

EXTREMITY COMPARTMENT PRESSURE MEASUREMENT ON THE BATTLEFIELD: TOWARD EVIDENCE-BASED MANAGEMENT OF TOURNIQUET SYNDROME

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Introduction: Drone warfare in Ukraine has led to casualty sequestration near the point of injury, unprecedented delays in evacuation, and a substantial rise in tourniquet (TQ) use and compartment syndrome (CS). We undertook an objective assessment of compartment pressure (CP) and perfusion pressure (ΔP) in combat casualties using an FDA-approved/CE-marked portable, field-deployable CP monitor, based on micro-electromechanical system (MEMS) sensor inserted via a needle.

Methods: Anesthetized male combat casualties (n=9) with severe extremity injuries underwent sterile placement of a CP monitor at the discretion of forward surgical teams. Deidentified demographics, injury mechanism/location, time from injury to CP measurement, TQ use time, systolic/diastolic/mean arterial blood pressure (SBP/DBP/MAP), heart rate (HR), diagnosed CS, CPs, affected compartments, and fasciotomy occurrence were recorded as available. $\Delta P = \text{DBP} - \text{CP}$. No CS diagnosis was made based on device data.

Results: Age 44 yrs (IQR 34-46); blast-polytrauma n=7, gunshot n=1, crush syndrome n=1; injuries to lower extremity n=8, upper extremity n=1. ≥ 1 TQ in n=5 cases; median TQ time: 3h (IQR 2-13; max 23). Time to CP-monitor: 23h (IQR 13-46; max 95). MAP=88mmHg (IQR 86-95) and HR=75 bpm (IQR 72-78; n=7). CS diagnosed n=7, all in the leg anterior compartment; with n=3 multi-compartment (superficial posterior or lateral). Highest CP: 54.6mmHg (IQR 32.2-67.1; n=8). ΔP =21.3mmHg (IQR 11.3-31.6; min -32; n=7). Fasciotomy in n=8 cases; post-fasciotomy CP=4.5mmHg (IQR 2.0-5.2; n=6).

Conclusions: This is the first study documenting CP and ΔP in combat casualties with CS. We identified heterogeneous intercompartment CP and extremely low ΔP in affected compartments. CPs decreased after fasciotomy. Objective assessment of CP and ΔP in austere environments with prolonged TQ use will enable evidence-based decisions on TQ revision, amputations, and management.

AN OFF-THE-SHELF BIOLOGIC VASCULAR GRAFT FOR EXTREMITY ARTERIAL TRAUMA: COMBINED LONG-TERM OUTCOMES FROM CIVILIAN AND CONFLICT SETTINGS

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Introduction: Extremity arterial trauma frequently occurs in contaminated, time-critical settings where autologous vein may not be available, and prosthetic grafts carry high infection risk. Trauma surgeons require a readily available vascular conduit that enables rapid revascularization without added logistical burden. The acellular tissue engineered vessel (ATEV, SymvessTM) is an off-the-shelf biologic vascular graft designed to address this need.

Methods: We evaluated long-term outcomes of Symvess for extremity, non-iatrogenic arterial trauma repair by combining data from two clinical studies: a prospective civilian trauma trial conducted in the United States and Israel (V005; n=54) and a retrospective real-world conflict experience in Ukraine (V017; n=16). All patients sustained extremity arterial injuries requiring open repair. Symvess is supplied refrigerated, shelf-stable for up to 18 months, requires no thawing or preparation, and is available in a single configuration suitable for most extremity repairs (6-mm inner diameter, 40-cm length). Kaplan–Meier analyses were performed through 36 months.

Results: Seventy patients were included. Mean Injury Severity Score was 21.0, and mean graft length implanted was 12.2 cm. At 36 months, primary patency was 50%, secondary patency 63%, infection-free rate 95%, and limb salvage 87%. Patency loss was driven predominantly by early thrombosis, reflecting trauma-related factors. Over 36 months, safety events included 3 graft infections, 5 graft ruptures due to insufficient or compromised tissue coverage, 18 thromboses, 2 pseudoaneurysms, 1 aneurysm, and 7 limb losses. Most adverse events occurred within the first year, with no late safety signals. No cases of graft rupture, limb loss, or death were attributed to Symvess.

Conclusion: Symvess provides trauma surgeons with an immediately available, off-the-shelf biologic conduit for extremity arterial repair, demonstrating durable limb salvage and low infection rates despite severe injury. These data support Symvess as a practical and effective option for urgent vascular reconstruction when vein is unavailable. *Includes data previously reported.* (V005: NCT03005418; V017: NCT05873959).

HUFFING AND PUFFING AND FRAIL: CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND FRAILTY ARE ASSOCIATED WITH HIGHER MORTALITY RISKS FOLLOWING SURGICAL STABILIZATION OF RIB FRACTURES

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Introduction: The geriatric population has been shown to benefit from surgical stabilization of rib fractures (SSRF), including the frail subset. However, it is unclear whether those benefits extend to all subsets of frail patients. Frailty is commonly assessed using the Modified Frailty Index-5 (mFI-5). Chronic obstructive pulmonary disease (COPD) has been associated with disproportionately higher mortality, despite similar mFI-5 scores, raising concern for a unique risk. The National Trauma Data Standard (NTDS) was used to evaluate whether COPD was independently associated with increased mortality or worse clinical outcomes among frail patients with rib fractures managed with SSRF.

Methods: Patients aged ≥ 65 with frailty ($mFI-5 \geq 1$) and abbreviated injury score (AIS) ≥ 3 in the thorax who were managed with SSRF in 2017-2022 NTDS were included in this study. A stepwise backward selection with a Wald test multivariate logistic regression identified predictors of hospital mortality.

Results: Of the identified 1,960 patient records, 320 (16.3%) had COPD. Patients with COPD were more likely to have severe frailty (77.5% vs. 35.5%; $p < 0.001$), higher risks of unplanned intubation (14.7% vs. 9.2%; $p = 0.003$), need for post-operative ventilation (44.7% vs. 33.9%; $p < 0.001$), increased hospital length of stay (IQR 10-20, $p < 0.001$ and hospital mortality (7.8% vs. 2.4%; $p < 0.001$). COPD patients had increased AIS (odds ratio [OR]: 2.8; $p = 0.020$), unplanned admission to intensive care unit (ICU) (OR: 4.8; $p < 0.001$) and use of ventilator (OR: 3.7; $p = 0.001$). COPD was associated with higher risk of mortality (OR: 4.1; $p < 0.001$); whereas diabetes mellitus (OR: 0.2; $p = 0.002$), hypertension (OR: 0.2; $p = 0.001$), and functional dependence (OR: 0.1; $p = 0.002$) were associated with lower risks of mortality.

Conclusion: Of the mFI-5 risk factors, COPD contributes to increased mortality despite comparable mFI-5 scores. COPD is associated with worse unadjusted outcomes among frail geriatric patients undergoing SSRF, its effects mediated by frailty severity and postoperative complications. This should be considered when evaluating this patient population for SSRF and preoperative counseling.

FROM THE PATIENT OR THE PACKAGE?: COMPARISON OF AUTOLOGOUS VS SYNTHETIC CONDUIT FOR EXTREMITY ARTERIAL BYPASS FOLLOWING PENETRATING TRAUMA

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Introduction: Polytetrafluoroethylene (PTFE) and autologous vein conduits are commonly used for peripheral arterial repair. While prior trauma literature showed no inpatient differences between conduit type, post-discharge outcomes remain limited. We evaluated pre- and post-discharge outcomes after penetrating peripheral arterial repair, hypothesizing no difference between vein and PTFE.

Methods: Patients undergoing open bypass for penetrating peripheral arterial injury at an urban Level 1 center were grouped by conduit type. Upper and lower extremities were included. Cohorts were propensity score matched, and inpatient and post-discharge outcomes were assessed.

Results: Overall, 178 vein and 32 PTFE patients were identified; after matching, 32 vein patients were compared with 32 PTFE patients with similar baseline characteristics. For vein vs. PTFE, there were no differences in inpatient vascular complications requiring reoperation (25.0% vs. 21.9%, $p=1.00$), graft infection (12.5% vs. 9.4%, $p=1.00$), early graft revision (0% vs. 3.1%, $p=1.00$), extremity compartment syndrome (9.4% vs. 6.3%, $p=1.00$), amputation (0% vs. 3.1%, $p=1.00$), or mortality (3.1% vs. 3.1%, $p=1.00$). Among patients surviving without early revision or amputation, postop follow-up rates (90.3% vs. 96.7%, $p=0.61$) and median follow-up duration were comparable (91 vs 94 days, $p=0.96$) for vein and PTFE, respectively. Vascular imaging ≥ 2 weeks post-op were obtained in 45% of vein vs 53% of PTFE ($p=0.61$) at a median of 124 vs 110 days ($p=0.85$), respectively. Delayed graft occlusion (7.1% vs. 17.2%, $p=0.43$) and stenosis (3.6% vs. 6.9%, $p=1.00$) were comparable for vein vs PTFE.

Conclusion: Vein and PTFE conduits yielded comparable inpatient outcomes following penetrating peripheral arterial repair. While PTFE was associated with a higher rate of delayed graft occlusion after discharge, this difference was not statistically significant.

CT-QUANTIFIED PULMONARY CONTUSION SEVERITY PREDICTS ARDS AND PROLONGED VENTILATION AFTER BLUNT TRAUMA

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Introduction: Pulmonary contusions after blunt thoracic trauma are associated with significant respiratory morbidity; however, predictors of respiratory failure and ARDS remain incompletely defined. We evaluated factors associated with mechanical ventilation and ARDS in patients with blunt trauma-related pulmonary contusions.

Methods: This was a retrospective cohort study of adults (≥ 18 years) admitted to two Level I trauma centers between January 1, 2022, and December 31, 2023, with ICD-10-coded pulmonary contusion following blunt trauma. Penetrating injuries were excluded. Contusion severity was quantified on admission chest CT using the Blunt Pulmonary Contusion-18 (BPC-18) score (0–18), with each lung lobe graded 0–3 based on extent of involvement ($>50\% = 3$). Patients were stratified as mild/moderate (BPC-18 1–6) or severe (7–18). The primary outcome was respiratory failure requiring mechanical ventilation. Secondary outcomes included pneumonia, ARDS, tracheostomy, ICU length of stay (LOS), and hospital LOS. Multivariable analysis evaluated associations controlling for fluid balance and concomitant injuries.

Results: The mean age of the sample was 44.7 (SD=19.4) years, 74.3% were male, with the majority white (59.7%) and non-Hispanic (80.1%). Of 191 patients, 157 (82.2%) had mild/moderate and 34 (17.8%) had severe contusions. Severe contusions were associated with increased pneumonia (38.2% vs 12.1%, $p<0.001$), longer mechanical ventilation (17 vs 3 days, $p=0.028$), longer ICU LOS (13 vs 5 days, $p=0.022$), and longer hospital LOS (30 vs 14 days, $p<0.003$). ARDS occurred more frequently in the severe group (50% vs 12.7%, $p<0.001$). Tracheostomy was significantly more prevalent (48.6%) in those with ARDS compared to those without ARDS (3.2%, $p<0.001$). In the multivariable model, neurologic injury independently predicted ARDS ($p=0.049$), whereas rib fractures ($p=0.444$), orthopedic injuries ($p=0.821$), and pre-existing pulmonary diseases did not ($p=0.999$). Severe BPC-18 score remained independently associated with ARDS after adjusting for positive fluid balance ($p<0.001$).

Conclusion: CT-quantified pulmonary contusion severity independently predicts pneumonia, ARDS, prolonged ventilation, and increased resource utilization. Early severity stratification may inform risk-adjusted respiratory management.

DATA VS DOGMA: A DATA-DRIVEN REAPPRAISAL OF PROPHYLACTIC FASCIOTOMY IN LOWER EXTREMITY VASCULAR TRAUMA

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Introduction: Prophylactic fasciotomy is commonly performed in penetrating lower extremity vascular trauma. Despite the known morbidity of this procedure, surgical dogma suggests liberal prophylactic fasciotomy, particularly in combined arteriovenous injury. 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. Those with blunt trauma, injury distal to the popliteal artery, or temporary vascular shunt were excluded. The primary outcome was development of compartment syndrome requiring delayed fasciotomy.

Results: After excluding 51 patients, including those who underwent prophylactic fasciotomy (25), 87 patients remained. 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 score (4 v 9, $P<0.001$) when compared to those with femoral injury. The groups were otherwise similar in age; sex; bone or nerve injury; mechanism; repair technique; initial operative time, length of stay (LOS) and venous injury rate. 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 no difference in 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.

SAVING FACE - THE ROLE OF PROPHYLACTIC ANTIBIOTICS IN BALLISTIC MANDIBULAR FRACTURES

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Introduction: Ballistic facial fractures are at high risk for infection due to bony and/or soft-tissue destruction, contamination from oropharyngeal flora, and environmental exposure. Lacking definitive data, recommendations for prophylactic regimens vary from 24 hours to 7 days. We evaluated the relationship between antibiotic administration and infectious complications in ballistic mandibular fractures.

Methods: This is a retrospective cohort study from a Level 1 trauma center of patients admitted with a ballistic mandibular fracture from January 2020 to December 2025. Patients were excluded if they had an infection present on admission or never received antibiotics. Data collected included age, time to antibiotic exposure (including face-specific coverage), time to first operation, number of operations, duration of antibiotic exposure, and development of infection. Using univariate and multivariate logistic regression analyses, we evaluated the relationship between antibiotic exposure, operative intervention, and infection.

Results: 108 patients met inclusion criteria. 89% of patients underwent surgery with a median time to OR of 2 d [IQR 1-3], median time to facial antibiotic prophylaxis 4 hrs [IQR 2-9.8], and median duration of antibiotic exposure 81 hrs [IQR 32-219]. 28 (25.9%) patients developed an infection. On univariate analysis, there was an inverse association between duration of antibiotic exposure and development of infection ($p = 0.003$). There was no correlation between infection and time to any antibiotic administration ($p = 0.158$), time to face antibiotic coverage ($p = 0.147$), or time to operation ($p = 0.104$). On multivariate analysis, higher cumulative duration of antibiotic exposure was associated with a decrease in infections (OR 0.993, 95% CI 0.988-0.998) while time to antibiotics and time to OR were not.

Conclusions: Infectious complications of ballistic mandible fractures are common. In our cohort, we found that extended antibiotic prophylaxis was associated with a reduction of infectious complications suggesting that a shorter duration of prophylaxis may be insufficient.

**EARLY SPINAL FIXATION REDUCES MAJOR IN-HOSPITAL
COMPLICATIONS IN TRAUMA PATIENTS WITH
CONCOMITANT CHEST INJURIES: AN INSTRUMENTAL
VARIABLE ANALYSIS OF THE AMERICAN COLLEGE OF
SURGEONS TRAUMA QUALITY IMPROVEMENT PROGRAM**

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Introduction: While early fixation of spinal fractures is associated with improved outcomes in the majority of injured patients, the timing of operative fixation in those with concomitant severe chest injuries is uncertain. The risk of perioperative mechanical ventilation and prone positioning in patients with severe chest trauma may outweigh reductions in immobility-related complications associated with early spine surgery. We evaluated the association between early spinal fixation and major in-hospital complications or death among trauma patients with concomitant severe chest injuries.

Methods: We conducted a retrospective cohort study using the American College of Surgeons Trauma Quality Improvement Program database. Adults with spinal fractures requiring operative fixation and severe chest injury (AIS $\geq$ 3) between 2017-2023 were included. Early fixation was defined as surgery within 24 hours of admission. The primary outcome was major in-hospital complications or death. To address unmeasured confounding, we performed an instrumental variable (IV) analysis using hospital-level early fixation rates as the instrument. Subgroup analyses were conducted among patients with and without spinal cord injury (SCI).

Results: Among 25,812 patients (mean age 49, 72% male, median ISS 22) treated at 385 trauma centers, 9,168 (36%) underwent early fixation. In IV analyses, early fixation yielded an absolute risk reduction (ARR) for major complications or death of 7.6% (95% CI 1.3%-13.9%) compared with late fixation. This effect held among patients without SCI (ARR 10.2% [1.0%-19.6%]) and those with SCI (ARR 7.3% [0.1%-14.4%]).

Conclusion: Among patients with severe chest injuries requiring spinal fixation, surgery within 24 hours is associated with fewer major in-hospital complications and death. Our findings support early spinal stabilization even in physiologically complex patients.

BCVI RISK IN PATIENTS WITH BLUNT FACIAL FRACTURES

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Introduction: Facial Fractures are commonly associated with Blunt Cerebrovascular Injury (BCVI), yet it remains unclear which specific facial fracture confers the highest BCVI risk.

Methods: A retrospective analysis of ACS-TQIP 17-23 was done to identify adult (≥ 18 years) patients with a blunt facial fracture. We excluded patients with AIS ≥ 3 injuries in Abdomen, Thorax and Extremity. Fractures were categorized into mandible, maxilla, nasal, orbital and zygomatic and pan facial fractures based on AIS codes. Multivariable Logistic Regression was performed to adjust for age, sex, race, mechanism, GCS, SBP, ISS & presence of cervical injury. Primary Outcome was risk of BCVI. Secondary outcome was Hospital LOS and mortality.

Results: Of 511,509 patients with a blunt facial fracture, 6,359 (1.2%) had BCVI. 69.7% of the population were male and median age was 49[32-68]. BCVI rates were highest among patients with mandible fractures, 2,588 (2.3%). After regression analysis, mandible fractures (aOR 1.78, $p < 0.001$) and maxillary fractures (aOR 1.33, $p = 0.036$) were significantly associated with increased odds of BCVI while nasal, orbital and zygomatic fractures were not. Among patients with facial fractures, BCVI was independently associated with increased in-hospital mortality (aOR 1.26, $p < 0.001$) and was associated with an increase in hospital LOS of (2.7 days, $p < 0.001$).

Conclusion: These findings support a more selective BCVI screening strategy, suggesting that routine screening may be unnecessary for patients with isolated nasal, orbital, or zygomatic fractures. While maxillary fractures, particularly Le Fort fracture types II and III, are already included in the Denver screening criteria, our analysis demonstrated that isolated mandibular fractures also confer a clinically significant risk of BCVI and warrant consideration for routine vascular imaging.

ENDOVASCULAR AND OPEN INTERVENTIONS HAVE EQUIVALENT OUTCOMES IN TRAUMATIC BLUNT POPLITEAL ARTERY INJURY

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Introduction: Traumatic popliteal artery injuries carry the highest risk of limb loss among peripheral vascular injuries. While open repair remains the gold standard, endovascular techniques are increasingly used. We aim to compare outcomes between endovascular and open repair in a large cohort of blunt popliteal artery injuries, hypothesizing equivalent amputation rates but reduced transfusion requirements and shorter length of stay with endovascular repair.

Methods: Patients with blunt popliteal artery injuries were identified from the National Trauma Data Bank (2023-2025) and stratified by repair type using ICD-10 procedure codes. Primary outcome was amputation.

Secondary outcomes included transfusion volume, length of stay, and mortality. Chi-square and t-tests were used with $p < 0.05$ for significance.

Results: Of 1452 patients, there were 204 (14%) endovascular and 1248 (86%) open repairs. When comparing endovascular to open patients, there was no difference in male gender (64% vs 69%, $p = .18$), White, non-Hispanic race (62% v. 63%, $p = 0.82$), admission systolic blood pressure (127 vs. 129, $p = 0.49$), heart rate (98 vs. 96, $p = 0.27$), or ISS (13 vs. 13, $p = 0.61$), but endovascular patients were older (43 vs 40, $p = .04$). Amputation rates were comparable (14% vs 19%, $p = 0.14$), as were transfusion volumes (357mL vs 505mL, $p = 0.09$), length of stay (21 vs 20, $p = .38$), and mortality (5% vs 3%, $p = .27$).

Conclusion: Endovascular and open repair of traumatic popliteal artery injuries demonstrate comparable outcomes including amputation rates, transfusion requirements, length of stay, and mortality. These findings support endovascular repair as a viable alternative in appropriately selected patients. Further studies should identify patient-specific factors that optimize treatment selection.