

Five-Year Review of Pediatric Vascular Trauma Patterns and Management in Conflict Zones: Insights from Somalia

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Background: Pediatric vascular trauma is uncommon but devastating, and risk is amplified in conflict zones with constrained systems. Evidence from Somalia is limited.

Objective: To describe patterns, mechanisms, anatomic distribution, management, and outcomes of pediatric vascular trauma over five years at a tertiary referral center in Mogadishu.

Methods: Retrospective study of patients ≤ 18 years with traumatic vascular injury (April 2019–April 2024). Variables included demographics, mechanism, injury site, time-to-presentation, procedures, transfusion, complications, limb salvage, and mortality. Diagnostics followed ATLS-guided pathways (clinical exam/Doppler/CTA). Standard open vascular techniques (primary repair, end-to-end anastomosis, interposition autologous vein/PTFE) were used. Ethical approval MSTH/16842.

Results: Fifty-four patients were included (83.3% male; 70.4% aged 13–18). Penetrating injuries predominated (81.5%: firearms, blast, stab, shrapnel). Commonly injured vessels were brachial (25.9%) and superficial femoral arteries (22.2%). Primary repair (40.7%) and vein grafting (35.2%) were most used. Limb salvage was 98.1% (53/54); one in-hospital death (1.9%). Delayed presentation (>6 h) and associated injuries correlated with worse outcomes.

Conclusion: In Somalia's conflict context, pediatric vascular trauma is largely penetrating and limb-threatening but shows excellent limb salvage with timely surgery. Findings support earlier referral, blood-bank capacity, standardized imaging pathways, and advanced vascular training to further reduce mortality.

Keywords: pediatric vascular trauma, penetrating injuries, limb salvage, conflict zones, blunt trauma, combat-related injuries

Introduction

Vascular injuries in pediatric trauma cases are relatively rare, representing just 0.6% to 1.4% of all injuries in children.^{1,2} Despite their rarity, the serious implications of these injuries make them a major concern in trauma management. Pediatric vascular trauma presents unique challenges due to the smaller diameter of blood vessels, increased likelihood of vasospasm, limited intravascular volume, and the necessity to accommodate future vessel growth. Moreover, the long-term viability of vascular repairs and the diagnostic complexity of such injuries add further difficulty to their treatment.³ These injuries can be difficult to detect, as vasospasm and concurrent trauma may mask their presence, making swift diagnosis and treatment critical. In younger children, the typical signs of vascular injury—such as visible pulsatile bleeding—are often less noticeable.⁴ In Somalia, due to the high prevalence of terrorism and conflict-related violence, blast and gunshot injuries are particularly common.⁵ The ongoing conflict in Somalia dates back to the collapse of Siad

Barre's regime, with varying levels of intensity over the years. Its primary drivers are terrorism and inter-clan disputes.⁶ Despite this context, there is a lack of comprehensive studies detailing the patterns, causes, surgical strategies, and outcomes of pediatric vascular injuries within Somali conflict zones. Our hospital, located in Mogadishu—the capital of Somalia—was established through a bilateral agreement between the health ministries of Somalia and Türkiye, aimed at strengthening collaboration in healthcare and medical services. It serves as a key referral center for vascular surgery across the country, receiving patients from both Mogadishu and other regions with traumatic vascular injuries.

This five-year retrospective study seeks to address the existing knowledge gap by examining pediatric vascular trauma cases treated at selected Somali hospitals. The study's objectives include documenting the mechanisms of injury, anatomical sites affected, types of surgical interventions performed, and patient outcomes such as limb salvage and mortality. In conflict-affected systems, delayed prehospital transport, limited imaging, and scarce graft materials compound ischemia time and increase the risk of limb loss. We aimed to quantify patterns and mechanisms of injury, describe operative strategies, and report limb-salvage and mortality, while identifying modifiable system factors (eg, time-to-care).

Methods

Study Design and Setting

This was a retrospective cohort study conducted at Mogadishu Somali-Türkiye Training and Research Hospital, the national referral center in Somalia. The study period spanned five years, from April 2019 to April 2024. Data were extracted from the hospital's FONET electronic medical records system and are available from the corresponding author upon reasonable request.

Participants

Eligible participants included all pediatric patients (≤ 18 years) presenting with clinically or radiologically confirmed arterial or major venous injuries due to trauma and managed at our center. Exclusion criteria were iatrogenic catheter-related injuries, and cases with missing operative or outcome data.

Data Collection and Variables

A single investigator performed the retrospective review and collected socio-demographic (age, sex, time to admission), clinical, and operative data. Mechanisms of injury were categorized as penetrating trauma (gunshot wounds, stabbings, glass cuts, saw-related injuries, shrapnel, or blast trauma) or blunt trauma (falls, motor vehicle accidents, or sports injuries). Associated injuries recorded included bone fractures, nerve injuries, and compartment syndrome. Complications of interest included infection, graft failure, limb amputation, and in-hospital mortality. All patients underwent initial evaluation by the cardiovascular surgery team upon admission. Resuscitation followed Advanced Trauma Life Support (ATLS) principles. Diagnosis of vascular injury was based on clinical examination supplemented by: handheld Doppler; color Doppler ultrasonography; computed tomography angiography (CTA) in hemodynamically stable patients with equivocal findings; or immediate surgical exploration in the presence of "hard signs" of vascular injury (pulsatile hemorrhage, expanding hematoma, bruit/thrill, or distal ischemia). Bone fractures were confirmed by plain radiographs when clinically indicated. Surgical management followed standard vascular repair principles. After vascular exposure, proximal and distal control was established, and systemic heparin (100 IU/kg) was administered unless contraindicated. Inflow and outflow were assessed, with thrombectomy performed when necessary. Definitive repair included: primary repair or end-to-end anastomosis when feasible; interposition grafting with the great saphenous vein (preferred), or cephalic/basilic veins for brachial artery injuries; polytetrafluoroethylene (PTFE) grafts when autologous vein was unavailable. Orthopedic stabilization was performed following revascularization to minimize ischemia time. Four-compartment fasciotomy was performed when reperfusion was delayed or compartment syndrome was suspected. Concomitant nerve injuries identified intraoperatively were repaired as appropriate. For patients presenting after >6 hours or with reduced distal mobility, the decision between revascularization and primary amputation was guided by intraoperative assessment of muscle viability via fasciotomy and contractility testing. The statistical analysis of this study was performed with the use of Statistical Package for Social Sciences Version 24.0 software (SPSS Inc., Chicago, IL, USA).

Ethical Approval

Ethical approval was obtained from the Mogadishu Somali Türkiye Training and Research Hospital's institutional review board MSTH/16842 reference number available upon request. The study adhered to the principles of the Declaration of Helsinki and local ethical guidelines. Informed consent was obtained from each patient's legal guardian.

Results

Among the 54 patients, 38 (70.4%) were aged between 13 and 18 years. The majority were male, with 45 patients (83.3%) being boys. The most common time for admission was during the evening hours from 6:00 PM to midnight, when 24 patients (44.4%) were hospitalized. In terms of injury mechanisms, penetrating trauma accounted for the majority of cases, affecting 44 patients (81.5%). These injuries included gunshot wounds, blast injuries, stab wounds, penetrating saw injuries, glass lacerations, and shrapnel wounds. Blunt trauma was less common, seen in 10 patients (18.5%), resulting from motor vehicle accidents, falls from heights, and sports-related blunt injuries such as those sustained during football, as shown in Table 1. The most frequently injured sites were the upper and lower limbs. The brachial artery in the upper limb was involved in 14 cases, highlighting its vulnerability, while the superficial femoral artery in the lower limb was affected in 12 cases. Venous injuries were less frequent but mainly involved the femoral vein, with 4 cases. Notable injuries were also recorded in the head and neck region, including 4 injuries to the common carotid artery and 3 to the internal jugular vein. Overall, arterial injuries (56 cases) were more common than venous injuries (10 cases), as detailed in Table 2. Regarding treatment, primary repair was the most frequently used method, performed in 22 patients (40.7%). Vein graft interposition was used in 19 patients (35.2%), and a combination of primary repair and vein grafting was applied in 6 patients (11.1%), reflecting a tailored approach in some cases to improve outcomes. Two patients (3.7%) received vein grafts with fasciotomy, and one patient (1.9%) underwent vein grafting combined with a muscle flap, indicating more complex interventions. Conservative management was chosen for two patients (3.7%), with an additional two patients (3.7%) receiving conservative treatment alongside

Table 1 Patient Demographics

Patient Demographics	Number	%
Age		
1-4 years	4	7.4%
5-8 years	6	11.1%
9-12 years	6	11.1%
13-18 years	38	70.4%
Gender		
Male	45	83.3%
Female	9	16.7%
Hospital administration time		
12:00 AM - 6:00 AM	7	13%
6:00 AM - 12:00 PM	12	22.2%
12:00 PM - 6:00 PM	11	20.4%
6:00 PM - 12:00 AM	24	44.4%
Mechanism of Injury		
Penetrating injury (Gunshot, Stabbing, saw, glass laceration, shrapnel and blast injury)	44	81.5%
Blunt trauma (motor vehicle, fall from height, blunt from football)	10	18.5%

Table 2 Site of Injury and Related Vessels

Site of Injury and Related Vessels			
Site	Vessel	Arterial No	Venous No
Head and Neck	Common carotid artery	4	
	Internal Jugular.		3
Upper limb	Brachial artery	14	
	Ulnar artery	3	
	Radial artery	3	
	Axillary artery	3	
	Axillary vein		1
Thorax	Subclavian artery	1	
Abdomen	Common Iliac artery	1	
Lower limb	Common femoral artery	1	
	Superficial femoral artery	12	
	Deep femoral artery	2	
	Femoral vein		4
	Popliteal artery	7	
	Popliteal vein		2
	Posterior tibial artery	3	
	Anterior tibial artery	1	
	Tibioperoneal trunk	1	
Multiple arterial injuries	Multiple	Single	
	2	54	
Total		56	10

fasciotomy, suggesting that even non-surgical approaches sometimes required intervention for complications, as shown in Table 3. A notable 23 patients (42.6%) had no associated injuries. Among those with additional trauma, fractures were the most common, with 14 patients (25.9%) sustaining upper extremity fractures and 11 patients (20.4%) having lower extremity

Table 3 Management of the Patients

Management of the Patients		
Management Options	Frequency	Percentage
Primary repair	22	40.7%
Vein graft interposition	19	35.2%
Primary repair and vein graft interposition	6	11.1%

(Continued)

Table 3 (Continued).

Management of the Patients		
Management Options	Frequency	Percentage
Vein graft with fasciotomy	2	3.7%
Vein graft with muscle flap	1	1.9%
Conservative	2	3.7%
Conservative with fasciotomy	2	3.7%
Total	54	100%

fractures. Nerve injuries were present in 4 patients (7.4%) affecting the upper extremity, and one patient (1.9%) developed compartment syndrome. There was also one case (1.9%) involving both a lower extremity fracture and nerve injury, as outlined in Table 4. Most patients (49, or 90.7%) experienced no complications following treatment. However, a small number faced adverse outcomes: 3 patients (5.6%) developed infections, one patient (1.9%) required amputation, and one patient (1.9%) died due to their injuries, as detailed in Table 5.

Table 4 Associated Injuries

Associated Injuries			
		Frequency	Percentage
No associated injury		23	42.6%
Injury site			
Upper extremity	Compartment syndrome	1	1.9%
	Nerve injury	4	7.4%
	Fracture	14	25.9%
Lower extremity	Fracture with nerve injury	1	1.9%
	Fracture	11	20.4%
Total		54	100%

Table 5 Complications Resulted from the Injury

Complications Resulted from the Injury		
Complication	Frequency	Percentage
Infection	3	5.6%
Amputation	1	1.9%
Death	1	1.9%
No complications	49	90.7%
Total	54	100%

Discussion

In this study, the majority of patients were male (83.3%), with 70.4% between the ages of 13 and 18 years. This aligns with trends observed in other studies, where male pediatric patients are more frequently affected by traumatic vascular injuries, especially in conflict or violence-related settings.^{7,8} In addition, there was an unusual penetrating vascular injury caused by a wooden stick.⁹ This pattern is consistent with the higher rates of violence in regions such as Somalia, where these injuries are commonly encountered in pediatric trauma centers.^{7,8} The evening hours (6:00 PM to 12:00 AM) accounted for the majority of hospital admissions, which suggests that these injuries are often a result of violent events occurring during these times. Regarding injury mechanisms, the study found a predominant pattern of penetrating trauma, with 81.5% of patients sustaining injuries from firearms, explosive devices, and shrapnel. This is consistent with other studies that have reported a higher prevalence of penetrating injuries in conflict zones.^{7,10} Although blunt trauma accounted for 18.5% of cases, it is often associated with more complex multisystem involvement, complicating both diagnosis and treatment.¹⁰ Prompt recognition of blunt trauma facilitates early intervention, thereby minimizing complications.¹¹ Furthermore, injuries related to motor vehicle accidents, falls, and sports-related trauma were present but less common, mirroring findings from other trauma studies.^{12,13} The upper and lower limbs were the anatomical regions most commonly affected, with the brachial artery in the upper limb (14 cases) and the superficial femoral artery in the lower limb (12 cases) being the most frequently injured vessels. This emphasizes the particular susceptibility of these arteries in pediatric trauma.^{10,14,15} In contrast, venous injuries were less common, with the femoral vein being most frequently injured. The head and neck region, though less commonly injured, still represented significant concerns, particularly for the common carotid artery and internal jugular vein (4 cases and 3 cases, respectively). Our rate of carotid and jugular injuries parallels findings from Villamaria et al, who reported similar distributions in wartime pediatric cohorts from Iraq and Afghanistan. The high frequency of arterial injuries, particularly in the lower limbs, is consistent with other studies where the lower extremities were the most commonly injured sites.^{10,12} Surgical management of vascular trauma predominated, with primary repair being the most commonly utilized approach (40.7%), followed by vein graft interposition (35.2%). The choice of surgical strategy was tailored to the nature and complexity of the injuries. Multiple arterial injuries were observed in 3.7% of cases, which compounded surgical complexity. Complex cases were addressed with a combination of primary repair and vein graft interposition (11.1%), while vein graft with fasciotomy and muscle flap were used in more challenging cases (3.7% and 1.9%, respectively). Conservative management was used for a small subset of patients (3.7%), particularly those who were hemodynamically stable with no clear signs of vascular injury. This mirrors the management trends observed in similar pediatric vascular trauma series, where open surgical repair remains the most frequently used approach.^{12,13,16} Fractures were the most prevalent associated injuries, especially in the upper and lower limbs. Additionally, nerve injuries were observed in several cases, and one patient developed compartment syndrome. The coexistence of fractures with vascular injuries often presents a challenge, complicating both surgical management and postoperative recovery. These findings align with previous research that underscores the complexity of pediatric vascular trauma.^{10,12} Most patients (90.7%) did not experience any postoperative complications. However, a small proportion developed infections (5.6%) or required limb amputation (1.9%). The most severe outcome observed in this group was the death of one patient due to a critical vascular injury. Bramparas et al reported a 13% mortality rate in their study of pediatric vascular trauma cases from the American College of Surgeons National Trauma Data Bank. This highlights the serious nature of pediatric vascular injuries, especially those involving major arteries such as the femoral artery, which has been associated with increased mortality in other studies.^{1,16}

The significant peak in hospital admissions for pediatric vascular injuries in 2023, as reflected in the time series graph, suggests a potential increase in either the incidence of these injuries or improvements in detection and reporting mechanisms.

Our study demonstrates a remarkably high limb salvage rate of 98.1% despite the constraints of working in a conflict-affected, resource-limited setting, with an overall mortality of only 1.9%. These outcomes underscore the critical influence of system-level factors such as time-to-care, referral delays, and the availability of blood products on patient survival and limb viability. Compared with multicenter series from the United States and

Europe, where penetrating trauma accounts for a smaller proportion of pediatric vascular injuries and repair strategies are similar, our cohort reflects the distinctive burden of conflict settings with a higher share of penetrating mechanisms and greater reliance on autogenous vein grafts. The findings highlight several actionable priorities: strict adherence to a standardized “hard signs → operating room” pathway, lowering thresholds for fasciotomy in delayed or high-risk reperfusion, systematic autologous vein harvesting protocols, establishment of a regional referral hotline, and creation of a trauma registry to strengthen coordinated care. Nonetheless, this study is limited by its retrospective, single-center design and the lack of long-term data on graft patency or functional outcomes. Future work should focus on prospective, multicenter registry development incorporating 6–12-month follow-up with duplex ultrasonography and validated functional measures such as the Pediatric Quality of Life (PedsQL) inventory and gait assessments to better define recovery trajectories and optimize outcomes for this vulnerable population.

Conclusion

Pediatric vascular trauma in Somalia is predominantly penetrating and closely linked to conflict-related mechanisms such as gunshot, blast, and shrapnel injuries, though unusual mechanisms such as wooden stick penetration were also observed. Despite severe injury patterns and resource limitations, timely surgical intervention achieved excellent limb salvage (98.1%) with very low mortality (1.9%). These findings highlight the critical importance of early recognition, rapid referral, and standardized management protocols to optimize outcomes. Strengthening system-level factors—including blood-bank capacity, referral networks, fasciotomy readiness, and vascular training—will be essential in reducing preventable limb loss and mortality in conflict-affected regions. Future multicenter prospective studies with long-term follow-up, including graft patency and functional outcomes, are warranted to guide evidence-based improvements in pediatric vascular trauma care.

Data Sharing Statement

The data for this study were obtained from the hospital’s FONET electronic system and can be accessed from the corresponding author upon reasonable request.

Author Contributions

All authors made a significant contribution to this work, whether that is, in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no conflicts of interest.

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