

Original Research Article

Reconstructive strategies for lower one-third leg soft tissue defects

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ABSTRACT

Background: Despite recent technical advances, reconstruction of lower third of leg wounds with soft tissue defects remains a challenge to the Plastic Surgeon. This is due to the inherent anatomical and structural configuration, including the limited vascularity of the skin of the lower third of the leg. Maintaining maximal function without compromising the aesthetic appearance of the leg is the goal of reconstruction.

Methods: This was a retrospective study conducted in the Department of Plastic Surgery, KIMS Hospital, Bangalore, from January 2016 to January 2018. Patients with soft tissue defects involving lower third of leg requiring flap cover were included in the study. Orthopedic intervention was done as required. All patients underwent loco-regional or free flap cover as clinically indicated. Outcomes were studied.

Results: Total of 20 patients were included in the study. Most common presentation was due to road traffic accidents (RTA). Right leg was involved in 12 cases and left in 8 cases. Fracture was present in 7 cases, exposed bone without fracture in 11 cases, exposed tendons alone in 1 case and exposed implants in 1 case. 3 Patients required orthopaedic intervention along with the flap procedure, and 4 had already undergone orthopaedic stabilisation. Most commonly performed procedure was muscle flap (45%), followed by perforator-based fascio-cutaneous flap (25%). No major complications were observed in the post-operative period.

Conclusions: Lower third of leg reconstruction is a challenge, but a wide variety of options ranging from loco-regional to free flaps can be employed, depending on the situation. In present study, various types of flap cover were adopted to cover the lower-third of leg defects, depending on the nature of the wound. Present study delineated that muscle flaps - particularly the reverse hemi-soleus flap, are an ideal flap for lower third of leg defects with fracture site exposed and wound infected. Local muscle flaps have the advantage of being single-staged, faster to perform and technically easier, compared to free flaps, which have long been considered the gold standard.

Keywords: Flaps, Lower third of leg, Muscle flaps, Soft tissue defects, Reconstruction

INTRODUCTION

Leg injuries are common, and account for about 40% of road traffic accident (RTA) related injuries. Disability resulting from leg injuries are a major cause of morbidity.¹ There have been tremendous advances in the management of lower-extremity trauma, and limbs which would have earlier required amputation can now be salvaged.² Successful reconstruction is flagged by stable bony union, healing soft tissue and normal ambulation.³

Soft tissue defects of the lower third of the limb remain one of the biggest challenges in reconstructive surgery. The limited vascularity, scarcity of tissue and tightness of skin are some of the major factors complicating the reconstruction. The subcutaneous position of tibia warrants flap cover, and as most muscles become tendons at this level, flap cover becomes mandatory.^{4,5}

Microvascular free-flaps have long been the routine for soft tissue defects of the leg, however, these are difficult

in resource-poor countries.³ The conventional standards recommend gastrocnemius muscle flaps and fasciocutaneous flaps for the upper third leg defects, soleus flaps for the middle third defects and free flaps for the lower third defects.⁶

Better understanding of the vascular supply of the muscles allowed for the development of simpler loco-regional flaps, providing more options for the coverage of lower third of leg defects in the Plastic Surgeons armamentarium.

METHODS

This was a retrospective study done in the department of Plastic Surgery, Kempegowda Institute of Medical Sciences, Bangalore, over a period of 2 years, from January 2016 to January 2018. All patients with soft tissue defects involving the lower third of leg (both post-traumatic and post-procedural) who required a soft tissue (flap) cover were included in the study. Patients who had exposed tendons, bone, fracture sites and implants requiring flap cover were included in the study.

Wounds treated by primary closure or skin grafting were excluded from the study.

Patients with polytrauma and those requiring emergency surgical procedures for other conditions were excluded from the study. A total of 20 patients were included in the study.

The data of the patients with respect to age, sex and nature of injury were tabulated. All patients initially underwent an X-Ray of the affected limb and Orthopedic evaluation. Vascular and neurological examination findings were noted.

Contaminated wounds were initially debrided, and regular dressings done until they were deemed fit for flap cover. Fractures requiring orthopaedic intervention prior to flap cover underwent necessary stabilization. One patient required flap cover following wide local excision for tumor around the right ankle.

With reconstructive ladder as a guide, the appropriate reconstructive technique was adopted to each patient, with consideration to the nature of the wound and exposed structures. Perforators were identified by hand-held Doppler pre-operatively when required. Patients were operated under general or spinal anesthesia. All patients received comparable post-operative care including antibiotic therapy, anti-edema measures and flap monitoring.

In patients who underwent skin grafting, first-look dressing was done on the 3rd post-operative day. Assisted ambulation was allowed wherever possible after the 5th post-operative day, and dependent weight-bearing was

allowed on the 7th post-operative day in all cases except those who underwent fracture stabilization.

RESULTS

Of the 20 patients in the study, mean age was 35.2±15.70years. Of the 20 patients, 16 (80%) were male and 04 (20%) were female. Etiology was RTA in 19 cases and malignancy in 01 case. Of RTAs, 18 patients were involved in 2-wheeler accidents and one patient was in an auto-rickshaw, which toppled over.

Table 1: Age distribution of patients in the study.

Age (years)	No. of patients	Percentage
10-20	5	25%
21-30	4	20%
31-40	3	15%
41-50	5	25%
51-60	2	20%
61-70	1	05%

The most common comorbidity encountered was diabetes mellitus, which was found in 3 (15%) patients. 3 (15%) patients were also smokers.

Table 2: Comorbidities of patients in the study.

Co-morbidities	No. of patients	Percentage
Diabetes mellitus	3	15%
Hypertension	1	05%
Smoking	3	15%

Fracture was present in 7 cases, exposed bone without fracture in 11 cases; and exposed tendons alone and exposed implant was seen in one patient each. Three patients required orthopaedic intervention along with the flap procedure, and 4 had already undergone orthopaedic stabilization prior to the coverage surgery. All 7 patients underwent fracture stabilization by external fixator application.

Table 3: Status of bone of patients in the study.

Fracture	No. of patients	Percentage
Tibia alone	3	15%
Fibula alone	0	0%
Both tibia and fibula	4	20%
No fracture but exposed bone	11	55%
No exposed bone	2	10%

Right leg was affected in 12 (60%) patients and left was affected in 8 (40%) patients. The most common type of injury encountered was degloving and mixed type.

In one case the defect was surgically created following resection of tumor.

Table 4: Distribution of cases with respect to type of injury.

Type of defect	No. of patients	Percentage
Degloving	6	30%
mixed injury	6	30%
Crush injury	4	20%
Run over	3	15%
Surgical wound	1	05%

Table 5: Distribution of cases with respect to size of the defect.

Size of defect	No. of patients	Percentage
Small (<30 cm ²)	12	60%
Medium (30-90 cm ²)	6	30%
Large (>90 cm ²)	2	10%

In most cases, the defect was of small size (60%). Most cases (70%) were operated in the sub-acute period (3 days to 6 weeks post injury).

Table 6: Distribution of cases with respect to timing of coverage.

Timing of Coverage	No. of patients	Percentage
Acute (within 72 hours of trauma)	5	25%
Sub-acute (3 days - 6 weeks)	14	70%
Chronic (>6 weeks)	1	05%

The 20 patients underwent procedures as clinically indicated. Eight different types of coverage procedures were done, the most commonly employed being reverse hemi-soleus flap (30%). Majority of the procedures done were muscle flaps (45%).

Table 7: Various coverage procedures employed in the study.

Broad category	Type of flap	No. of cases	Percentage	Overall Percentage
Muscle flap	Reverse hemi-soleus	6	30%	45%
	Hemi-soleus flap	2	10%	
	Soleus	1	05%	
Fascio-cutaneous flap	Perforator based	5	25%	25%
Axial vascular flap	Reverse Sural Artery Flap (RSAF)	3	15%	20%
	Lateral Supra-Malleolar Artery flap	1	05%	
Free flaps	Latissimus Dorsi (LD) free flap	1	05%	10%
	Anterolateral Thigh (ALT) flap	1	05%	

Table 8: Various complications encountered post-operatively.

Complication	No. of patients	Percentage
Complete flap loss	0	0%
Partial flap loss	1	5%
Complete graft loss	0	0%
Partial graft loss	1	5%
Flap edema	1	5%
Infection	3	15%

The most common complication observed in the post-operative period was local infection (15%). One case of partial flap loss was observed which required debridement and subsequent flap advancement.

DISCUSSION

Reconstruction of lower third of leg defects is challenging due to poor vascularity, dependent position and limited locally available tissue.^{4,7} Reconstructive

options include free-flaps, cross-leg flaps and loco-regional flaps.

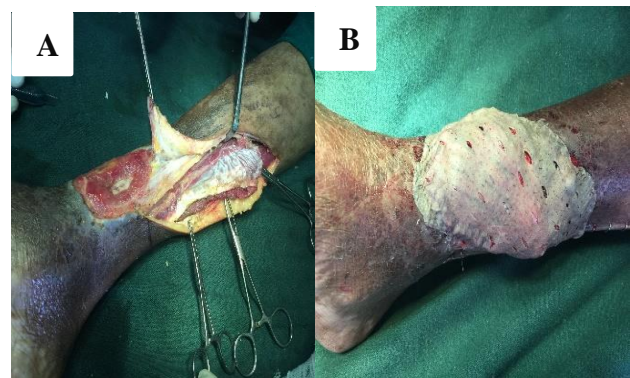


Figure 1: (A): Harvesting reverse hemi-soleus flap, (B): post-operative appearance with skin graft.

Comorbidities like diabetes and habits such as smoking significantly affect flap survival. The most common comorbidity encountered was diabetes mellitus, which

was found in 3 (15%) patients. 3 (15%) patients were also smokers. The most common complication observed in the post-operative period was local infection (15%). This is comparable to other studies.⁴

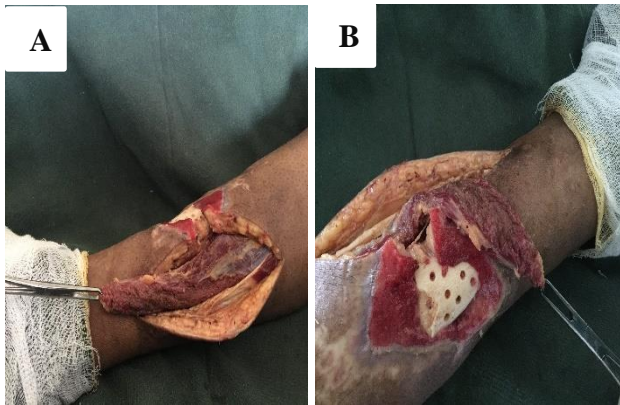


Figure 2: (A): Harvesting hemi-soleus flap, (B): wound closure with hemi-soleus flap.

One case of partial flap loss was observed which required debridement and subsequent flap advancement. Two of the three cases of local infection, and the patient who suffered partial flap loss were observed in diabetics. In addition, the patient who suffered partial flap loss was a chronic smoker, thus high-lightening the impact of diabetes and smoking on flap healing.

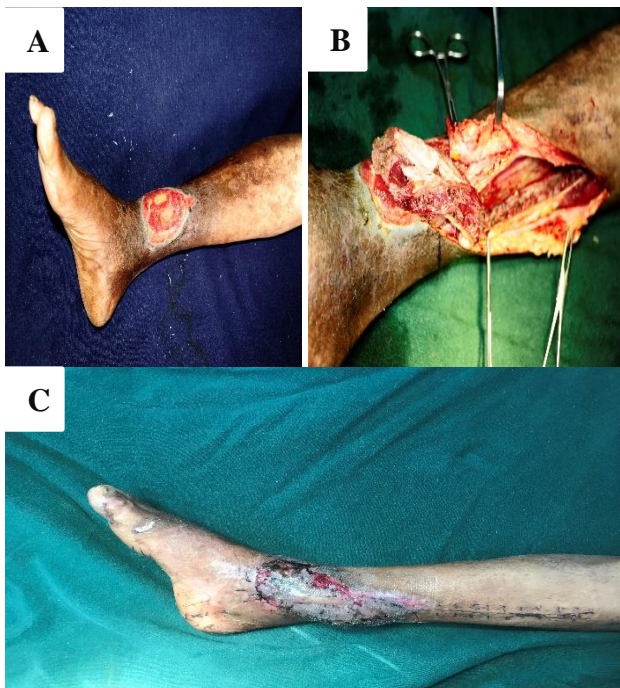


Figure 3: (A): Defect over lower third of leg, (B): harvesting reverse hemi-soleus flap, (C): post-operative appearance of well-settled reverse hemi-soleus flap with skin graft.

In present study, most patients underwent local muscle flaps (45%) (Reverse Hemi-soleus, Hemi-soleus and

Soleus Flaps) followed by fasciocutaneous (25%) and Reverse Sural Artery Flap (15%).

As in literature, the most common indication for flap cover was exposed tibia, which was seen in 11 (55%) of the cases.⁴ Fractures were present in 7 patients, of whom both bone fracture was present in 4 and fracture of tibia alone was present in 3 patients. Of these, 4 patients had undergone stabilization prior to our intervention, and 3 patients were stabilized with external fixators by an orthopedic surgeon in the same sitting as our flap cover.



Figure 4: (A): Defect over back of heel with exposed Achilles tendon, (B): lateral supra-malleolar artery flap.

The Soleus muscle is classified as type II according to Mathes and Nahai. The muscle can be used for reconstruction of middle third and proximal part of lower third of leg defects based on its major vascular pedicle, the posterior tibial artery. For extremely distal leg wounds, the muscle can be used in a reverse manner based on its secondary pedicles (the perforating branches of the posterior tibial artery).⁸

In present study, soleus flap, hemi-soleus flap and reverse hemi-soleus flap were all used with good outcomes where fracture site was exposed, and wound infection was present. The hemi-soleus flap employs the medial part of the muscle, thus preserving plantar flexion, which is performed by the lateral portion of the muscle.⁹

Fascio-cutaneous perforator flaps are a good alternative for covering wounds with exposed bones without fractures.^{4,7} This is a versatile technique with decreased donor site morbidity. There is a better cosmetic and reconstructive outcome as the donor is from the adjacent area. The main drawback of the perforator flaps however is the higher risk of venous congestion and skill required for raising of the flaps.^{10,11}

In present study, reverse sural artery flaps (RSAF) were employed in 15% of the cases. This is comparable to other studies.⁷ RSAF is an especially important flap for foot and ankle defects, having the advantage of reliable vascularity, minimal donor site morbidity, no functional

muscle loss and wide arc of rotation. Various modifications of the sural artery flap are available.¹¹ A disadvantage of RSAF, the loss of sensation, can be overcome by sural nerve preservation.¹²

In present study, free flaps were done in two cases, one being LD flap for a post-traumatic wound with exposed calcaneum, and the other being ALT flap for defect around the ankle following wide excision for soft tissue sarcoma. These require greater intra-operative skill and post-operative monitoring and thus require careful patient selection.⁷

The lateral supra-malleolar artery flap is based on a perforator of the peroneal artery. It is a reliable and useful flap for coverage of lower third leg, ankle and back of heel.¹³ In present study, this was employed successfully in one case with defect over the heel with exposed Achilles tendon.

Local flaps can be performed under spinal or regional anesthesia. In present study, 18 patients were operated under spinal anesthesia. 2 patients were operated under general anesthesia, one patient was a 13-year-old female who underwent RSAF, and the other was a patient who underwent LD free flap.

Maximum patients (70%) were operated in the sub-acute period, which is similar to that reported in other studies.⁴ In literature, early intervention is recommended.¹⁴ The delay in present study can be explained by wounds being unsatisfactory for early intervention and need for debridement and delayed consent for the procedure. Early intervention has the advantages of shorter hospital stay and cost, need for fewer dressings, decreased infection rates and secondary necrosis of exposed tissues.⁴

No mortalities occurred in present study. Mortalities in other studies were attributed to co-morbid conditions like diabetes and peripheral vascular disease.³ Average duration of hospital stay was least in muscle flaps and fasciocutaneous flaps (60% of patients were discharged within 10 days) and most in free flaps (2-3 weeks). This is comparable to other studies.⁴

CONCLUSION

Lower third of leg injuries are a common presentation at the emergency department, and a wide variety of options are available when soft tissue cover is required. In our study, muscle flaps were the most commonly performed surgery with good outcomes for covering exposed fracture sites with infected wounds of the lower third of the leg.

Technically-challenging and time-consuming free-flaps still remain the gold standard for the coverage of soft tissue defects of the lower third of the leg. However, with better understanding of vascular anatomy of the lower limb, a wide variety of loco-regional flaps have been

developed, and are a good alternative to free flaps, especially when microsurgical facilities are not available.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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