Comparison of Reverse Sural Artery Fasciocutaneous Flap in Soft Tissue Reconstruction Between above Ankle and Below Ankle Defect

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ABSTRACT

Background

Fasciocutaneous reverse sural artery flap is a popular option to treat soft tissue defects in the distal leg, ankle, and foot region.

Objective

To compare the results of sural artery flap reconstruction between the above ankle and below ankle soft tissue defect.

Method

It was a retrospective study of sural flap reconstruction of varied etiology for the defect grouped as above ankle and below ankle operated over a period of five years. Flap and graft take-up, rate of primary healing, margin necrosis, and complications were the assessed outcome variables.

Result

There were a total of 37 patients, 17 cases of the above ankle and 20 cases of below ankle sural flap reconstruction analyzed in the study. Road traffic accident was the most common cause and the mean size of the defect was 40.70 cm^2. The overall flap take-up rate was 94.6%, partial margin necrosis was in 6 patients, and > 50% flap necrosis was in 2 cases. The rate of primary healing, margin necrosis and mean healing time were 17 (100%) vs 12 (60%), 0 vs 8 cases (6 margin necrosis and 2 cases of > 50% of flap necrosis), and 20.04 days vs 22.50 days respectively in the above ankle and below ankle flap reconstruction groups. These differences were statistically significant.

Conclusion

Fasciocutaneous reverse sural artery flap is an excellent choice for reconstruction of the defect at the distal leg and around the ankle region with a high success rate. Below ankle flap reconstruction showed a higher rate of margin necrosis, longer healing time, and less rate of primary healing as compared to the above ankle group.

KEY WORDS

Above ankle, Below ankle, Fasciocutaneous reverse sural artery flap, Flap take-up, Margin necrosis

INTRODUCTION

Exposed bone, joint, tendons or neurovascular structures in the distal leg, ankle, and foot region due to trauma and other causes are common orthopedic challenges in daily clinical practice. Management of these soft tissue defects entails a lot of effort from the team of orthopedic and plastic surgeons. There are several options to address such reconstructive procedures. Fasciocutaneous reverse sural artery flap (RSAF) and their different modification, muscle pedicle flap, and free flaps are the common surgical techniques.[1] RSAF is the most common and popular procedure to reconstruct these defects with a high success rate and acceptable rate of complications.[2-4] Ease of raising the flap, reliable vascular pedicle, and good arc of rotation make it a workhorse for flap reconstruction around the distal leg, ankle, heel, and foot region.

There seems to be a higher rate of RSAF margin and flap necrosis when the pedicle of the flap is long and the application of the flap is distal to the ankle joint level due to a longer arc of rotation as compared to RSAF applied on the defect above the ankle.[1] There is a paucity of literature comparing the results of RSAF between these two groups. So, this study was undertaken to assess and compare the results of RSAF in the reconstruction of the soft tissue defect above the ankle and below the ankle defects. The objective was to assess and compare the flap take up, healing time and complications.

METHODS

It was an observational study of retrospective case series of soft tissue defects in the distal leg, ankle, and foot region of varied etiology treated with fasciocutaneous RSAF performed by a single surgeon from June 2015 to January 2022. The defect at the distal 3rd leg, malleoli region, and above the ankle joint level was arbitrarily considered group I (above the ankle defect), and defects in the heel, tendoachilles insertion site, and foot region were considered group II (below the ankle defect). Ethical clearance was taken from the institutional review committee.

Inclusion criteria were all the cases that underwent fasciocutaneous RSAF for exposed bone at the distal third leg, exposed implant, ankle joint, tendon, or heel avulsion of traumatic and non-traumatic etiology in the age group between 15-65 years in the stipulated period of time.

Exclusion criteria were patients with peripheral vascular disease, a refusal for flap operation, defects not amenable for RSAF reconstruction, and the patient operated elsewhere.

Operative technique

The patient was operated on in the prone position under spinal anesthesia. Under all aseptic precaution, wound debridement was done and the size of the defect was measured. The course of the sural artery and nerve was marked taking reference from the midpoint of the proximal third calf to the point midway between lateral malleolus and tendoachilles. The pivot point of the pedicle was taken Seven cm above the lateral malleolus. Defect size was measured along with pedicle length from the pivot point with the help of a gauze piece and it was transposed to the midcalf posteriorly. Flap length and width were taken one to one and half cm more than the measured defect size. Fascia deep incision at the proximal mark was made first at the location of the sural artery, vein, and nerve located subfascially. These structures were dissected, identified, ligated, and divided. A few fasciocutaneous temporary stitches were used to prevent sliding of fascia to minimize the chance of margin necrosis. Fasciocutaneous flap was raised subsequently and the pedicle was designed taking at least Two cm of skin, adipose tissue, and fascia. The flap was transposed to the defect site through a superficial skin incision or as a free pedicle. No flap was tunneled and preoperative and intraoperative doppler was not used in any cases. Sutures were applied from the margin of the flap to the skin margin around the recipient site and the donor site was covered with a split-thickness skin graft taken from the same thigh. Proper attention was paid to avoid tension and pressure at the pedicle and flap. Below knee slab anteriorly was applied for one week to keep the ankle in gravity equinus in case of flap applied at the ankle, heel, and foot.

Postoperative flap inspection was done through a small window the next day and graft inspection was done on the fourth postoperative day. The patient was discharged when there was no evidence of infection and a good flap and graft take-up. Flap division and insetting were done between three to four weeks in cases where the pedicle was left free on the skin. Follow-up in OPD was made at two, four, eight, twelve weeks, and then six weekly.

Demographic data and wound characteristics, intraoperative details, postoperative course, flap take-up, graft take-up at the flap donor site, and possible complications were taken from the inpatient chart, OPD card, phone interview, and request for follow-up and assessment during the OPD visit.

Data analysis was done using SPSS version 20.0 software. Frequency and percentage were calculated for the categorical variables and mean median, range, and standard deviation for the discrete and continuous variables. Comparison of the flap healing, flap, and graft take up, patient satisfaction, and complications between the above ankle and below ankle groups were compared and the Chi-square test was used to assess the test of significance wherever applicable. Fisher's exact test was used for variable with less than five value. Student's T-test was used to compare the continuous variables. P-value < 0.05 was considered significant.

RESULTS

There was a total of 37 cases of RSAF reconstruction (male=21 and female=16) in the study period. Right side was predominant (n=25, 67.6%) to left lower limb (n=12, 32.4%). The mean age was 41.59 years (range 18-60), the mean follow-up duration was 7.27 months (range 4-12), and the mean length of hospital stay was 13.16 days (range 9-18). The overall mean size of the recipient wound was 40.70 cm^2 (range 12-108).

Table 1. Comparison of demographic data and wound characteristics

Variables	RSAF group I (n=17)	RSAF group II (n=20)	p value
Age (mean ± SD)	44.06 ± 9.2	39.50 ± 15.12	0.28
Sex (Male : Female)	11:6	10:10	0.50
Presence of DM, number	0	4	0.1
Presensce of prior infection n (%)	8 (47)	8 (40)	0.21
Presence of fracturen (%)	11 (64.68)	5 (25)	0.02
Wound size in cm^2 (mean ± SD)	43.53 ± 29.19	38.3 ± 27.54	0.57

Out of the total of 37 cases of RSAF, 17 cases were of above ankle RSAF named as group I and 20 cases of below ankle RSAF named as group II. Distribution of age, sex, presence of diabetes mellitus, prior infection and wound sizes in the two groups were similar as stated in table 1. But, there was a significantly higher number of fractures in the above ankle RSAF reconstruction group. The most common indication for flap reconstruction was due to Gustilo and Anderson IIIB open fracture followed by exposed tendon Achilles due to various reasons. Details of the cause of the wound defect have been presented in table 2.

Table 2. Overall diagnosis, number, and percentage of operated cases

Diagnosis	Number (%)
Grade IIIB Open fracture*	13 (35.1)
Exposed Tendoachilles	6 (16.2)
Heel avulsion	5 (13.5)
Diabetic foot ulcer	2 (5.4)
Tendoachilles transection	4 (10.8)
Venous ulcer	2 (5.4)
Degloving injury	4 (10.8)
Trophic ulcer	2 (5.4)
Malignant Melanoma	3 (8.1)
SCC	1 (2.7)

*indicates open fractures which included distal third tibia fracture, malleoli, and tarsal bone fracture or ankle fracture-dislocation
SCC = squamous cell carcinoma

The overall flap take-up was 94.6% (35 cases) and two cases had > 50% flap necrosis (one heel and ankle degloving injury and one case of trophic ulcer heel due to old spinal injury). Two cases of > 50% flap necrosis were managed with skin graft in revision surgery. There was an excellent take-up of the partial thickness skin graft at the flap donor site in all the cases. Partial margin necrosis was found in a total of six cases (21.6%) that were managed with minor debridement in OT and secondary closure. The overall healing time was 21.38 days (SD ±3.33) and the rate of primary healing was 78.4% (29 cases).

The comparison of margin necrosis, healing time, and rate of primary healing between the two groups has been given in table 3. There were nine cases (24.1%) of minor complaints of paresthesia at the dorsolateral aspect of the ankle and foot but it was not disturbing their activities. No case had a post-operative infection, stiffness of the ankle joint, and problematic venous congestion. All but two cases were satisfied with their result. Two unsatisfied cases were heel reconstruction with RSAF.

Table 3. Comparison of the outcome variables between two groups

Outcome variables	Group I n=17	Group II n=20	p value
Primary healing: n(%)	17 (100)	12 (60)	0.01
Mean healing time (days ± SD)	20.04 ± 1.56	22.50 ± 4.02	0.01
Flap necrosis*n(%)	0 (0)	8 (40)	0.001

*indicates both margin necrosis (6 cases) and > 50% flap necrosis in 2 cases, n=number

A B C D

Figure 1. Shows grade IIIB open fracture tibia with the improperly applied external fixator in situ A, RSAF intraoperative picture B, good flap take up at 3 weeks C, and conversion to Ilizarov fixation with excellent flap healing D.

A B C D

Figure 2. Shows skin necrosis in grade IIIB open fracture distal 3rd tibia treated with intramedullary interlocking nail A, exposed bone with wound defect after debridement in second stage B, intraoperative RSAF to reconstruct the defect C, and excellent healing of the flap at 6 weeks D.

A B C D

Figure 3. Shows a large diabetic foot ulcer with gross infection A, wound status after debridement and infection control B, intraoperative picture with RSAF covering the defect C, and excellent healing of the flap at 3 months D.

A B C D

Figure 4. Shows complete degloving foot and ankle with exposed bone and joints with gross contamination A, wound status after debridement B, intraoperative picture of RSAF C, and excellent healing of the flap at 6 months D

DISCUSSION

The present study showed excellent overall flap take-up (almost 95%) and graft take-up (100%) in the soft tissue reconstruction of the distal leg, ankle, heel, and foot region with the use of fasciocutaneous reverse sural artery flap (RSAF). Comparison of the flap take-up and complications between the above ankle and below ankle RSAF showed a relatively higher rate of complications in the flap reconstruction in the region below the ankle joint.

Masquelet first described the sural artery flap as a neurocutaneous flap in 1992 and popularized its use.[5] Later on, Huisinga et al. modified the term to reverse sural artery flap as the viability of this distal-based reverse sural artery comes from the arterial supply of the perforator arising from the peroneal artery which communicates to descending sural artery.[6] This flap is a workhorse for the soft tissue reconstruction of the defect exposing distal tibia, ankle, heel, hind and midfoot region due to its reliability and consistently good results. Raising the flap is relatively easy and residual morbidity and complications are less.[3] There have been numerous modifications of this flap which include taking fasciocutaneous pedicle, adipofascial pedicle, tunneling the pedicle, and suturing the pedicle at incised skin margin, two-stage flap, and myofasciocutaneous flap.[7] Our study involved fasciocutanous flap with fasciocutaneous pedicle which was sutured to a superficial skin incision or free pedicle without suturing. Tunneling is generally not preferred because of the risk of compression and increased flap necrosis.[8] Tunnelling was avoided in all the cases in our study.

The most common indication for RSAF is traumatic wound defect resulting in exposed bone, tendon, joint, implants, and heel avulsion as shown in the different studies.[3,9,10] This holds true in our study as well. The most common reason for flap reconstruction were due to trauma and its complication.

The overall flap take-up rate was excellent in the present study (94.6%). This finding was comparable to most of the findings in other studies.[1,2,7,11] Schmidt et al. in their meta-analysis of 4386 RSAF showed a failure rate of only 5.1% and total complications rate of 14.8%.[7]

Assi et al. in their study of a total of 24 cases of traumatic and diabetic foot soft tissue flap reconstruction with RSAF showed a mean flap healing time of 22 days, one total flap necrosis, and 5 margin necrosis.[3]

Perumal et al. in their comparative study of a total of 85 patients between two groups of the above ankle and below ankle flap reconstruction with RSAF showed an overall mean healing time of 30 days, primary flap healing in 65% in the above ankle group as compared to 42% in below ankle group.[1] It was statistically significant. The rate of complications in terms of margin and flap necrosis and revision operation was more in below ankle defects. This is true in the present study also with a significantly increased rate of flap and margin necrosis in the distal defect. It could be probably so because of the long pedicle, longer arc or rotation, and increased risk of posture-related compression to the pedicle and flap.[9,12] There is a paucity of published literature in English comparing the results of RSAF between the above ankle and below ankle soft tissue defect and the findings of the present study have been able to add further comparative outcomes in the literature.

The important reasons for the risk of flap necrosis are increased venous congestion, the very proximal extent of the flap margin at the donor site, and larger flap size.[13,14] In all our cases, we did not encounter significant venous congestion leading to flap failure. Baumester et al. emphasized the role of venous congestion as an important determinant of flap failure.[15] We made a broader fasciocutaneous pedicle, about a width of 4 cm, and the flap was sutured without tension. The limb was strictly elevated during the postoperative phase. Probably, these measures helped to avoid venous congestion in the current study as suggested by the study of Sugg et al.[11]

There were two cases of diabetic foot ulcers giving rise to infected wounds over the heel (one case) and medial border of the ankle and heel (one case). They healed well with good flap and graft take. Assi et al., Huisinga et al. and Yildirim et al. in their study had shown comparable outcomes in diabetic and nondiabetic patients for RSAF reconstruction.[3,6,16]

We managed all the cases of partial margin necrosis with repeat debridement under local anesthesia or spinal anesthesia in the operation theatre and suturing. They all healed well. Out of two cases of more than half of flap necrosis, one was a trophic ulcer of the heel due to

an old spinal injury and one case was degloving of the ankle and heel with a large wound defect. They failed probably because of poor healing capacity in the trophic ulcer and large wound defect with probable injury to peroneal perforator also as we did not have the facility of preoperative or intraoperative doppler. All the cases were done based on the anatomical landmark and marking of the natural course of the supplying vessel.

The retrospective nature of the study, relatively less number of subjects, and operating surgeons assessing the results also are some of the limitations of the current study. A prospective comparative study with larger sample size is recommended to substantiate the conclusion of this study further.

CONCLUSION

Fasciocutaneous RSAF is an excellent choice for the reconstruction of the defect in the distal leg, ankle, heel, and foot region in indicated cases with good results in most of the cases. The risk of complications in terms of margin necrosis and flap necrosis is more in the below ankle defect as compared to the above ankle defect.

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