

Data Driven Reappraisal of Prophylactic Fasciotomy in Penetrating Lower Extremity Arterial Trauma

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Abstract

Purpose: Prophylactic fasciotomy is commonly performed in penetrating extremity vascular trauma. Despite the known morbidity of this procedure, surgical dogma suggests liberal prophylactic fasciotomy. We performed a single-center evaluation of injury patterns associated with development of compartment syndrome requiring delayed fasciotomy.

Methods: We examined 138 consecutive patients with penetrating lower extremity arterial trauma (2016-2024). Patients who underwent up front revascularization without prophylactic fasciotomy were included. The primary outcome was development of compartment syndrome requiring delayed fasciotomy.

Results: 87 patients were included. Of those meeting criteria, 23/87 (26.4%) had popliteal artery injury and 64/87 (73.6%) had common femoral artery or superficial femoral artery injury. Patients with popliteal injury had a significantly higher rate of delayed fasciotomy (43.4% v 6.3%, $P<0.001$), but lower injury severity (4 v 9, $P<0.001$). The groups were otherwise similar. All vein injuries were ligated. Among patients with popliteal injuries there were no differences between those who required delayed fasciotomy and those who did not, including no difference in rate of venous injury (46% v 50%, $P=0.85$). Among patients with femoral injury, those who required delayed fasciotomy had longer LOS ($P=0.038$), but were otherwise similar, including rate of venous injury (37% v 50%, $P=0.59$).

Conclusions: Delayed fasciotomy was required in less than one-fifth of all patients with sharp distinction between femoral (6.3%) and popliteal (43.4%) injuries. Combined arteriovenous injury did not predispose patients to delayed fasciotomy. These findings support injury-specific risk stratification when determining need for prophylactic fasciotomy and high index of suspicion among popliteal arterial injuries regardless of vein status.

Introduction

Extremity vascular trauma remains a major contributor to morbidity and limb loss. Contemporary cohorts demonstrate that penetrating mechanisms predominate. (1, 2) Despite advances in trauma systems and operative techniques, complications following revascularization remain common, particularly acute compartment syndrome, which is a critical determinant of limb preservation and long-term functional outcomes. (3, 4)

The pathophysiology of compartment syndrome in vascular trauma is well established, reflecting the combined effects of destructive injury, hemorrhage, tissue edema, and ischemia–reperfusion injury following restoration of arterial inflow. (3) Timing of fasciotomy is critical. Historically, six hours is accepted as a clinical turning point in compartment syndrome after which irreversible neuromuscular damage ensues causing permanent loss of function. Accordingly, decompression after 6 hours confers a high rate of late amputation. (3, 5, 6, 7)

Diagnosis of compartment syndrome is primarily clinical, based on patient history and symptoms coupled with physical examination. Objective measurements are often used to inform fasciotomy in instances of equivocal examination or limited history. (8) However, given the severe consequences of missed or delayed diagnosis of compartment syndrome, a liberal approach to prophylactic fasciotomy has been historically advocated. (9)

Prior studies have suggested that combined arterial and venous injury may be a key risk factor, proposing that impaired venous outflow contributed to elevated compartment pressures and increased risk of compartment syndrome. (5, 10) Additionally, these investigations suggested that prolonged ischemia, popliteal artery injury, and severe soft tissue damage as major determinants of limb loss. (5, 11) Several recent analyses challenge the routine use of prophylactic fasciotomy in extremity vascular trauma, suggesting that this practice may not confer an advantage over delayed intervention when close clinical monitoring is available. (9, 12)

Emerging literature has questioned the independent role of traditional risk factors. Contemporary cohort analyses demonstrate that combined arterial and venous injury, while associated with increased utilization of fasciotomy, is not consistently associated with an increased risk of delayed compartment syndrome or amputation. (13, 14) Similarly, venous injury and ligation may not be associated with worse limb outcomes as initially proposed. (15–17) However, clinical practice guidelines continue to recommend liberal use of fasciotomy in the setting of venous injury and data regarding venous management and subsequent outcomes are mixed even among modern studies. (10, 18) Injury location remains a consistent predictor of adverse limb outcomes. Popliteal artery injury is consistently associated with increased risk of limb-threatening ischemia, fasciotomy, and amputation. (10, 17, 19)

This study evaluated patients with penetrating lower extremity arterial trauma managed without prophylactic fasciotomy at a high-volume trauma center. We identified factors associated with delayed progression to compartment syndrome requiring fasciotomy to better define patients that may benefit from selective versus routine prophylactic decompression. We hypothesized that anatomic injury location, particularly popliteal artery involvement, would be more strongly associated with the development of compartment syndrome than concomitant injuries or surgical management strategy.

Methods

We performed a retrospective cohort study using a prospectively collected trauma registry review at Hospital Sótero Del Río, a 710 bed, high-volume, tertiary referral center in Santiago, Chile. The institution maintains a trauma registry capturing detailed demographic, injury, and operative data for all trauma admissions. Annually, the trauma service evaluates over 5,000 patients with approximately 3,500 admissions. Among those admitted, 32% are admitted after penetrating trauma. Vascular repairs after trauma are managed almost exclusively by trauma surgeons with rare exceptions for endovascular procedures and complex staged reconstructions. The study period spanned January 2016 through December 2024. Ethical review and approval was obtained from Hospital Sótero Del Río and Brigham

and Women's Hospital institutional review board. Given the retrospective design and utilization of trauma registry data, waiver of informed consent was obtained. No funding was obtained for this study.

All adult patients (≥ 18 years) identified from the institutional trauma registry with penetrating lower extremity arterial injury were screened for inclusion. Patients were included if they underwent definitive open or endovascular revascularization without prophylactic fasciotomy at the index operation.

Exclusion criteria were prophylactic fasciotomy performed during the index operation, vascular injuries distal to the popliteal artery, primary amputation, and incomplete registry data. Given small sample size (4/138, 3%) and probability of resultant confounding, patients who were treated with temporary intravascular shunts prior to definitive reconstruction were also excluded.

Data were obtained from the institutional trauma registry and supplemented by targeted chart review to confirm injury characteristics and outcomes. Variables collected included patient demographics (age, sex), mechanism of injury (gunshot wound vs stab wound), Injury Severity Score (ISS), associated injuries (bone, nerve, and vein), operative time, amputation status, length of stay (LOS).

Vascular injuries were categorized by anatomic location into femoral (including common femoral artery [CFA] and superficial femoral artery [SFA]) injury and popliteal injury categories. Operative variables included type of vascular repair (primary repair, interposition graft, bypass, prosthetic graft, or endovascular intervention), operative duration, and management of associated venous injury (ligation vs repair).

The primary outcome was development of compartment syndrome requiring delayed fasciotomy following index revascularization. Diagnosis of compartment syndrome was based on clinical findings including pain out of proportion, tense compartments, and/or neurologic compromise, with or without adjunctive pressure measurements. Delayed fasciotomy was defined as any fasciotomy performed after completion of the initial vascular procedure.

Secondary outcomes included hospital length of stay (LOS), amputation, and perioperative characteristics associated with delayed fasciotomy.

Statistical Analysis

Patients were stratified by anatomic injury location (femoral vs popliteal) and by the occurrence of delayed fasciotomy. Continuous variables were reported as mean with standard deviation or median with interquartile range, depending on distribution, and compared using the rank-sum test. To examine the relationship between location of arterial injury and development of compartment syndrome, we examined need for delayed fasciotomy using the Chi square test given small event numbers. Given low event rate, multivariable analysis was deferred.

Results

During the study period, 138 patients with penetrating lower extremity arterial trauma were identified. 87 patients met criteria for analysis. Among the 51 excluded patients, 15 were excluded because they had undergone up-front fasciotomy. Injuries treated with up-front fasciotomy were similarly distributed between anatomic regions with 8 femoral injuries and 7 popliteal. Two thirds (10/15) of these patients had combined arteriovenous injury and one-third (5/15) had orthopedic involvement. There were no amputations among patients treated with prophylactic fasciotomy.

Among the study cohort, 23 patients (26.4%) sustained popliteal artery injuries, and 64 patients (73.6%) had injuries involving the common femoral or superficial femoral arteries. Most patients were male (84/87, 97%), and penetrating mechanisms consisted of gunshot and stab injuries, with similar distributions between groups. Patients with popliteal artery injury had a significantly lower median ISS compared to those with femoral injury (4 vs 9, $p < 0.001$). There were no significant differences between femoral and popliteal injury patients in age, sex, mechanism of injury, or rates of associated bone, nerve, or venous injury (Table 1).

Table 1
Patient characteristics by injury location

	Femoral Injury			Popliteal Injury		
	No fasciotomy (N = 60)	Fasciotomy (N = 4)	P value	No fasciotomy (N = 13)	Fasciotomy (N = 10)	P value
Male, N (%)	57 (95)	4 (100)	0.65	13 (100)	10 (100)	1.0
Trauma type, N (%)			0.16			0.23
Gunshot wound	40 (67)	4 (100)		9 (69)	9 (90)	
Stab	20 (33)	0 (0)		4 (31)	1 (10)	
Vein injury, N (%)	22 (37)	2 (50)	0.59	6 (46)	5 (50)	0.85
Index OR time (min), N (%)	158 (110, 210)	240 (180, 273)	0.13	200 (125, 282)	243 (215, 260)	0.18
Arterial repair, N (%)			0.056			0.43
Ligate	3 (5)	0 (0)		0 (0)	0 (0)	
Primary repair	2 (3)	0 (0)		2 (15)	0 (0)	
Primary anastomosis	21 (35)	1 (25)		2 (15)	2 (20)	
Vein bypass	22 (37)	0 (0)		9 (69)	8 (80)	
PTFE	7 (12)	1 (25)		0 (0)	0 (0)	
Dacron	3 (5)	2 (50)		0 (0)	0 (0)	
Endovascular	2 (3)	0 (0)		0 (0)	0 (0)	
Bone injury, N (%)	11 (18)	1 (25)	0.74	4 (31)	1 (10)	0.23
Nerve injury, N (%)	0 (0)	0 (0)		0 (0)	0 (0)	
Amputation, N (%)	0 (0)	0 (0)		0 (0)	1 (10%)	0.24
Hospital LOS, median (IQR)	4.0 (2.0, 6.0)	21.0 (14.0, 28.0)	0.038	8.0 (2.0, 11.0)	8.0 (7.0, 12.0)	0.55

Table 1: Cohort summary including demographics, injury characteristics, operative management strategy, and resultant outcomes. Legend: Operating Room (OR), length of stay (LOS), polytetrafluoroethylene (PTFE).

Operative management was similar between groups. Most patients underwent open revascularization (85/87). Most commonly, vein bypass (39/87) or interposition grafting (13/87) was performed with a small number of primary repairs (4/87) and primary anastomoses (26/87) performed. All associated venous injuries were managed with ligation. Stab injuries rarely required fasciotomy regardless of injury location. There were no significant differences between femoral and popliteal injury patients in operative duration, type of arterial repair, or presence of associated injuries.

Overall, delayed fasciotomy was required in 14 of 87 patients (16.1%). The incidence of delayed fasciotomy differed by anatomic injury location. Patients with popliteal artery injury had a markedly higher rate of delayed fasciotomy compared to those with femoral artery injury (43% (10/23) vs 6.25% (4/64), $p = 0.0001$).

Within the popliteal injury subgroup, in unadjusted analyses, there were no significant differences between patients who required delayed fasciotomy and those who did not, including rates of associated venous injury (46% vs 50%, $p = 0.85$). Similarly, among patients with femoral artery injury, the presence of venous injury was not associated with delayed fasciotomy (37% vs 50%, $p = 0.59$). Among patients with femoral injury, those who required delayed fasciotomy had a significantly longer hospital LOS compared to those who did not (21 vs 4 days, $p = 0.038$). However, no significant difference in LOS was observed among patients with popliteal injury. There were no differences in rates of amputation between groups with only one amputation across the cohort.

Discussion

In this cohort of selected patients undergoing arterial revascularization for lower extremity trauma who did not undergo upfront fasciotomy, delayed fasciotomy was required in fewer than one-fifth of patients overall. However, a strong association was observed between popliteal artery injury and subsequent development of compartment syndrome, whereas concomitant venous injury was not associated with increased risk. These findings add to a growing body of literature seeking to better define which patients derive benefit from fasciotomy in the setting of vascular trauma.

The role of fasciotomy in vascular trauma continues to evolve. While the detrimental effects of delayed decompression of compartment syndrome are well established, there remains substantial uncertainty regarding which patients require prophylactic intervention. Prior large database analyses have demonstrated improved outcomes when fasciotomy is performed early in patients who ultimately develop compartment syndrome, including lower amputation rates and shorter hospital length of stay. Recent prospective and multicenter data suggest that routine prophylactic fasciotomy may not confer a clear advantage over delayed fasciotomy. The findings of our investigation reinforce the importance of timely decompression when indicated and highlight a separate question of how to predict which patients have high enough risk to warrant prophylactic intervention at index operation.

Within this evolving framework, our findings support the concept that risk is not uniform across vascular injuries, both mechanistically and by location. The strong association between popliteal artery injury and

delayed fasciotomy observed in this cohort is consistent with both historical and modern literature identifying this anatomic location as particularly vulnerable. These data reinforce the concept that popliteal injury represents a distinct clinical entity requiring heightened vigilance.

Gunshot wounds similarly predisposed patients to development of compartment syndrome. The destructive nature of firearm injuries and penumbra of regional soft tissue damage combined with the ischemia/reperfusion insult of revascularization represents a distinct clinical entity, further highlighting the need for injury-specific risk stratification.

In contrast, the absence of an association between concomitant venous injury and delayed fasciotomy in this study adds to accumulating evidence questioning its independent role in decision-making. While early landmark studies emphasized venous injury and ligation as a driver of elevated compartment pressures, more recent civilian and military cohorts have demonstrated that venous injury, including when ligated, is not consistently associated with increased amputation or fasciotomy risk after adjustment for injury severity. Our study, in which all venous injuries were ligated without impact on fasciotomy rates, is consistent with this evolving understanding and highlights that the risk of compartment syndrome is multifactorial with both anatomical and physiologic factors at play.

Importantly, modern management of vascular trauma has shifted toward prioritizing rapid restoration of perfusion. Contemporary analyses demonstrate widespread adoption of temporary intravascular shunts as an adjunct to expedite reperfusion. More recent studies suggest that shunt utilization may also improve early limb salvage by reducing ischemic time even outside damage control settings with minimal burden of complication. (20, 21) This broader emphasis on minimizing ischemia may be more impactful in preventing compartment syndrome than reliance on static injury characteristics alone.

Taken together, these data suggest that decision-making regarding fasciotomy should be grounded in a risk-stratified, injury-specific framework. Patients with popliteal artery injury and significant ischemic burden represent a high-risk subgroup in whom a lower threshold for prophylactic fasciotomy or intensified postoperative monitoring may be appropriate. Conversely, patients with femoral artery injury, even in the presence of concomitant venous injury, may be more frequently safely managed with selective observation if adequate monitoring is available.

This study has several limitations. The retrospective design introduces potential selection bias, particularly in surgeon decision-making regarding fasciotomy. Need for prophylactic fasciotomy was determined by surgeon discretion without standard criteria. Additionally, the diagnosis of compartment syndrome was based on clinical assessment rather than standardized pressure measurements. These limitations reflect real-world practice but should be considered when interpreting the results.

As a single-center study from an international, high-volume trauma institution with generally short prehospital transit times and rare interfacility transfer, the findings may not be generalizable to all practice environments, particularly those with differing access to rapid revascularization and postoperative monitoring. Patients presenting with clinical signs of acute limb ischemia or absent pulses

were taken directly to the operating room, limiting total ischemic burden. Prehospital time, time of injury, and time to reperfusion were not captured within the registry. This limited our ability to measure and assess the contribution of total ischemia time; however, total operative time was not statistically associated with development of compartment syndrome. Furthermore, the relatively small sample size and low overall event rate limits the ability to detect more subtle associations.

Despite these limitations, this study provides a focused evaluation of patients managed without prophylactic fasciotomy and offers insight into factors associated with delayed compartment syndrome. These data contribute to ongoing efforts to refine patient selection for prophylactic fasciotomy and offer guidance for heightened postoperative monitoring for select patients after revascularization and deferral of fasciotomy.

Conclusions

In appropriately selected patients undergoing revascularization for penetrating lower extremity arterial trauma without prophylactic fasciotomy, delayed fasciotomy is infrequent. However, the rate of delayed fasciotomy is substantially higher in the setting of popliteal artery injury and gunshot wounds, suggesting a more aggressive approach in these patients or particularly close observation in the immediate postoperative period. Concomitant venous injury does not appear to independently increase risk.

These findings support a selective, risk-based approach to fasciotomy, emphasizing anatomic injury patterns, mechanism of injury, and ischemic burden over traditional dogmatic risk factors. These findings are aligned with a growing body of contemporary evidence suggesting that rapid restoration of perfusion and careful postoperative surveillance are cornerstone to optimize limb-related outcomes rather than aggressive prophylaxis. Further studies are needed to validate these observations, translate findings to blunt trauma mechanisms, and better define patient-specific risk factors that can guide decision-making.

Declarations

Author Contribution

J.P.G., N.R., and J.P.R.P. conceived and designed the study. J.P.G., T.N., K.T., and J.P.R.P. contributed to data acquisition and curation. J.P.G., T.N., K.T., K.M., M.P.J., N.S., and J.P.R.P. performed data analysis and interpretation. J.P.G. drafted the manuscript. T.N., K.T., K.M., J.G., N.S., M.P.J., A.S., N.R., and J.P.R.P. critically revised the manuscript for important intellectual content. A.S., N.R., and J.P.R.P. provided supervision and project oversight. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

Data Availability

For sake of patient privacy, original data are maintained on secure internal data storage facilities at Brigham and Women's Hospital and the Mass General Brigham Center for Surgery and Public Health. Data are not available openly but can be made available by the corresponding author upon reasonable request.

References

1. Sharrock AE, Tai NRM, Perkins ZB, et al. Contemporary management and outcomes of peripheral vascular trauma in civilian practice. *J Vasc Surg.* 2019;70(5):1627–35. 10.1016/j.jvs.2019.02.050.
2. Urrechaga EM, Aguayo P, Vial M, et al. Contemporary outcomes of lower extremity vascular trauma in a civilian trauma center. *Ann Vasc Surg.* 2022;78:201–9. 10.1016/j.avsg.2021.08.051.
3. Farber A, Tan TW, Hamburg NM, et al. Early fasciotomy in patients with extremity vascular injury is associated with decreased risk of adverse limb outcomes: a review of the National Trauma Data Bank. *Injury.* 2012;43(9):1486–91. 10.1016/j.injury.2011.06.006.
4. Wahlgren CM, et al. European Society for Vascular Surgery (ESVS) 2025 clinical practice guidelines on the management of vascular trauma. *Eur J Vasc Endovasc Surg.* 2025;69(2):115–210.
5. Feliciano DV, Moore FA, Moore EE, et al. Evaluation and management of peripheral vascular injury. *Arch Surg.* 1989;124(6):707–13. 10.1001/archsurg.1989.01410060083015.
6. Glass GE, Staruch RM, Simmons J, Lawton G, Nanchahal J, Jain A, Hettiaratchy SP. Managing missed lower extremity compartment syndrome in the physiologically stable patient: A systematic review and lessons from a Level I trauma center. *J Trauma Acute Care Surg.* 2016;81(2):380–7.
7. Cone J, Inaba K. Lower extremity compartment syndrome. *Trauma Surg Acute Care Open.* 2017;2:e000094.
8. Al-Dadah OQ, Darrah C, Cooper A, Donell ST, Patel AD. Continuous compartment pressure monitoring vs. clinical monitoring in tibial diaphyseal fractures. *Injury.* 2008;39(10):1204–9.
9. Rao AS, Scalea TM, Feliciano DV, Harfouche MN. More Harm Than Good: It is Time to Reconsider Prophylactic Fasciotomy in Lower-Extremity Vascular Injury. *Am Surg.* 2025;91(7):1108–12. 10.1177/00031348241244629.
10. Matsumoto S, Jung K, Smith A et al. Outcomes Comparison Between Ligation and Repair after Major Lower Extremity Venous Injury *Annals of Vascular Surgery*, 2018; 54, 152–60.
11. Keeley JA, Fox CJ, Rasmussen TE, et al. Contemporary outcomes of civilian popliteal artery injury repair. *Ann Vasc Surg.* 2016;31:33–41. 10.1016/j.avsg.2015.07.020.
12. Harfouche MN, Scalea TM, Rao AS, et al. Dispelling dogma: a prospective multicenter AAST study evaluating prophylactic versus delayed fasciotomy in extremity vascular trauma. *J Am Coll Surg.* 2023;236(5):1025–34. 10.1097/XCS.0000000000000601.
13. Grigorian A, Kuza CM, Schubl SD, et al. Association of combined arterial and venous injury with fasciotomy and limb outcomes after lower extremity vascular trauma. *J Trauma Acute Care Surg.* 2023;95(3):512–9. 10.1097/TA.00000000000003694.

14. O'Shea TF, Rasmussen TE, Baer DG, et al. Concomitant femoropopliteal venous injury in military lower extremity vascular trauma: implications for limb outcomes. *Ann Vasc Surg.* 2022;82:244–52. 10.1016/j.avsg.2021.12.038.
15. Byerly S, Cheng V, Plotkin A, Matsushima K, Inaba K, Magee GA. Impact of ligation versus repair of isolated popliteal vein injuries on in-hospital outcomes in trauma patients. *J Vasc Surg Venous Lymphat Disord.* 2020;8(3):437–44. 10.1016/j.jvsv.2019.09.014.
16. Cheng VMD, Byerly SMD, Matsushima KMD, Inaba K, Kenji MD, Magee FACSFRCS, MD GA. MSc. Popliteal Vein Ligation Is Not Associated with Worse Outcomes in Trauma Patients. *Journal of the American College of Surgeons* 227(4): p S271, October 2018. | 10.1016/j.jamcollsurg.2018.07.558
17. Abouezzi Z, Nassoura Z, Ivatury RR, Porter JM, Stahl WM. A Critical Reappraisal of Indications for Fasciotomy After Extremity Vascular Trauma. *Arch Surg.* 1998;133(5):547–51. 10.1001/archsurg.133.5.547.
18. Penetrating Venous Extremity Trauma, Management of - Practice Management Guideline. East.org. Published 2026. Accessed May 2. 2026. <https://www.east.org/education-resources/practice-management-guidelines/details/penetrating-venous-extremity-trauma-management-of>
19. Kluckner M, Staudacher DL, Huber S, et al. Predictors for the need for fasciotomy after arterial vascular trauma of the lower extremity. *Injury.* 2021;52(9):2527–32. 10.1016/j.injury.2021.06.
20. Polcz JE, White JM, Ronaldi AE, et al. Temporary intravascular shunt use improves early limb salvage after extremity vascular injury. *J Vasc Surg.* 2021;73(4):1304–13. 10.1016/j.jvs.2020.08.137.
21. Inaba K, Aksoy H, Seamon MJ, et al. Multicenter evaluation of temporary intravascular shunt use in vascular trauma. *J Trauma Acute Care Surg.* 2016;80(3):359–65. 10.1097/TA.0000000000000949.