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Original Article

Reconstruction of Lower One-third Leg Soft Tissue Defects

P Suresh Kumar[1], E R Srinivas[2], Heber Anandan[3]

[1]Associate Professor, Department of Plastic Surgery, Tirunelveli Medical College Hospital, Tirunelveli, Tamil Nadu, India, [2]Assistant Professor, Department of Plastic Surgery, Meenakshi Medical College and Research Institute, Kanchipuram, Tamil Nadu, India, [3]Senior Clinical Scientist, Department of Clinical Research, Dr. Agarwal's Healthcare Limited, Chennai, Tamil Nadu, India

Abstract

Introduction: Major limb injuries involve many or all components of the limb architecture, namely, skin and soft tissue, osseous, vascular, and neural elements which makes for prompt and precise evaluation and management for optimizing functional outcome.

Aim: The aim of this is to evaluate various reconstructive options for the management of lower one-third leg soft tissue defect.

Methods: All patients with post-traumatic soft tissue defects of the lower one-third leg who required a soft tissue cover were included in the study. Detailed history was taken on the mechanism of injury, the time since injury and history of neurological deficits. Then, all the patients were subjected to a full general and local clinical examination to rule out other coexisting injuries and to assess the site and size of the defect, the presence or absence of exposed bone, tendons or neurovascular structures, the degree of wound contamination, and the condition of surrounding skin.

Results: The indication for flap cover was exposed tibia (71%), followed by exposed tendon 21% and exposed implant 8%. The most commonly performed procedure is the inferiorly based fasciocutaneous flaps (45%) followed by reverse fasciocutaneous flaps (32%). Edema and infection were the common complications encountered 23 and 18%, respectively. 70% of patients graded the reconstruction as good, 23% as fair, and 7% as poor.

Conclusion: Fasciocutaneous flaps may represent a good alternative to the free flaps in the areas were other local reconstructive procedures are not possible.

Key words: Leg injuries/surgery, Lower extremity, Reconstructive surgical procedures, Surgical flaps

INTRODUCTION

Increasingly, urban trauma is becoming a major health-care issue. Large emergency departments are inundated with patients with multiple injuries, requiring state-of-the-art care. Most of these complex injuries involve trauma to the extremities, often due to motor vehicle accidents. In a study by MacKenzie *et al.*, it was shown that lower extremity injuries accounted for about 40% of the charges for motor vehicle trauma treatment in a given year. Hospital-based studies reveal that disabilities persist for a long time with a mean time taken to return to work ranges from 42 to 120 months.[1] Coverage of soft tissue defect of the leg presents unique defects requiring the ingenuity of the surgeon in planning flaps for stable coverage. Although well-established norms are in place regarding the time and nature of cover, it requires a team effort, practising it with the involvement of the orthopedic surgeon and allied specialities such as vascular surgeons and general surgeons. The relatively unprotected anteromedial portion of tibia results in exposed bone after trauma, which requires specialized soft tissue cover.[2,3] Most muscles become tendons at this level, and hence, flap cover becomes mandatory in case of soft tissue loss.[4,5] Treatment of lower extremity trauma has evolved over the past two decades to the point that many that would require amputation are now routinely salvaged.[6] Plastic surgeons role becomes not only important in covering a raw area but also in providing a functional lower limb with an acceptable esthetic result. Although we live in an era of zero delay

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Corresponding Author: E R Srinivas, Department of Plastic Surgery, Meenakshi Medical College and Research Institute, Kanchipuram, Tamil Nadu, India. Phone: +91-9095145019. E-mail: drshrii@rediffmail.com

work, microvascular transfer, and a single stage workup, due to circumstances beyond our control, it is still necessary to revisit the older methods which are reliable, comparable, and easily reproduced.[7-9] The study was done to reflect our work and thus to enhance our quality of work to produce good results with a few complications as possible. There is need to challenge the concept that distally based flaps are inferior to proximally based flaps just as the dogma that skin flap survival depends on rigid length to width ratios has been refuted. Adjusting all other factors, the true critical factor of flap viability is the nature of their intrinsic blood supply rather than any arbitrary orientation or configuration in either case.[10] The patient expectations, an understanding of quality of existing source vessels in the given region, and local anatomical constraints should be considered. One should go for other alternatives if any of the above prerequisites cannot be met.[8]

Aim

The aim of this study is to evaluate various reconstructive options for the management of lower one-third leg soft tissue defect.

MATERIALS AND METHODS

This study was conducted in the Department of Plastic Surgery, Government Rajaji Hospital, Madurai. Cases with soft tissue defect of lower one-third leg requiring flap cover, i.e., defects with tendon, bone or implant exposed, or in patients undergoing staged procedures were included in this study. A total of 73 patients were included in the study. Timing of coverage was classified into acute - within 72 h, subacute - 3 days to 6 weeks, and chronic - >6 weeks. Defects were classified according to their site as per the usual norms of upper-, mid-, and lower-third. Inclusion criteria: All patients with post-traumatic soft tissue defects of the lower one-third leg who required a soft tissue cover were included in the study. Exclusion criteria: Patients with degloving injuries, arterial injury, head injury, abdominal injury, thoracic injury, bony injuries elsewhere, and brachial plexus injuries and patients who were not willing to participate in the study and for whom skin graft was planned were excluded from the study. All the patients included in the study were admitted to the trauma ward under the care of the attending orthopedician and received first aid. They were then resuscitated to minimize bleeding, restore airway, and correct shock. Detailed history was taken on the mechanism of injury, the time since injury and history of neurological deficits. Then, all the patients were subjected to a full general and local clinical examination to rule out other coexisting injuries and to assess the site and size of the defect, the presence or absence of exposed bone, tendons or neurovascular structures, the degree of wound contamination, and the condition of surrounding skin. A complete vascular and neurological examination with the comparison to the other healthy limb was performed. Laboratory investigations necessary for surgical fitness were done. X-rays and hand-held Doppler studies were done to identify and classify the fracture and assess vascular status. All patients were taken up for wound toilet and debridement on the day of admission. Skeletal stability was achieved if necessary with external fixators, Ilizarov ring fixators, plates, or K-wires as deemed appropriate by the orthopedic surgeon. To control the infection, the wound pus culture and sensitivity done and the systemic antibiotics used accordingly. Wounds were dressed daily with a saline dressing. Once the wounds were free of infection, the soft tissue cover was planned. The appropriate reconstructive technique was selected for every patient according to the reconstructive ladder putting into consideration the site, size and type of the defect, the condition of local tissues, previous surgical procedures in the injured limb, future planned surgical procedures and the patient's general condition. All the patients received post-operative care including proper antibiotic therapy, analgesics in the post-operative period, elevation of the limb to prevent edema and monitoring of the flap color, temperature, and capillary refill. First look dressing of the skin graft was done on the 5th post-operative day. Assisted ambulation was allowed for the patients whenever possible at the end of the 5th post-operative day. Dependable weight bearing was allowed at the end of the 7th post-operative day depending on the presence of bone fractures and the method of bone fixation. Sutures were removed on the 10th post-operative day, and the patients were transferred back to the orthopedic surgeon for further treatment. Patients were evaluated on their 1st, 5th, 10th, 15th, 30th, and 60th post-operative day. Evaluation parameters included viability and stability of the flap, take of the skin graft for secondary defect, presence of pain, ulceration, functional deficit, hospital stay, and patient satisfaction with the reconstruction. On the 30th day, patients were asked to subjectively grade the reconstruction in terms of functionality, return to work, and esthetic appeal. Follow-up periods varied from 6 months to 2 years depending on the patient's compliance. Data were collected in the form of a pro forma which included epidemiological data, clinical data, wound area measurements, and operative surgical information. The data so obtained were subjected to simple statistical analysis to determine and analyze the various reconstructive options used.

RESULTS

The age of patients ranged from 10 to 70 years in this study. Common age group affected is between 21 and 30

years and 41-50 years, 19% each, n = 14. Male-to-female ratio is 7: 1 (M = 64, F = 9) (Table 1). The most common indication for flap cover was exposed tibia (71%), followed by exposed tendon 21% and exposed implant 8%. The most common size of defect was small, i.e., <30 cm^2 (51%), followed by medium-sized defects 30-90 cm^2 (40%) and large defects >90 cm^2 (9%).

The most commonly performed procedure is the inferiorly based fasciocutaneous flaps (45%), followed by reverse fasciocutaneous flaps (32%).

Table 1: Age and gender distribution

Age in range (years)	Male	Female
10-20	9	0
21-30	14	0
31-40	12	5
41-50	14	1
51-60	12	1
61-70	3	2

Table 2: Flap distribution

Name of flap	Number of cases (%)
IBFTL	33 (45)
IBFTM	3 (4)
IBFST	6 (8)
RSNFP	24 (33)
RSNFI	2 (3)
PBM	1 (1)
PF	1 (1)
ALTFF	2 (3)
LDFF	1 (1)

IBFTL: Inferiorly based fasciocutaneous transposition flap - lateral side, IBFTM: Inferiorly based fasciocutaneous transpostion flap - medial side, IBFST: Inferiorly based fasciocutaneous sliding transpostion flap, RSNFP: Reverse sural neurofasciocutaneous island flap, RSNFI: Reverse sural neurofasciocutaneous island flap, PBM: Peroneus brevis muscle flap, PF: Propellar flap, ALTFF: Anterolateral thigh-free flap, LDFF: Latissimus dorsi-free flap

Table 3: Distribution of fasciocutaneous flap

Variety of fasciocutaneous flap	Number of cases
IBFTL	33
IBFTM	3
IBFST	6

IBFTL: Inferiorly based fasciocutaneous transposition flap - lateral side, IBFTM: Inferiorly based fasciocutaneous transpostion flap - medial side, IBFST: Inferiorly based fasciocutaneous sliding transpostion flap

Inferiorly based fasciocutaneous flap from lateral side (79%) was the most commonly performed fasciocutaneous flap because of the presence of reliable and constant perforator.

Inferiorly based fasciocutaneous flaps are the most common procedure performed for small-to-medium sized defect. Neuro fasciocutaneous flaps are excellent choice for medium-to-large size defect. We have done a muscle flap for a smaller defect. Propeller flap was done in one patient with a small defect. Free flaps were done in three patients with large-sized defects (Tables 2 and 3).

The average duration of hospitalization was least for fasciocutaneous flaps - (57% of patients were discharged within 10 days) and longest for pedicled neuro fasciocutaneous flaps and free flaps (2-5 weeks) (Table 4).

Edema and infection were the common complications encountered 23 and 18%, respectively (Table 5).

Of the 46 patients who rated the reconstruction as good, 26 (57%) had underwent distally based fasciocutaneous flap from lateral side, 12 (26%) had underwent distally based reverse neuro fasciocutaneous flap of them rated the reconstruction as good, 2 islanded RSA, 1 muscle flap, 1 propeller flap, 1 ALT, and 1 LD. Of the 5 patients who had rated the reconstruction as poor, 3 (60%) had underwent distally based reverse neuro fasciocutaneous flap, and 2 (40%) distally based fasciocutaneous flap (Table 6).

70% of patients graded the reconstruction as good, 23% as fair, and 7% as poor (Table 7).

Of the 73 patients, 64 were operated in the subacute phase (88%), 7 (9%) were operated in the chronic phase, and 2 (3%) in the acute phase.

DISCUSSION

The wound coverage of lower one-third of leg is a challenging problem because of its anatomical features. The tibia and fibula are vulnerable to injury, open fractures being more common due to the paucity of soft tissues

Table 4: Falp versus duration of stay in hospital

Days in hospital	IBFLT	IBFTM	IBFST	RSNFP	RFNFI	PB	PF	ALTFF	LDFF
0-10	16	2	3	5	1	1			
10-20	7	1	2	12	1		1	1	1
20-30	7		1	6				1	
30-40	3			1					

IBFTL: Inferiorly based fasciocutaneous transposition flap - lateral side, IBFTM: Inferiorly based fasciocutaneous transpostion flap - medial side, IBFST: Inferiorly based fasciocutaneous sliding transpostion flap, RSNFP: Reverse sural neurofasciocutaneous island flap, RSNFI: ???, PBM: Peroneus brevis muscle flap, PF: Propellar flap, ALTFF: Anterolateral thigh-free flap, LDFF: Latissimus dorsi-free flap

around them. Moreover, as most muscles become tendons at this level, flap cover becomes mandatory in the event of trauma. Early return to work and restoration of near normal functionality should be the aim of reconstruction of the lower extremity.

The etiological indications for lower one-third leg soft tissue defect in this study showed road traffic accidents to be the most common cause at 94%.

In concordance with Santanelli,[11] road traffic accidents continue to be the major cause of soft tissue defect in a developing country like ours just as in the developed nations.

In this study, the age of the patients varied from 10 to 70 years with the mean age of 30 years, which not comparable with Gururaj *et al.*, 25 to 35 years.[2]

Common age group affected is between 21 and 30 years and 41-50 years, 19% (n = 14) each.

Almost 88% (n = 64) of patients in this study were stabilized with external fixator despite conclusive studies by Trabulsy *et al.* Fixators *et al.* proving nonreamed locked nails were more effective than external fixators.[12]

Again this may reflect availability rather than personal preference. In this series, the maximum number of flaps was done in the subacute phase - 88% and the least in the acute phase 3%, chronic phase being 10%.

This is in total contrast to literature elsewhere where an early cover is recommended (Godina and Byrd *et al.*).[9,13]

Table 5: Distribution of complications

Complications	Number of cases (%)
Nil	43 (46)
Partial necrosis	3 (3)
Dehiscense	2 (2)
Complete necrosis	2 (2)
Graft loss	1 (1)
Superficial necrosis	5 (5)
Edema	21 (23)
Minor infection	17 (18)

The results from other studies showed that immediate wound reconstruction is preferred to delayed wound reconstruction in that it shortens the period of hospital stay significantly, few dressing changes, fewer operations, decreased infection rate, and secondary necrosis of exposed tissues. Thus, early consultation for soft tissue reconstruction is advised, and all attempts should be done to perform immediate reconstruction.

We emphasize the importance of cooperation at the time of primary surgery between orthopedic and plastic surgeon to preserve access to potential flaps. The technique of bony fixation of the tibia may prevent the use of this flap, especially in the presence of external fixation pins, which may injure perforating vessels or tether the flap, restricting its range of transposition.

The most commonly performed procedure is the inferiorly based fasciocutaneous flap (57%), followed by reverse fasciocutaneous flaps (36%). Inferiorly based fasciocutaneous flap from lateral side is the most common procedure (45%) performed for small-to-medium sized defect as the perforator is constant and reliable in the lower lateral aspect of the leg. Neuro fasciocutaneous flaps are excellent choice for medium-to-large size defect. Peroneus muscle flap was done for smaller defect. Propeller flap was executed in one patient with small defect. Three patients with large defects underwent free flaps. The use of microsurgical techniques for the difficult problems revolutionized the field with literally limitless tissue available for transfer, and defects deemed to be unsalvageable were suddenly salvageable, but with the advent of newer techniques like perforator flaps and neurocutaneous flaps, there is a resurgence of interest in non-microsurgical reconstructive options. This is of special significance in a resource-challenged center like ours. In this study, we have attempted to explore the abovementioned reconstructive strategies for lower 3rd leg reconstruction. However, the indications and the criterion of selection of a particular technique for a particular defect are not well established and is rather a matter of personal judgment. 51% (n = 37) of patients had small-sized defects, 40% (n = 29) had medium-sized defects, and only 6% (n = 7) presented with large defects. The size of the defect and the experience of the center in

Table 6: Flap versus Patient's satisfaction

Patient satisfaction	IBFTL	IBFTM	IBFST	RSNFP	RSNFI	PBM	PF	ALTFF	LDFF
Good	26	2	5	12	2	1	1	1	1
Fair	5	1	1	9	0	0	0	1	0
Poor	2	0	0	3	0	0	0	0	0

IBFTL: Inferiorly based fasciocutaneous transposition flap - lateral side, IBFTM: Inferiorly based fasciocutaneous transpostion flap - medial side, IBFST: Inferiorly based fasciocutaneous sliding transpostion flap, RSNFP: Reverse sural neurofasciocutaneous Island flap, RSNFI: ???, PBM: Peroneus brevis muscle flap, PF: Propellar flap, ALTFF: Anterolateral thigh-free flap, LDFF: Latissimus dorsi-free flap

microvascular surgery was a significant factor in deciding reconstructive options.

Perforator Plus Technique

While raising the local fasciocutaneous flap, we always tried to include the perforator at the base of the flap, which was identified pre-operatively with hand-held Doppler.[14]

The average duration of hospitalization was least for fasciocutaneous flaps (57% of patients who underwent fasciocutaneous flaps were discharged or transferred to ortho ward before 10th day). and longest for pedicled neuro fasciocutaneous flaps and free flaps.

Edema ($n = 21$) and infection ($n = 17$) was the most common complication in this series, and it was managed by conservative measures - Anti-edema measures appropriate antibiotics/irrigation, but one case necessitated a sequestrectomy in the operation theater. Partial flap loss in three patients (2 reverse sural artery neuro fasciocutaneous flaps and 1 distally based fasciocutaneous flap) was managed in 2 ways. (1) Where bone was not exposed, wound was allowed to granulate after removing the necrosed part and later covered with split skin graft. (2) Where bone was exposed, the patient was taken to the operation theater and the flaps were adjusted after shifting the pedicle further distally as needed.

Total flap loss in 2 cases (1 reverse sural artery neuro fasciocutaneous flap and 1 distally based fasciocutaneous flap) was covered with a skin graft after allowing it to granulate after making drill holes in the exposed bone and the other reconstructed with alternate flap cover - reverse sural artery flap. Resuturing or strapping was done for two patients with minimal dehiscence. Complications were greatest in the subacute phase, the chronic cases surprisingly mirrored the early phase, perhaps owing to adequate preparation with repeat debridements, sequestrectomy, antibiotic cover, and wound homeostasis in the interim period with adequate skeletal stabilization (Table 8).

Complication rate was least in those cases given early cover and highest in the subacute phase, and in chronic cases, the complication rate was comparable to acute phase. The complication rates for the acute and subacute phases were correlating with Byds's series where he had complication rates of 18% and 50%, respectively.[9] This once again emphasizes the need for early cover (Table 9).[15]

93% of the patients in this study were satisfied with the surgery and the outcome. As expected, local flaps had a high satisfaction rates while distant flaps had fair or poor satisfaction rates, but we have to take into consideration that these patients had significantly more severe injuries than those who underwent local and regional flaps, and hence, identification of these patients and early education regarding the possible functional outcomes will mentally prepare the patient for the long road ahead and significantly improve the long-term functional outcome after such difficult reconstruction. With the knowledge of perforators supplying the lower-third leg, perforator flaps are now being done. They are to be done with equal care as though performing a microvascular procedure. Although free tissue transfer has revolutionized coverage of lower one-third leg defects, it may not be feasible to have the personnel with the necessary skill and facilities at that time. Fasciocutaneous flaps and reverse neuro fasciocutaneous flaps still have well-established roles to play in lower extremity reconstruction. Limb reconstructive is a long and complicated process in which unlike other surgical emergencies protocols are still evolving and evidenced-based guidelines are not available.

Table 7: Overall satisfaction of patients

Patient satisfaction	Number of case
Good	51
Fair	17
Poor	5

CONCLUSION

Although free flaps are the gold standard for coverage of lower one-third leg soft tissue defects, distally based

Table 8: Flap versus complications

Complication	IBFTL	IBFTM	IBFST	RSNFP	RSNFI	PBM	PF	ALTFF	LDFF
Nil	24	1	1	11	1	1	1	1	1
Partial necrosis	2	0	0	1	0	0	0	0	0
Complete necrosis	1	0	0	1	0	0	0	0	0
Dehiscence	2	0	0	0	0	0	0	0	0
Graft loss	0	0	0	0	1	0	0	0	0
Superficial necrosis	3	0	0	2	1	0	0	0	0
Edema	7	0	2	11	0	0	0	1	0
Minor infection	6	0	1	9	0	1	0	1	0

IBFTL: Inferiorly based fasciocutaneous transposition flap - lateral side, IBFTM: Inferiorly based fasciocutaneous transpostion flap - medial side, IBFST: Inferiorly based fasciocutaneous sliding transpostion flap, RSNFP: Reverse sural neurofasciocutaneous island flap, RSNFI: ???, PBM: Peroneus brevis muscle flap, PF: Propellar flap, ALTFF: Anterolateral thigh-free flap, LDFF: Latissimus dorsi-free flap

Table 9: Complications versus phase of cover

Complications	0-3	4-42	>42
Nil	1	42	0
Partial necrosis	0	2	1
Dehiscence	0	1	1
Complete necrosis	0	2	0
Graft loss	0	1	0
Superficial necrosis	0	4	1
Edema	1	20	0
Minor infection	0	16	1

fasciocutaneous flaps and distally based reverse neuro fasciocutaneous flaps are still very useful in a set up like ours where sophisticated instruments, prolonged theater time, back-up anesthesia team for reexploration is not available all the time, and also because of the long wait list of trauma patients for surgery. Fasciocutaneous flaps are reliable, safe, and fast to learn.

REFERENCES

1. MacKenzie EJ, Cushing BM, Jurkovich GJ, Morris JA Jr, Burgess AR, deLateur BJ, *et al.* Physical impairment and functional outcomes six months after severe lower extremity fractures. J Trauma 1993;34:528-38.
2. Gururaj G. Injuries in India: A national perspective. In: Burden of disease in India: Equitable development-Healthy future. New Delhi: National Commission on Macroeconomics and Health, Ministry of Health and Family Welfare, Government of India; 2005. p. 325-47.
3. World Health Organization, Center for Neurotrauma. Prevention, critical care and rehabilitation of neurotrauma perspectives and future statergies. Geneva: World Health Organisation; 1995.
4. Barclay TL, Cardoso E, Sharpe DT, Crockett DJ. Repair of lower leg injuries with fascio-cutaneous flaps. Br J Plast Surg 1982;35:127-32.
5. Bhattacharya V. Fasciocutaneous Flaps, Plastic and Reconstructive Surgery: Current Trends Proceedings of CME Programme at National Conference of APSI, Calcutta; 1988. p. 36-40.
6. Kumar P, Bhasker KG, Chittoria R, Thomas PC. Flaps in lower limb trauma: Current status. Indian J Pharm Sci 2000;33:30-7.
7. Aldea PA, Shaw WW. The evolution of the surgical management of severe lower extremity trauma. Clin Plast Surg 1986;13(4):549-69.
8. Brown RF. The management of traumatic tissue loss in the Lower Limb, especially when complicated by skeletal injury. Br J Plast Surg 1965;18:26-50.
9. Byrd HS, Spicer TE, Cierney G. Management of open tibial fractures. Plast Reconstr Surg 1985;76:719-30.
10. Yaremchuk MJ, Brumback RJ. Acute and definitive management of traumatic osteocutaneous defects o f the lower extremity. Plast Reconstr Surg 1982;70:1-10.
11. Santanelli F. Lower Extremity Reconstruction, Tibia, e-medicine; 2005.
12. Tornetta P, Bergman M, Watnik N, Berkowitz G, Steuer J. Treatment of grade-IIIb open tibial fractures. A prospective randomised comparison of external fixation and non-reamed locked nailing. J Bone Joint Surg Br 1994;76:13-9.
13. Godina M. Early microsurgical reconstruction of complex trauma of the extremities. Plast Reconstr Surg 1986;78:285-92.
14. Sharma RK. Perforator plus flap: Evolution of the concept and its place in plastic surgeons repertoire. Indian J Plast Surg 2010;43:148-50.
15. Coskunfirat OK, Ozgentas HE. Reversed neurofasciocutaneous island flap based on the vascular supply accompanying the superficial peroneal nerve. Plast Reconstr Surg 2001;108:1305-8.

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