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ORIGINAL ARTICLE

Outcome of Free Flap Reconstruction for Composite Defects of the Lower Third Leg and Foot: A Prospective Observational Study

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ABSTRACT

Introduction: *Composite defects of the lower third leg and foot present major reconstructive challenges due to limited soft tissue availability, poor local vascularity, and frequent exposure of critical structures. Free flap reconstruction has become the gold-standard approach, yet outcome data from Bangladesh remain scarce.* ***Methods & Materials:*** *This descriptive observational study was conducted at Sylhet M.A.G. Osmani Medical College Hospital, Bangladesh, from July 2015 to June 2017. Eleven patients with composite defects requiring free flap coverage were included. Demographics, etiology, defect characteristics, flap type, recipient vessels, and postoperative outcomes were recorded. Flap success was graded using the Srikant classification. Only descriptive statistics were applied.* ***Results:*** *The mean patient age was 45.45 ± 5.3 years, with a predominance of males (73%). Road traffic accidents were the most common cause of defects (55%), followed by tumor excision (27%). Defects ranged from 8 × 5 cm to 20 × 7 cm. The anterolateral thigh (ALT) flap was the most frequently used flap (73%), and the anterior tibial artery served as the recipient vessel in 82% of cases. According to the Srikant system, 100% flap survival was achieved, with 73% classified as Grade 1 (complete success without complications). No patient experienced complete flap failure, major morbidity, or amputation.* ***Conclusion:*** *Free flap reconstruction is a highly reliable option for managing complex composite defects of the lower third leg and foot, even within resource-limited settings. The high flap survival rate and absence of catastrophic complications demonstrate the feasibility and effectiveness of microsurgical reconstruction in Bangladesh.*

Keywords: *Reconstruction, Microsurgery, Flaps, Trauma, Defects, Limb-salvage, ALT, Anastomosis, Foot*

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INTRODUCTION

Composite defects of the lower third leg and foot continue to pose a significant reconstructive challenge due to the unique anatomical constraints of this region. The distal leg and foot are characterized by thin soft-tissue coverage, minimal subcutaneous padding, and a limited muscular envelope. These features make defects in this zone particularly difficult to manage with local or regional options, as the available tissues are often insufficient to cover exposed bone, tendon, or implants [1,2]. Free tissue transfer has therefore emerged as the most reliable solution for achieving durable, well-vascularized coverage, especially in cases involving high-energy trauma or oncologic resection. In low- and middle-income countries, including Bangladesh, the incidence of complex lower extremity injuries has increased in parallel with urbanization, industrialization, and road traffic density. Road traffic accidents account for a substantial proportion of severe limb trauma, frequently resulting in composite defects involving multiple tissue layers [3,4]. Traditional techniques such as split-thickness skin grafting, local fasciocutaneous flaps, and cross-leg flaps have distinct limitations in the distal leg and foot because they cannot reliably provide stable coverage or withstand shear forces during ambulation. These limitations have strengthened the role of microsurgical free flaps as the gold-standard reconstructive method for this region. Advances in microsurgical instrumentation, perforator-based flap design, and perioperative monitoring have significantly improved free flap outcomes over the past decade. Contemporary literature consistently reports free flap survival rates exceeding 94–98%, even in patients with comorbidities or traumatic contamination [5,6]. Among various donor sites, the anterolateral thigh (ALT) flap has gained widespread acceptance due to its long pedicle, consistent anatomy, pliability, and ability to be thinned for contouring around the foot and ankle [7]. Its versatility allows reconstruction of a wide range of defect sizes and depths, contributing to its status as a global workhorse flap. But lower extremity microsurgical reconstruction continues to present

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challenges that are less common in other anatomic regions. Factors such as local vessel damage, wound contamination, delayed presentation, and pre-existing peripheral vascular disease may increase the risk of flap compromise [8]. In addition, geographic variations in injury mechanisms, healthcare access, and microsurgical expertise influence clinical outcomes between countries. South and Southeast Asian studies show that RTAs contribute to more than half of the cases requiring free flap reconstruction for the distal leg and foot, a pattern that aligns with the epidemiological context of Bangladesh [9]. Despite the growing adoption of free flap reconstruction in the region, there is a notable lack of published data from Bangladesh describing outcomes specific to composite defects of the lower third leg and foot. As microsurgical capability expands within the country, documenting outcomes is crucial for benchmarking performance, identifying challenges unique to local practice, and guiding future improvements. Therefore, this study aimed to evaluate the outcome of free flap reconstruction for composite defects of the lower third leg and foot in a tertiary hospital in Bangladesh.

METHODS & MATERIALS

This descriptive observational study was conducted in the Departments of Orthopaedics and Burn & Plastic Surgery at Sylhet M.A.G. Osmani Medical College Hospital, Bangladesh, from July 2015 to June 2017. Patients with composite defects of the lower third leg and foot requiring free flap reconstruction were consecutively enrolled using convenience sampling, yielding a final sample of 11 cases. Inclusion criteria were: composite defects in the distal leg or foot, fitness for anesthesia, and willingness to undergo free flap surgery. Exclusion criteria were: defects suitable for simpler coverage, absent distal arterial pulses, or medical unfitness for prolonged anesthesia. For each patient, demographic data, defect characteristics, flap type, recipient vessel selection, and postoperative outcomes were recorded using a structured questionnaire. All free flaps were performed under general or spinal anesthesia with standard microvascular techniques. Flap outcomes were classified using the Srikant system. Data were analyzed in SPSS version 21 using descriptive statistics only. Ethical approval was obtained, and written informed consent was collected from all participants.

Inclusion Criteria

- Composite defect of the lower third leg or foot requires free flap coverage.
- Patients fit for general or spinal anesthesia.
- Patients provided written informed consent.

Exclusion Criteria

- Defects suitable for skin grafts or local/regional flaps.
- Absent distal arterial pulses.
- Patients were medically unfit or unwilling to undergo free flap surgery.

RESULTS

A total of 11 patients were included, with ages ranging from 20 to 60 years. The highest proportion belonged to the 51–60-year age group (45%), while the lowest proportion was among patients aged 20–30 years (9%). The mean age was 45.45 ± 5.3 years, indicating a middle-aged cohort predominantly affected by such injuries. Males constituted the majority (73%), reflecting the higher exposure of men to road traffic trauma in Bangladesh. Two patients (18%) had notable comorbidities—one with diabetes and one with hypertension. No statistical comparison between demographic subgroups was performed (p-value not applicable due to sample size). [Table I]

Table – I: Baseline Characteristics of Patients (*n* = 11)

Variable	Category	Frequency n (%)	Mean ± SD
Age (years)	20–30	1 (9%)	
	31–40	3 (27%)	
	41–50	2 (18%)	
	51–60	5 (45%)	45.45 ± 5.3
Sex	Male	8 (73%)	
	Female	3 (27%)	
Comorbidities	Diabetes mellitus	1 (9%)	
	Hypertension	1 (9%)	

The most common cause of composite soft tissue defects was road traffic accidents (RTA), accounting for 55% of all cases, followed by tumor excision (27%). Assault and exposed implant each contributed to 9%, making them the least frequent etiologies. Regarding anatomical location, the lower leg was most frequently affected (36%), while heel and sole involvement were the least common (9% each). No statistical significance testing was performed due to limited sample size. [Table II]

Table – II: Etiology and Anatomical Site of Composite Defects (*n* = 11)

Variable	Category	Frequency n (%)
Cause of Defect	Road traffic accident	7 (55%)
	Tumor excision	3 (27%)
	Assault	1 (9%)
	Exposed implant	1 (9%)
Anatomical Site	Lower leg	4 (36%)
	Foot dorsum	2 (18%)
	Heel	1 (9%)
	Sole & dorsum	3 (27%)
	Sole	1 (9%)

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Defect sizes varied widely, ranging from 8 × 5 cm to 20 × 7 cm, indicating the presence of both moderate and large composite defects. Correspondingly, flap dimensions ranged from 10 × 5 cm to 23 × 7 cm to ensure adequate coverage. The largest flap was an ALT flap measuring 23 × 7 cm, while the smallest was 10 × 5 cm. Because the raw thesis data did not include standard deviations, no inferential analyses were performed. [Table III]

Table – III: Summary of Defect and Flap Sizes (*n* = 11)

Parameter	Mean ± SD	Range
Defect size (cm)	Summarized from individual cases	8 × 5 to 20 × 7
Flap size (cm)	Summarized from individual cases	10 × 5 to 23 × 7

The anterolateral thigh (ALT) flap was by far the most frequently used flap, representing 73% (n=8) of all reconstructions. Rectus abdominis, gracilis, and latissimus dorsi flaps each constituted 9%, making them the least utilized options. The predominance of ALT flaps reflects surgeon preference and the versatility of this flap for lower limb reconstruction. No statistically significant differences were assessed between flap type usage due to sample limitations. [Table IV]

Table – IV: Types of Free Flaps Used (*n* = 11)

Type of Free Flap	Frequency n (%)
Anterolateral thigh (ALT)	8 (73%)
Rectus abdominis	1 (9%)
Gracilis	1 (9%)
Latissimus dorsi	1 (9%)

The anterior tibial artery served as the recipient vessel in 82% of cases, making it the most commonly used vessel, whereas the posterior tibial artery was used in 18% of cases. No venous complications or mismatches requiring vessel changeover were reported. p-values were not calculated as only descriptive data were obtained. [Table V]

Table – V: Recipient Vessels Used for Microvascular Anastomosis (*n* = 11)

Recipient Vessel	Frequency n (%)
Anterior tibial artery	9 (82%)
Posterior tibial artery	2 (18%)

According to the Srikant grading system, complete flap success (Grades 1–3) was achieved in 100% of patients. The highest proportion of outcomes was Grade 1 (73%), reflecting uneventful postoperative recovery. Grade 2 accounted for 18%, involving minor partial non-critical flap loss, while Grade 3 represented 9%, requiring additional procedures such as skin grafting. Importantly, no Grade 4 or Grade 5 events occurred, indicating 0% complete flap failure and 0% limb loss in this cohort. Due to perfect success across all cases, no comparative statistics were applicable. [Table VI]

Table – VI: Free Flap Outcomes According to Srikant Classification

Grade	Description	n (%)
Grade 1	Complete flap success; uneventful course	8 (72.7%)
Grade 2	Complete success with minor partial non-critical loss	2 (18.2%)
Grade 3	Complete success with major partial non-critical loss	1 (9.1%)
Grade 4	Partial critical/complete flap failure	0
Grade 5	Amputation or catastrophic morbidity	0

DISCUSSION

This prospective study demonstrated excellent outcomes for free flap reconstruction of composite defects of the lower third leg and foot, achieving a 100% flap survival rate with no cases of complete flap failure. The age distribution showed that patients aged 51–60 years were most commonly affected (45%), while only 9% were in the 20–30-year group. This pattern aligns with modern literature, where the mean age of patients requiring free flap reconstruction of the lower limb often falls between 40 and 50 years [10,11]. Similarly, another study reported middle-aged predominance, likely reflecting greater exposure to high-energy trauma, comorbidity burden, and occupational hazards in this population [12]. In this cohort, 73% were male, consistent with reports from Altam et al showing male proportions of 70–85% in lower extremity microsurgical cases [6]. Male predominance is typically attributed to increased involvement in outdoor labor, construction work, transportation, and industrial settings all of which are common in Bangladesh and contribute to a higher incidence of severe limb trauma. Regarding etiology, road traffic accidents accounted for 63.6% of all defects, followed by tumor excision (27.3%). Recent studies from South Asia report similar patterns, with RTAs representing 55–70% of indications for lower limb free flap reconstruction [4,13]. The high rate of trauma-related cases in the present study reflects the national burden of road injuries and limited prehospital trauma systems. The anatomical distribution showed that the lower leg (36.4%) was the most commonly affected region, followed by combined sole–dorsum defects (27.3%). The distal third of the leg is widely recognized as a challenging reconstructive zone due to its sparse soft tissue and poor local vascularity. Contemporary reconstructive algorithms emphasize free flaps as the primary modality for these defects [14,15]. The anterolateral thigh (ALT) flap was used in 72.7% of cases, making it the most commonly used flap. This finding mirrors international trends; recent studies by Lee et al., and Brambullo et al, show ALT usage rates between 60% and 80% in lower limb reconstruction [16,17]. The flap's long pedicle, large skin paddle, and ability to be thinned make it particularly suitable for the contour demands of the foot and ankle. Recipient vessel selection in the current study favored the anterior tibial artery (81.8%), consistent with global recommendations that prioritize anterior tibial vessels due to their reliable anatomy and accessibility [18]. Song et al. also highlighted anterior tibial artery anastomosis as a predictor of free flap success in lower limb reconstruction [19]. The 100% flap survival rate observed in this study slightly exceeds the typical 94–98% survival rates reported in modern microsurgical series [6]. While encouraging, this result must be interpreted cautiously due to the small sample size.

Nevertheless, it demonstrates the feasibility and reliability of microsurgical reconstruction in the Bangladeshi context.

LIMITATIONS OF THIS STUDY

This study includes a small sample size, a single-center design, and a lack of long-term functional and quality-of-life outcomes.

CONCLUSION

In this study, free flap reconstruction proved to be a highly reliable option for managing composite defects of the lower third leg and foot. Despite the anatomical challenges and the complexity of these injuries, every patient in our series achieved successful flap survival, and none required secondary flap procedures or amputation. These outcomes highlight not only the effectiveness of microsurgical reconstruction but also the important role it plays in preserving limb function, mobility, and quality of life for patients who often present in vulnerable conditions following trauma or major surgical excision. The predominance of anterolateral thigh flaps and the consistent use of dependable recipient vessels demonstrate that, even in resource-limited settings, well-planned microsurgical techniques can deliver outcomes comparable to those reported internationally. Ultimately, the findings of this study reinforce that free flap reconstruction is not just a technical solution it is a meaningful intervention that restores form, function, and hope for patients facing complex lower limb defects.

RECOMMENDATIONS

Based on the findings of this study, it is recommended that free flap reconstruction services be expanded across more tertiary hospitals in Bangladesh to improve access to limb-salvage procedures for patients with complex distal leg and foot defects. Strengthening training programs in microsurgery for surgeons, anesthetists, and operating room staff is essential to ensure consistent, high-quality outcomes. Additionally, future research should focus on larger, multicenter studies with longer follow-up periods to assess functional recovery, gait, long-term flap durability, and patient-reported outcomes, which will help refine reconstructive protocols and better tailor treatment strategies to the needs of the local population.

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