

Research Article**Outcomes of Fasciotomy in Acute Compartment Syndrome of the Lower Limb****Muhammad Attique Sadiq¹, Maham Sheraz², Attiq ur Rehman³, Muhammad Idrees Achakzai⁴, Hamna Rizwan⁵, Muhammad Nasir Iqbal⁶****Affiliations:**¹ Associate Professor Surgery, Foundation University Medical College, Rawalpindi / Islamabad.² Consultant General Surgery, Hearts International Hospital.³ Associate Professor Orthopedic, Bolan Medical College.⁴ Associate Professor Surgery, Post Graduate Medical Institute, Quetta.⁵ Jinnah Hospital, Lahore.⁶ Senior Registrar General Surgery, Doctors Hospital & Medical Center, Lahore.**Corresponding author: Muhammad Attique Sadiq**

Abstract: Acute compartment syndrome (ACS) of the lower limb constitutes a surgical emergency requiring prompt decompressive fasciotomy to avoid irreversible tissue damage, amputation and death. This prospective cohort study aimed to evaluate functional and limb-salvage outcomes of fasciotomy in lower-limb ACS, and to identify independent predictors of adverse outcome (amputation or death). Between January 2020 and December 2023, 150 adult patients presenting with lower-limb ACS confirmed by clinical and/or pressure monitoring, and managed by decompressive fasciotomy at a tertiary hospital, were enrolled. Demographic, injury, surgical timing and outcome data were recorded, with a minimum follow-up of six months. Overall limb-salvage rate was 84% (n = 126) and six-month mortality was 5.3% (n = 8). Patients who underwent fasciotomy within 6 hours of diagnosis demonstrated significantly higher salvage (92% vs 78%; p = 0.01). On multivariate logistic regression, delay to fasciotomy >6 hours (adjusted OR 3.9; 95% CI 1.8-8.6; p = 0.001), concomitant vascular injury (adjusted OR 2.7; 95% CI 1.2-6.0; p = 0.015) and pre-operative serum creatine kinase >10,000 U/L (adjusted OR 2.4; 95% CI 1.1-5.2; p = 0.028) were independent predictors of amputation or death. The findings reinforce the crucial importance of early surgical decompression and highlight high-risk features that may warrant heightened monitoring or adjunctive vascular intervention. Keywords: acute compartment syndrome; fasciotomy; lower limb; limb salvage.

Introduction: The lower limb is susceptible to acute compartment syndrome (ACS), a condition in which elevated intracompartmental pressure compromises perfusion within the non-expandable

fascial compartment, precipitating muscle and nerve ischemia, necrosis, and ultimately permanent functional loss or limb amputation. The etiologies of lower-limb ACS are diverse and include high-energy fractures (particularly tibial shaft fractures), crush injury, reperfusion injury following vascular occlusion, and iatrogenic causes such as prolonged limb compression or surgery. The consequences of delayed diagnosis or treatment are severe: muscle necrosis, rhabdomyolysis with systemic complications such as acute kidney injury, infection, compartment-related tissue necrosis necessitating amputation, and increased mortality. In low- and middle-income settings, additional factors such as transfer delay, resource constraints, and limited access to immediate surgical decompression exacerbate risk and impair outcomes.¹⁻⁴

Decompressive fasciotomy is universally accepted as the definitive treatment for established ACS. The technique involves full-length surgical opening of all involved compartments to decompress pressure, restore microvascular flow, and prevent irreversible tissue injury. Procedural success depends heavily on timing: earlier decompression is strongly correlated with better muscle viability, reduced need for amputation, and improved functional recovery. Published series have shown variable outcomes depending on timing, etiology, presence of vascular injury, and the timeliness of subsequent wound closure. Complications of fasciotomy include significant wound morbidity such as infection, delayed closure requiring skin graft or flap, prolonged rehabilitation, and in some cases persistent muscle weakness, contracture or chronic pain. Despite these risks, the alternative—non-decompression—carries inevitable muscle necrosis and profound functional loss.⁵⁻⁸

Previous literature has begun to delineate predictors of poor outcomes in lower-limb ACS. For example, meta-analyses have shown that delayed decompression (>6 h) and presence of vascular compromise significantly increase the odds of amputation. Intracompartmental pressure monitoring and early decompression reduce risk of limb loss. However, many of the existing studies originate from high-income centres and include heterogeneous patient populations or mixed anatomical sites (upper and lower limbs). There remains a paucity of data from resource-limited settings on outcomes of fasciotomy in lower-limb ACS, particularly incorporating local delays, vascular injury prevalence and regional wound-care complications. Understanding these contextual factors is essential to optimise local protocols for timely referral, decompression and postoperative care.⁹⁻¹²

In addition, functional recovery after limb salvage remains under-reported in many series. Ensuring limb salvage is only the first step; subsequent wound healing, muscle preservation, return to ambulation and quality of life measure the true success of intervention. Many patients remain disabled despite salvage, and the burden of wound complications, infection, and secondary surgeries can be high in environments with limited reconstructive resources. Moreover, identifying high-risk features at presentation may facilitate stratification of patients for intensified monitoring, adjunctive vascular or soft-tissue reconstruction and tailored rehabilitation. Thus, it is crucial to evaluate both limb-salvage rate and functional outcome in lower-limb ACS managed by fasciotomy, and to identify predictors of adverse outcome in a local tertiary-care context.

The present study was designed to address this gap. The primary objective was to evaluate outcomes of fasciotomy in acute lower-limb compartment syndrome treated at a tertiary hospital over a four-year period, focusing on limb salvage (avoidance of amputation) and mortality at six months. The secondary objective was to identify independent predictors of adverse outcome (amputation or death) from among variables including time to decompression, presence of vascular injury, pre-operative serum creatine kinase (CK), delay to presentation, fracture type, and wound closure modality. The hypothesis was that early fasciotomy (within six hours of diagnosis) and absence of vascular injury would be associated with higher limb-salvage rates and lower mortality. The findings from this cohort are expected to inform local surgical referral, decompression timing and post-operative wound-care protocols, and may serve as a benchmark for other institutions in similar resource settings.

Methodology: This prospective observational cohort study enrolled adult patients (age ≥ 18 years) who presented to the trauma service of Foundation University Medical College, Rawalpindi / Islamabad between 1 January 2020 and 31 December 2023 with a diagnosis of acute lower-limb compartment syndrome (ACS) requiring decompressive fasciotomy. ACS diagnosis was made on the basis of clinical assessment (pain disproportionate to injury, pain on passive stretch, tense compartment, sensory or motor deficit) and, where available, intracompartmental pressure measurement (≥ 30 mmHg absolute or within 30 mmHg of diastolic blood pressure). Exclusion criteria comprised chronic exertional compartment syndrome, isolated upper-limb ACS, patients who underwent initial primary amputation without attempted decompression, and those lost to follow-up by six months. Written informed consent was obtained from patients (or next of kin if

incapacitated) for data collection; the institutional ethics committee approved the protocol with waiver of additional risk beyond standard care. Sample size was calculated using Epi Info StatCalc with anticipated adverse outcome (amputation or death) rate of 20% from auditing pilot data, a 95% confidence level, 80% power and a precision of $\pm 6\%$; the calculation yielded a minimum of 138 subjects; allowing for 10% loss to follow-up, recruitment target was 152; 150 completed six-month follow-up and constituted the analysed sample. Surgical protocol comprised prompt four-compartment fasciotomy (anterolateral, posterolateral, anterior, deep posterior) via standard open incisions. Time from diagnosis to decompression was recorded in hours. Concomitant injuries (fracture, vascular injury, crush) were documented; vascular injuries were managed by immediate repair or bypass where indicated. Pre-operative serum CK was recorded on admission. Post-operative management included daily wound assessment, timing of delayed closure (primary, skin graft, flap), infection monitoring, and rehabilitation. Outcome variables included limb salvage (no amputation during index hospitalisation or within six-month follow-up), mortality within six months, wound complication (infection requiring re-intervention), time to ambulation and functional status at six months (walking with/without aid). Statistical analysis employed SPSS v26.0; continuous variables were expressed as mean $\pm$ standard deviation (or median and inter-quartile range if non-normal) and compared using t-test or Mann-Whitney U test. Categorical variables were compared by chi-square test. Univariate predictors of adverse outcome (amputation or death) with $p < 0.10$ were entered into multivariate logistic regression; adjusted odds ratios (aOR) with 95% confidence intervals (CI) were reported. A p-value < 0.05 was considered statistically significant.

Results

Table 1: Baseline characteristics (N = 150)

Characteristic	Value
Age (years), mean $\pm$ SD	34.8 $\pm$ 12.6
Male sex, n (%)	108 (72.0%)
Etiology of ACS	
• Tibial shaft fracture	65 (43.3%)

Characteristic	Value
• Crush injury	38 (25.3%)
• Vascular occlusion/reperfusion	27 (18.0%)
• Others (soft-tissue trauma)	20 (13.4%)
Time to presentation (hours), median (IQR)	4 (2–9)
Time from diagnosis to fasciotomy (hours), median (IQR)	5 (3–10)
Vascular injury (requiring repair), n (%)	34 (22.7%)
Pre-operative CK (U/L), median (IQR)	8,700 (4,100–15,300)
Six-month follow-up achieved	150 (100%)

The cohort comprised predominantly young male patients with a variety of etiologies for ACS, median presentation delay of 4 h and median time to decompression of 5 h.

Table 2: Outcomes and comparison by fasciotomy timing

Fasciotomy timing	≤6 hours (n = 92)	>6 hours (n = 58)	p-value
Limb salvage rate, n (%)	85 (92.4%)	41 (70.7%)	0.001
Amputation, n (%)	7 (7.6%)	17 (29.3%)	0.001
Mortality, n (%)	3 (3.3%)	5 (8.6%)	0.15
Wound infection requiring re-intervention, n (%)	14 (15.2%)	18 (31.0%)	0.02
Median time to ambulation (days)	8 (6–12)	14 (10–20)	<0.001

This table shows that earlier decompression (≤6 h) was significantly associated with higher salvage rates, lower amputation and infection rates, and faster ambulation.

Table 3: Multivariate logistic regression for adverse outcome (amputation or death)

Predictor	Adjusted OR	95% CI	p-value
Time to fasciotomy >6 h	3.9	1.8 – 8.6	0.001

Predictor	Adjusted OR	95% CI	p-value
Vascular injury present	2.7	1.2 – 6.0	0.015
Pre-operative CK >10,000 U/L	2.4	1.1 – 5.2	0.028
Crush injury etiology	1.7	0.8 – 3.7	0.14
Age ≥50 years	1.5	0.6 – 3.8	0.38

The logistic regression identifies delay to fasciotomy, vascular injury and high CK as independent predictors of amputation or death.

Discussion: This study demonstrates that decompressive fasciotomy in lower-limb acute compartment syndrome yields a limb-salvage rate of 84% and six-month mortality of 5.3% in a tertiary-care environment. The salvage rate compares favourably with published pooled amputation rates of approximately 10–11% after fasciotomy in lower-limb ACS. The key determinant of outcome in this series was timing: fasciotomy within six hours of diagnosis resulted in a salvage rate of 92.4%, while delays beyond six hours increased the likelihood of amputation (29.3% vs 7.6%; $p = 0.001$). This finding aligns with recent meta-analysis data demonstrating that early decompression (especially within six hours) significantly reduces risk of amputation. The biological basis is clear: prolonged elevated intracompartmental pressure leads to progressive muscle necrosis, capillary collapse, rhabdomyolysis, and systemic sequelae, which are not reversed by late surgery. Thus, institutional efforts to streamline diagnosis, expedite transfer and reduce surgical delay appear critical.¹³⁻¹⁶

A second major finding is the independent role of concomitant vascular injury in predicting adverse outcome (adjusted OR 2.7; $p = 0.015$). Patients with vascular repair demand not only fasciotomy but also hemostatic and perfusion restoration, which likely compounds the ischemia–reperfusion injury. The literature consistently highlights that vascular compromise amplifies the risk of compartment syndrome and adverse outcome; thus, when present, heightened vigilance, monitoring and possibly extended decompression may be warranted. Additionally, pre-operative serum CK >10,000 U/L emerged as a predictor of outcome (aOR 2.4; $p = 0.028$), representing a surrogate for muscle injury and ischemic burden. High CK underscores the severity of cartilage

muscle damage and indicates that even with decompression, functional tissue may have been lost.¹⁸⁻²⁰

Wound infection requiring re-intervention occurred in 21% of the cohort and was significantly higher in the delayed-fasciotomy group (31% vs 15%; $p = 0.02$). This finding emphasises that not only limb salvage, but also wound complications increase with delayed intervention, likely reflecting more extensive necrosis, greater tissue debridement and longer open wounds before closure. Post-fasciotomy wound morbidity is increasingly recognised in recent literature, and in resource-limited settings where skin grafting and flap coverage may be delayed, the impact on rehabilitation and functional return may be considerable.

The median time to ambulation was longer in the delayed group (14 vs 8 days; $p < 0.001$), indicating that early decompression not only saves limbs, but also accelerates recovery and reduces hospital length of stay and resource consumption. Functional recovery is critical in lower-limb ACS: limb salvage without functional mobility confers limited benefit. This study reports earlier ambulation as a favourable outcome, but longer-term functional status (walking unaided, return to pre-injury activity) warrants further study.

The limitations of this study must be acknowledged. Although the cohort is prospective, it remains single-centre and may reflect local referral patterns and surgical capacity not generalisable to all settings. Follow-up was limited to six months; longer-term functional and quality-of-life outcomes were not assessed. Intracompartmental pressure monitoring was used inconsistently and the threshold timing definitions were pragmatic rather than strictly protocolised. Despite inclusion of a vascular-injury variable, further granularity (ischemic time, severity of reperfusion injury) was not captured. Nevertheless, the study's strengths include a well-defined cohort, uniform surgical protocol with clearly documented timing intervals, and multivariate analysis identifying independent predictors of adverse outcome.

In total, these findings reinforce the standing principle that “time is muscle” in lower-limb ACS and extend it to a setting with variable delays and resource constraints. They suggest that local trauma systems should prioritise protocols for early identification (clinical and pressure monitoring) and rapid decompression, and that patients with vascular injury or markedly elevated

CK may benefit from targeted adjunctive management (e.g., extended monitoring, early rehabilitation, wound-care optimisation). Future research should explore wound-closure strategies, long-term functional outcomes and cost-effectiveness of early transfer pathways in lower-limb ACS.

Conclusion: In acute lower-limb compartment syndrome managed by fasciotomy, early intervention (≤ 6 h) yields markedly higher limb-salvage rates and fewer complications, while delays, vascular injury and elevated pre-operative CK are independent predictors of amputation or death. Implementation of rapid diagnostic and referral pathways and prompt decompression is essential; future work should evaluate long-term functional recovery and optimal wound-closure protocols.

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