

FACTORS WHICH DETERMINE SUCCESS OF REVERSE SURAL ARTERY FLAP FOR REPAIR OF LOWER LIMB DEFECTS: A RETROSPECTIVE STUDY IN A TERTIARY CARE CENTRE IN SOUTH INDIA

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ABSTRACT

BACKGROUND

Reverse sural artery flap is a fasciocutaneous flap which is still a workhorse in covering distal third of leg defects when the option of free tissue transfer is not practical.

To know the association between the successful outcome of the flap and the selected factors.

MATERIALS AND METHODS

Our retrospective study included 40 patients who had soft tissue defect in the distal third of the leg, heel, ankle and dorsum of the foot. Detailed history was obtained, thorough clinical examination performed, necessary preoperative investigations done and reverse sural artery fasciocutaneous flap cover performed.

STATISTICAL ANALYSIS USED- IBM-SPSS-STATISTICS-VERSION 20.

RESULTS

All the patients selected in the study group underwent reverse sural artery flap cover in a satisfactory way. Majority of the patients were discharged with no complications and a minor group of them with minimal complications.

CONCLUSION

Reverse sural artery flap is a versatile and reliable flap for the coverage of soft tissue defects of distal lower extremity. The leading independent factors which contribute to the success of the flap are trauma as the aetiology, distal third of the leg, and dorsum of the foot being the site of the defect and flap size of 24 sq. cm in comparison to the rest of the factors in the study.

KEYWORDS

Reverse Sural Artery Flap, Defects in Distal Third of Leg, Fasciocutaneous Flap Cover.

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INTRODUCTION

Soft tissue cover for distal lower limb defects, where vascular support for tissue is critical has been a continuous challenge for orthopaedic and plastic surgeon for many years. Exposed bone, fracture segments, tendons should be closed as early as possible to reduce the rate of infection.¹⁻⁶ As the subcutaneous tissue in distal third of lower limb is thin, the tendons, bones and implants are frequently exposed following trauma to this anatomical zone.⁷ Although few flaps exist for soft tissue cover of distal third of lower limb, many of them were not popular and not practised due to surgical difficulties in raising the flap, limited arch of rotation and high degree of unreliability.⁸⁻¹⁶ Fasciocutaneous flaps have significantly helped to solve the problems involved with distal third of leg, ankle and hind foot.¹⁷ Free flap is currently the treatment of choice for large

soft tissue defects of distal extremity. But non-availability of microsurgical expertise and facility at peripheral centres, the cost and sometimes the patient related factors may preclude the option of free flap.¹⁸ The objective of the study is to find the association between the outcome of the reverse sural artery flap and the factors.

MATERIAL AND METHODS

This retrospective study was conducted at Department of Plastic Surgery, SDM College of Medical Sciences, Dharwad from January 2005 to December 2011. It includes 40 patients having soft tissue defects of distal third leg, heel, dorsum of foot and chronic ulcers.

Details like age, sex, cause, site of the defect, dimensions of defects, exposure of the bone, tendon, ankle joint, fracture site, and history of smoking, diabetes mellitus and complications, if any, were noted from patients' medical records. All the patients underwent radiographs.

Culture and sensitivity was sent for appropriate cases. Injection Cefuroxime intravenous 12th hourly was started empirically and was continued or changed according to culture and sensitivity report for 7-10 days. Patient followup was between one to three years (Figure 1 to 6).

In our study, the factors considered to know the association between them and outcome of the sural artery flap were age of the patient, aetiology of the defect, site of the

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defect, smoking and diabetes mellitus. Patients with defects in the distal third of the leg, ankle and foot were included in the study. Patients with polytrauma were excluded.

The Surgical Procedure

All patients were operated under spinal anaesthesia under tourniquet control by the same plastic surgery team. Preoperatively, we have performed hand held Doppler ultrasound in all cases and located the cutaneous perforators. With the patient in a lateral position or prone position, the recipient site defect was debrided, edges were freshened. In case of chronic exposure of the bone, debridement was carried out until healthy bleeding from the bone noted. Depending upon the size of the defect, the flap was outlined at the posterior aspect of the junction of upper and middle third leg. A line was marked beginning at a point midway between lateral malleoli and Achilles tendon and extending superiorly, in between the two heads of gastrocnemius corresponding to the proximal one third and distal two thirds of the leg. The peroneal perforators were marked 5-7 cm proximal to the tip of lateral malleolus. Skin was incised down to the level of dermis and fascia. Dissection was done to expose the sural nerve and short saphenous vein. At proximal margin of the flap, the nerve and the vessels were ligated, severed and incorporated into the flap (Figure 7 to 9). Then, the flap was elevated with fascia, transposed to cover the defect and half-buried mattress suturing performed using 4-0 or 5-0 Nylon. Secondary defect was covered with split-thickness skin graft. Wound was dressed; ankle kept in plantar flexion with anterior plaster of Paris slab.

We immobilised ankle postoperatively for three weeks and did suture removal on 10th postoperative day. Postoperatively, patient was nursed in prone or lateral position with limb elevation. We monitored the flap clinically based on skin colour, temperature, skin turgor and capillary refill.

All the patients were followed up weekly for three weeks. On end of third week, under local anaesthesia, flap pedicle was divided and final inset given. The excess remnant of flap was discarded.

RESULTS

In our retrospective study with a sample size of 40 patients, age group of the patients varied from 6 years to 72 years. Maximum number of patients being in the age group between 20-30 years, forming 37.5% (n=15) of total patients. The youngest patient was 6 years old and the eldest being 72 years.

Majority of the patients were males forming 62.5% (n= 25) of total patients and females formed the remaining 37.5% (n=15). Most of our patients had traumatic aetiology which formed 70% (n=28) of the study group, followed by chronic ulcer forming 10% (n=4) of study group. Diabetic ulcer and unstable scar formed 7.5% (n=3) each. Venous ulcer and defect created by tumour excision contributed 2.5% (n=1) each. 25% (n=10) of the patients had defect in the heel, whereas 22.5% (n=9) had defect in the distal third of the leg. 20% (n=8) of patients had ankle defects, 15% (n=6) suffered from defects over the dorsum of foot, 10% (n=4) of study group had defects over medial malleolus, 5% (n=2) had defect over middle 3rd of the leg and 2.5% (n=1) had defect over lateral malleolus.

The size of the pedicled fasciocutaneous flap varied from 11 x 9 cm to 3 x 4 cm. Smokers constituted 25% (n=10) of the study group population and non-smokers formed the rest of the group. 77.5% (n=31) of the study group were non-diabetics and remaining 22.5% (n=9) were diagnosed with diabetes mellitus. There were no surgical complications in 85% (n=34) of the patients. Epidermal loss, partial flap necrosis and complete flap necrosis were witnessed in 5% (n=2) each of the study group respectively.

Variable	Rate in %	No Complication	Complication+	Odds Ratio & 95% CI	P (by Chi-square/ Fisher exact Test)
Age Groups					
21 to 40 yrs.	84	21	4	0.81 (0.13-5.05)	0.81
Others	86.6	13	2	1	
Aetiology					
Trauma	92.9	26	2	6.5 (0.99-42.3)1)	0.10
Others	81.8	18	4	1	
Site					
Leg (Distal Third) Plus Ankle	94.1	16	1	4.44 (0.47-42.18)	0.21
Others	78.3	18	5	1	
Part Exposed					
Tibia and Tibia Fracture Site	90.9	10	1	2.08 (0.22-20.17)	0.88
Others	82.8	24	5	1	
Flap Size					
20 to 40 sq. cm.	100	13	0	3.71 (1.4-34.44)	0.15
Others	77.7	21	6	1	
Smoking					
Yes	100	10	0	2.5 (0.27-23.53)	0.38
Others	80	24	6	1	
DM					
Present	88.9	8	1	1.54 (0.16-15.17)	0.87
Absent	83.9	26	5	1	

Table 1: Determinants of Outcome of Surgery of Sural Flap

TABLE 2: SUMMARY OF LOGISTIC REGRESSION ANALYSIS

Step	-2Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	6.491 ^a	.495	.867

Table 2a): Model Summary

Step	Chi-Square	df	Sig
1	.000	7	1.000

Table 2b): Hosmer and Lemeshow test

2c) The Wald Criterion demonstrated the significance of the following independent factors.

1. Trauma as the aetiology.
2. Distal 1/3rd of the leg and dorsum of the foot as site of the defect.
3. A flap size of 24 sq. cm.



Fig. 1: Post-traumatic Defect in a Diabetic Patient



Fig. 2: Postoperative Photograph with the Defect Covered in a Diabetic Patient



Fig. 3: Unstable Scar over Achilles Tendon



Fig. 4: Postoperative Cover of Achilles Tendon.



Fig. 5: Post-traumatic Defect with Exposed Ankle



Fig. 6: One year of Followup Photo showing Ankle Cover and Skin Graft on Dorsum of Right Foot.



Fig. 7: Intraoperative showing the Sural Nerve and Short Saphenous Vein.

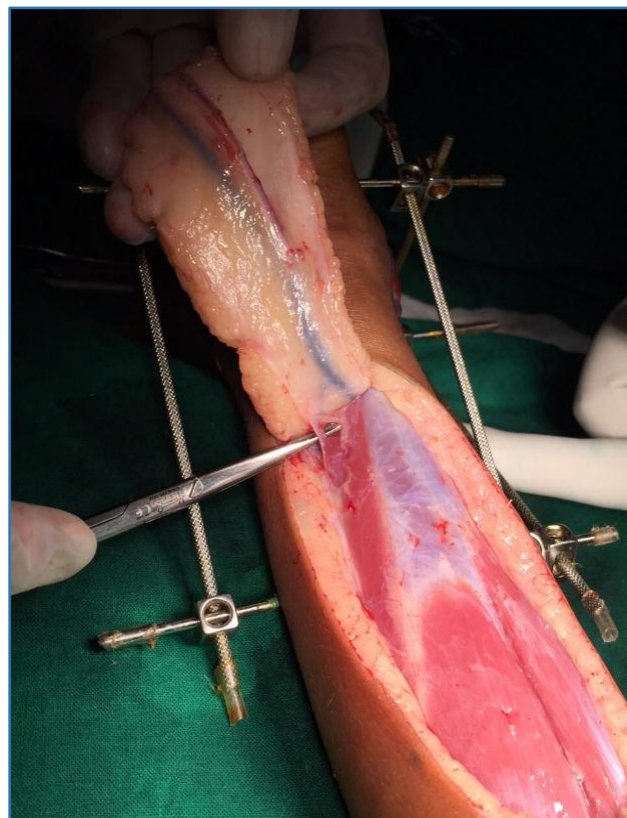


Fig. 9: Intraoperative showing Peroneal Artery Perforator Supplying the Flap



Fig. 8: Sural Nerve and Short Saphenous Vein Incorporated into the Flap



Fig. 10: Partial Flap Necrosis



Fig. 11: Complete Flap Necrosis.

DISCUSSION

Reconstruction of distal third of the leg and foot continues to be one of the challenging tasks for the reconstructive surgeon.¹⁹ This has stimulated a continued research and modification in obtaining an ideal method of reconstruction for such defects. In recent years, fasciocutaneous flap and free flap have become the workhorses for reconstruction of distal third of the leg.

Various fasciocutaneous flaps have been described to solve this problem; each has its own indications, limitations, advantages and disadvantages.²⁰ Although innovations in microsurgery have solved many problems, not all cases are best suited for microsurgical procedure. There are some situations in which microsurgical procedure may not be feasible due to technical or patient related factors. Easy dissection, single surgeon operating, no sacrifice of any major vessel and large arc of rotation, all of these things have made reverse sural artery flap more popular. Distal based sural artery flap has stood the test of time in being a reliable and effective method in reconstruction of distal leg, ankle and foot.²¹

In our study, four were children. Three were having defect over the dorsum of foot and one child had exposed ankle joint. The mean size of the flap was 6 x 7 cm. Complete flap survival was observed in all four children which implies that reverse sural artery flap is equally applicable and is safe in paediatric patients. Trauma constituted 70% and was the main aetiological factor in our study. This is similar to other studies reported in the literature, where trauma was the aetiological factor in 70-90% of the cases.^{7,20,22} Three patients with diabetic ulcer were treated successfully. This has also been observed in other studies which state flap can be safely performed in diabetic and medically compromised patients.²³ Patients with occlusion of anterior and posterior tibial arteries occlusion and varicose veins are not considered absolute contraindication to the use of this flap.^{18,24}

Our complication rate was 15%. Two patients (5%) who had epidermal loss were treated conservatively by regular wound dressings. Two patients (5%) who had partial flap necrosis (Figure 10) underwent wound debridement, underneath tissue was found healthy and treated conservatively by regular wound dressings. Yet, another two patients (5%) who had complete flap necrosis (Figure 11) were posted for secondary procedure, necrosed flap excised, negative pressure wound therapy by vacuum assisted closure done and later skin graft was performed once the healthy granulation tissue appeared. Our complication rate is comparable with previous similar studies conducted by Samira Ajmal et al²⁵ which reports 20% complication rate.

Probable cause for complete flap necrosis was thick subcutaneous fat in flap donor area in one patient and poor compliance of the patient to maintain the lower limb postoperatively in another patient respectively. One of the studies signifies the importance of thickness of subcutaneous fat of the flap rather than its surface area. Further, the same study quotes peroneal artery perforator may not support a flap with large volume.²⁰

The major issues which we should make a note of in determining the survival of reverse sural artery flap are—reverse arterial and venous flow to be established through axial vessels and no kinking of the pedicle of the flap following inset. Venous congestion which is the predominant factor for flap failure is prevented by including short saphenous vein and lower limb elevation in postoperative period. Apart from all these, there may be some other factor which can influence in better outcome of the flap. This has to be answered comprehensively.

Although extensive anatomical studies have been carried out earlier, with respect to the safe extension of reverse sural artery flap and its exact dimension there is no definitive

answer for the same till date. Few of the previous studies have been performed to know the association between success of reverse sural artery flap and individual factors like diabetes mellitus,²³ venous ulcer,²⁴ smoking, etc. In our study, random independent factors like age of the patient, aetiology of the defect, site of the defect, smoking habit of the patient and diabetes mellitus as a chronic disease in patient were selected by us and these factors were assessed to know if any association existed between the former and the successful outcome of the reverse sural artery flap which was statistically tested. We did not come across any earlier studies which included all the above-mentioned factors and its relation to the successful outcome of reverse sural artery flap.

A logistic regression analysis was conducted to predict the outcome in 40 patients who underwent reverse sural artery flap surgery using the surgical and baseline parameters as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between Absence of complications and Occurrence of complications as outcomes (The final omnibus tests of model coefficients showing a Deviance Chi-square= 30.195, p= 0.305 with df=27 improving to 27.326, p= 0.446 demonstrating a good fit prediction model).

Similarly, the -2 log likelihood model also showed the initial value decreasing from -2LLnull = 33.817 to -2LLk = 6.491 from Step 0 to Step 1.

Nagelkerke's R² of .867 indicated a strong 86.7% relationship between prediction and grouping. Prediction success overall was 97.5% (100% for absence of complications and 83.3% for the outcome of complications). Hosmer and Lemeshow Test of significance of the goodness of fit also returned a value of 1.000, for df=7 thereby indicating a good fit of the model (Table 2).

The Wald criterion demonstrated that 1) Trauma as the aetiology, 2) Distal 1/3rd of the Leg and dorsum of the foot as the site of the defect, and 3) A Flap size of 24 sq. cm. were leading independent factors which contributed to the absence of complications in comparison to the rest of the factors. Exp (B) values are not reported because none of these probable factors were significant as Odds Ratios predicting the good outcome of surgery. The probable reason is that a minimum of 50 samples for each independent variable is recommended and desired in logistic regression analysis. However, this study is useful as a pointer for further studies to model the factors associated with good outcome of plastic surgery of reverse sural artery flaps.

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