducted during July 2016 to March 2019 on patients admitted through Plastic Surgery OPD, General Surgery OPD , Casualty or transferred from Orthopaedics in NetajiSubhash Chandra Bose Subharti Medical College, Meerut,India after taking permission from the institutional ethical committee and taking informed concent from patient.The present work is based on study of 15 patients who underwent reconstruction of lower limb using perforator based flaps. The study was carefully and meticuosly performed and an attempt made to cover all possible aspects. Flap selection was done regarding site, size, shape

of the defect, status of surrounding tissue, presence of external fixator, patient comfort. The cases included belonged to different age groups and both sexes.

Patient Selection:

The inclusion criteria are:

1. Soft tissue defect with or without exposed bone, joint, tendon or implant either due to trauma, infection or surgery admitted directly in Department of Surgery or Referred from Orthopedics
2. Patients having Triphasic flow on Arterial Doppler.

The exclusion criteria are:

1. Patients with history of vaso-spastic or vascular diseases/ Atherosclerosis / Buerger's disease
2. Patients not having Triphasic flow on Arterial Doppler
3. Patients in whom repair of vascular injury has been done.

The patients were studied under following headings:

1.Particulars of the patient**:**.

2.History **:** Careful history is taken to determine etiology of defect, injury and its duration on preformed working performa.

3.Clinical Examination including .general examination and local examination :

Detailed local examination of the wound is done and following are noted:

1.Site and size of defect

2.Condition of wound – for infection , pus discharge and necrotic tissue.

3.Exposure of deeper structures such as bone, muscle and tendon.

4.Type of associated fracture of bone and presence of any orthopaedic implant such as external fixator,plates and screw.

5.Vascular status of limb: Presence of vascular pulsation of anterior tibial, posterior tibial and dorsalispedis arteries.

6.Condition of surrounding skin for any scar, external fixator pins and their location.

7.Functional status of the limb and movements of knee and ankle joints.

8. Orthopaedic management.

4.Investigations:

a. Laboratory Investigations
b. Pus: culture and sensitivity
c. Radiological Study
d. ECG and Chest X-Ray – in elderly patients
e. Colour Doppler (Arterial)- whether Triphasic flow present or not in Anterior Tibial, Posterior Tibial Arteries.

5.Pre-operative evaluation of perforator with hand held Doppler device (8MHz Probe)– We consider preoperative Doppler as routine standard operating procedure for performing a perforator flap. The Doppler study was made with a hand held Doppler with an 8 Hz frequency probe around the axis of the major vessel adjoining the defect. The perforator with a consistent, audibly loud and high pitched Doppler signal was marked.

6.Surgical Management

a)Anaesthesia –

General or Spinal anaesthesia and under tourniquet control, the primary defect was debrided and prepared. With the help of lint piece, flap was marked and then transposed or rotated to the defect, based on the nearest perforator.

b) Incision-

A non-committal generous exploratory incision was made. Incision was made in such a fashion that if need arises, tissue on both sides of the incision could be used for harvesting a flap. Due care was taken to make maximum use of the available tissue on both sides of the incision. Due care was also taken while making the incision so that, if appropriate perforator is not identified or if found to be in trauma zone, the same incision can be used to delay a fasciocutaneous flap or harvest a regional axial flap or as a gateway to dissect the recipient vessel for microanastomosis. Skin incision was given at most distal part of the flap fascia.

c) Flap planning and designing-

After a non-committal exploratory incision was made, the perforators were identified. The perforator which is close to the edge of the wound is used. Perforator which is too far from the defect was also not chosen as it increases the length of the flap unnecessarily.

After an appropriate, reliable perforator was identified, the distance of the perforator to the distal edge of the defect was measured. Planning was made in reverse, considering the degree of rotation involved, and distal edge of the flap was marked along the long axis of the extremity. Due care was taken to add 1-1.5 cms to the long axis of the flap. The width of the defect was noted and marked on either side of the perforator. The flap was then harvested, and if possible islanded on the perforator and the perforator was skeletonised to prevent its kinking. Under loupe magnification the flap was raised proximal to the distal direction in the subfascial plane. Fascia was stitched to the skin to prevent shearing forces and impairment of fascial blood circulation. All the fibrous strands were dissected to prevent compression on the perforator after rotation. Throughout the procedure, a lignocaine soaked small piece of gauze was kept over the perforator. The perforator/ gauze was irrigated by lignocaine solution to prevent drying and spasm of the perforator.

After raising/ harvesting the flap was permitted to perfuse for a while before rotation. Whenever possible, a subcutaneous vein was kept at the base of the flap. It is possible to anastomose this vein to a local vein to augment the venous outflow if a venous compromise is anticipated. Cautery was used judiciously as and when needed, away from the perforator to achieve absolute hemostasis. The flap was then placed over the defect. The flap was turned from the side which causes the least degree of torsion on the perforator. This was decided on visual inspection. The initial sutures were taken along the sides of the perforator to prevent traction to the perforator. Due care was taken to inset the flap without any tension.

The secondary defect was closed by split skin grafting. Aseptic dressing was done.

7.Result evaluation was done taking flap survival ,outcome and aesthetic result

8) Follow-up –Necessary rehabilitation for functional and aesthetic debility was provided at follow-up. Physiotherapy was given regarding gradual weight bearing in case of lower limb recipient site and range of motion of adjacent joint.

III. Results

The patients age ranged from 15-55yrs in the study. 13.3% (2) patients in age group of 15-20, 40% (6) patients in age group of 21-25, 13.3% (2) patients in age group of 26-30, 7% (1) patients in the age group 31-35 & 13.3% (2) patients in age group 36-40 and 13.1% (2) in age group 51-55.

There were 13 males (87%) and 2 (13%) females cases in the study. This shows male predisposition to traumatic wounds.

Road traffic accident was the most common cause of leg and foot defects responsible in 13 (87%) patients and 2 (13%) patients had post infective chronic ulcer.In our study 6 (40%) patients presented with Exposed bone with fracture Tibia, 7 (47%) patients with Non Healing Ulcer and 2 (13%) patients with Non-union fracture Tibia at the recipient or defect site.

The area between the tibial tuberosity to foot was equally divided into 3 parts - Upper 1/3rd , Middle 1/3rd and Lower 1/3rd and foot. 4 (27%) patients had defect in the middle 1/3rd and 11 (73%) patients had defect in lower 1/3rd and foot.

Six (40%) patients under went external fixator application and 2 (13%) patients underwent internal fixator application. No fixation was done in 7 patients (47%).

In our study 7 (47%) patients presented within 1 week of Injury, 2 (13%) patients between 1-2 weeks of Injury, 2 (13%) patients between 2-3 weeks of Injury and 4 (27%) patients presented after more than 3 weeks of Injury.

Peroneal ArteryPedicled Perforator FlapPre-Operative

Intra-Operative

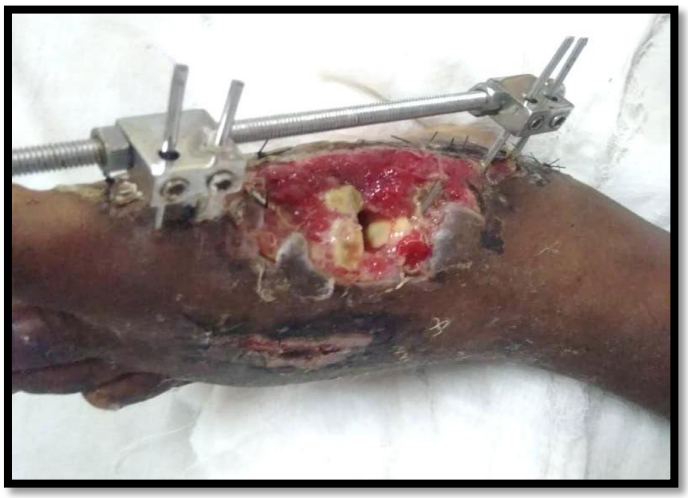
Post-Operative

Peroneal Artery Island Perforator Flap
Pre-Operative

Intra-Operative

Post-Operative

Posterior Tibial Artery Pedicled Perforator Flap
Pre-Operative



Post-Operative

In our study, 7 (47%) flaps were based on perforator arising from Posterior Tibial Artery and 8 (53%) flaps were based on perforators arising from Peroneal Artery.
In our study out of 7 Posterior tibial perforator flaps , 4 flaps were Pedicled Flap and 3 flaps were Island flap.
In our study out of 7Peroneal artery perforator flaps , 4 flaps were Pedicled Flap and 4 flaps were Island flap.

Location of the Perforator to the Defect

a) Posterior Tibial Artery Perforator Flaps

Location of the Perforator to the defect	No. of patients	Percentage
Proximal	5	34
Central	0	0
Distal	2	13
Total	7	47

b) Peroneal Artery Perforator Flaps

Location of the Perforator to the defect	No. of patients	Percentage
Proximal	6	40
Central	2	13
Distal	0	0
Total	8	53

Distance of the Perforator from the defect

a. Posterior Tibial Artery Perforator Flaps

Patient No.	Distance of the perforator from the defect (in cm)
1	9
2	5
3	17
4	6
5	8
6	10
7	9

b. Peroneal Artery Perforator Flaps

Patient No.	Distance of the perforator from the defect (in cm)
1	10
2	6
3	5
4	6
5	7
6	9
7	8
8	7

Perforator localization with the help of Hand held Doppler

	No. of perforators	Percentage
True Localization	18	90
False Localization	2	10
Total	20	100

In our study out of 15 patients maximum size of defect was 9x5 cm^2 and minimumsize of defect was 3x3 cm^2.
In our study the maximum size of the flap was 12x5 cm^2 and minimal size was 8x5 cm^2.

Degree of Rotation of flap

Degree of Rotation of flap (in degrees)	No. of patients	Percentage
<90	2	13
90-135	4	27
135-180	9	60
Total	15	100

In our study 12 (80%) patients turned up for follow up in OPD and 3(20%) patients did not turn up for follow up in OPD.
In our study management of Secondary defect in all the 15 (100%) patients was done by Split Skin Grafting.

IV. Discussion

Time of presentation of injury was less than 1 week in 61(61%) and 7(47%) patients in study conducted by **Schaverien MV et al (2010)** [1]and the author.
In a study conducted by **Schaverien et al (2010)**[1] and the author time of presentation of injury was more than 1 week in 39(39%) and 8(53%) patients respectively.
In our study the mean defect size was 6.4x3.8 cm. It is similar to studies conducted

by**T.-C. Lu et al (2011)**[2] **, Chang SM et al (2014)**[3]**,** and **Kerfant N et al (2018)**[4] where

mean defect size was 5.8x4.6cm, 6.4x4cm and 5.5x4.1 cm respectively.

According to Mean Flap Size

	Parrett BM et al[5] (2008) (n=6)	Tos P et al[6] (2011) (n=22)	Cheng L et al[7] (2017) (n=55)	Author (n=15)
Mean Flap Size (in cm)	8x5.5	10x9.7	9.2x4.5	9.9x4.6

According to Artery on which the perforator flap is based

Artery	Jakubietz RG et al[8] (2007) (n=8)	Tos P et al[6] (2011) (n=22)	Chang SM et al[3] (2014) (n=12)	Ozalp B et al[9] (2016) (n=7)	El-Sabbagh AH et al[10] (2017) (n=12)	Author (n=15)
Posterior Tibial	3(38%)	13(59%)	7(58%)	4(57%)	8(67%)	7(47%)
Peroneal	5(62%)	6(27%)	5(42%)		4(33%)	8(53%)
Anterior Tibial				2(29%)		
Lateral circumflex femoral artery		1(5%)		1(14%)		

According to Perforator localization with Hand-held Doppler

	Khan UD et al[11] (2007) (n=14)	Lethaus B et al[12] (2017) (n=45)	Author (n=15)
True Localization (True Positive)	40(82%)	86(74%)	18(90%)
False Localization (False Positive)	3(6%)	21(18%)	2(10%)
False Negative	6(12%)	9(8%)	

According to Angle of Rotation (Range) of Flap

	Lecours C et al[13] (2010) (n=22)	Tos P et al[6] (2011) (n=22)	Hafeez K et al[14] (2012) (n=24)	Bekara F et al[15] (2016) (n=428)	Ozalp B et al[9] (2016) (n=7)	Author (n=15)
Angle of Rotation of Flap (Range)	70-180	90-180	120-180	60-180	90-180	60-180

The author studied 15 patients in which all 15(100%) patients were managed by split skin grafting for secondary defects. The result was similar to studies conducted by **Hafeez et al (2012)[14] , Ozalp B et al (2016)[9] , Kerfant N et al (2018)[4]** where split skin grafting was done for secondary defects in 22(92%), 7(100%) and 12(92%) patients.

In study conducted by **Hafeez K et al (2012)[14]**and**Kerfant N et al (2018)[4]**primary closure was done in 2(8%) and 1(8%) patients.

In our study the mean operating time was 130 minutes. **Parrett BM et al (2008)[5] ,Ozalp B et al (2016)[9] , Cheng et al (2017)[7]** conducted studies in which the mean operating time was 103, 106 and 132 minutes respectively. A longer mean operating time was due to a learning curve and because operations were done by 3 plastic surgeons.

In studies conducted by **Parrett et al (2008)[5] ,Schaverien MV et al (2010)[1] , T.-C. Lu et al (2011)[2] ,Hafeez et al (2012)[14]**and **Cheng et al (2017)**[7]the outcome were 100%, 91%, 100%, 96%, 100% respectively. Outcome in our study was 87%. It is attributed to a learning curve and as 3 plastic surgeons were involved in our study.

V. Conclusion

The perforator flap is a reliable option providing low postoperative morbidity, good daily functions, and relatively satisfactory cosmetic results. It is intended to be a suitable alternative for the reconstruction of lower limb defects. Use of perforator flaps also spares the major vessels and muscles. Stable coverage with good contour, colour match and less operative time makes it a good choice for small reconstruction of lower limb defects. It is also a single stage procedure and avoids the complications of free tissue transfer and is cost effective. It can be done under loupe magnification and the use of hand held Doppler increases its efficacy. Replacing like with like and limiting the donor-site to the same area and possibility of complete or partial primary closure are other advantages of these flaps.

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Conflict of Interest - Nil

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