

Toward Evidence-Based Tourniquet Management: Continuous Compartment Pressure Monitoring in Forward Surgical Units in Ukraine

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Introduction

- Drone-dominated warfare in Ukraine has produced prolonged casualty sequestration near the point of injury due to a lack of air superiority and targeting of medical evacuation vehicles.
- Thus, tourniquet (TQ) times and limb ischemia durations frequently exceed those from traditional combat casualty care doctrine.
- One critical complication of prolonged extremity ischemia is compartment syndrome (CS), characterized by:
 - elevated intra-compartmental pressure (CP) inside the closed fascial compartments.
 - low perfusion pressure (ΔP); reflects CPs greater than systemic pressures, resulting in compromised perfusion.
- CP measurements are typically single measurements performed in a hospital setting and have historically been unavailable in forward medical settings.

Objective

- Evaluate the feasibility and utility of deploying a portable continuous CP-sensing device across multiple roles of care for combat casualties with heterogeneous injuries, prolonged evacuation timelines, and austere conditions.

Methods

- N=9 combat casualties with severe extremity trauma were assessed across multiple roles of care in Ukraine from Aug. - Oct. 2025.
- A portable intramuscular pressure monitoring device (MY01, Montréal, QC) using a microelectromechanical systems (MEMS) sensor was inserted under sterile conditions at the discretion of forward surgical teams.
- Deidentified demographic information, injury mechanism, tourniquet duration, time from injury to monitoring, vital signs, CP, and surgical interventions were recorded when available.
- ΔP was calculated as diastolic blood pressure (DBP) minus CP.

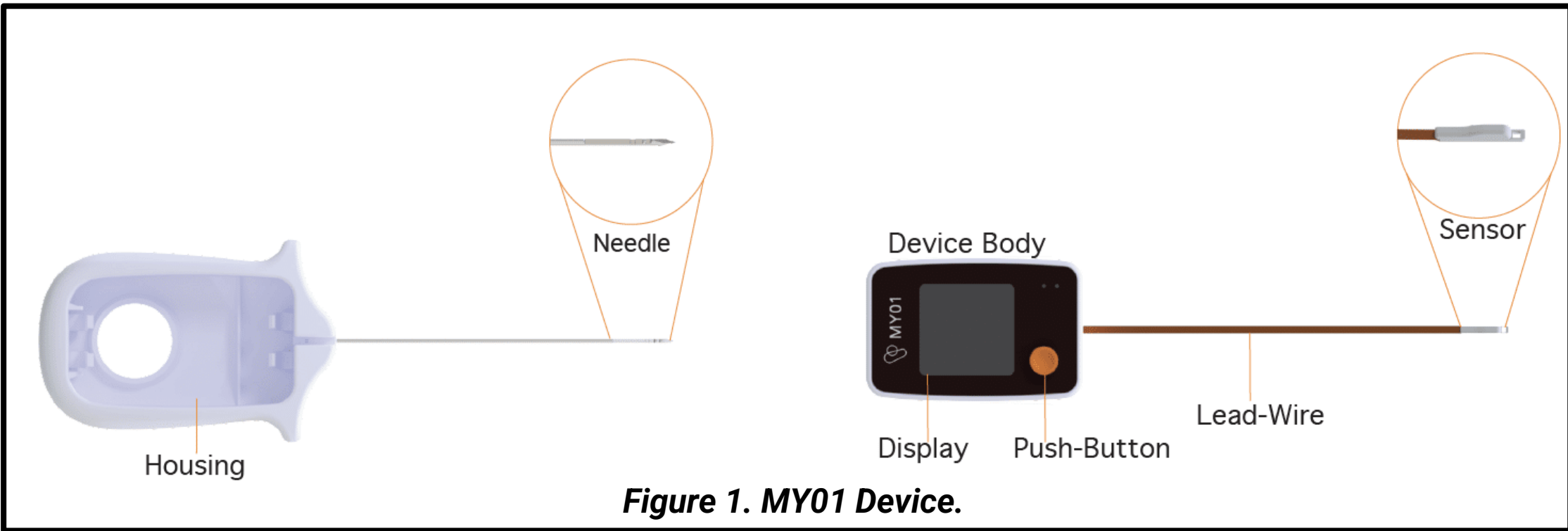


Figure 1. MY01 Device.

Results

- Median age was 44 years (IQR 34–46).
- Blast injuries accounted for most cases, with one gunshot and one crush injury.
- TQs were used in five patients with a median duration of 3 hours (IQR 2–13; max 23 hours).
- Median time from injury to pressure monitoring was 23 hours (IQR 13–46).
- CS was clinically diagnosed in seven cases.
- The median highest measured CP was 54.6 mmHg (IQR 32.2–67.1).
- Median ΔP was 21.3 mmHg (IQR 11.3–31.6), with negative values observed in one case.
- Fasciotomy was performed in eight patients, reducing pressures to a median of 4.5 mmHg.

One Example Case

- M 34; Gunshot wound through left knee
- Damage to soft tissues and vascular structures
- Two tourniquets: upper and distal third of the left thigh
- Tourniquet duration: 12 hours 50 minutes
- HR: 103, SBP: 90, DPB: 60 (upon admission)
- Forward surgical team addressed the leg and used the MY01 device



Figure 2. Example use of MY01 device on a combat casualty with two TQs, and delayed evacuation.

Conclusions

- Continuous CP monitoring was feasible across forward medical environments.
- Objective physiologic measurements of CP demonstrated critically low limb perfusion pressures (ΔP) and variability between affected compartments.
- Incorporating CP monitoring into prolonged casualty care may improve assessment of evolving limb ischemia and support evidence-based decisions regarding fasciotomy, tourniquet revision, and limb salvage during extended evacuation scenarios.

Results (cont.)

Table 1. Demographics, injury mechanisms, tourniquet (TQ) use time, vital signs, and compartment syndrome (CS) indication and intervention. ("—" indicates data not available)

Case No.	1	2	3	4	5	6	7	8	9
Demographics									
Sex	Male	Male	Male	Male	Male	Male	Male	Male	Male
Age (years)	27	45	49	44	34	46	36	57	33
Evacuation									
Location	Surgical Aid Post	Military Mobile Hospital	Surgical Aid Post	Military Mobile Hospital	Military Mobile Hospital	Military Mobile Hospital	Military Mobile Hospital	Stabilization Point	Surgical Aid Post
Time to Arrival (hrs)	95	51	46	26	13	23	4	6	15
Injury									
Injury Mechanism	Blast	Crush	Blast	Blast	Gunshot	Blast	Blast	Blast	Blast
Fracture	L Ulna	—	L Foot	R Tibia + Fibula + Foot	L Femur	R Foot	L Tibia	R Femur	—
Joint Injury	L Elbow	—	—	—	L Knee	R Ankle	—	—	—
Soft-tissue Injury	L Upper Arm	R Lower Leg	L Foot	R Lower Leg + Foot	L Lower Leg + Foot	R Foot	L Lower Leg	R Thigh	R Gluteal + Thigh + Lower Leg
TQ Placement	Distal Third L Upper Arm	—	Unspecified	—	Middle + Distal Third L Thigh	Middle Third R Thigh	—	Middle Third R Thigh	—
TQ Duration (hrs)	1.5	—	3	—	13	23	—	0.5	—
Vital Signs									
SBP (mmHg)	110	120	—	126	90	50	—	130	120
DBP (mmHg)	60	85	—	65	60	30	—	85	75
MAP (mmHg)	77	97	—	85	70	37	—	100	90
HR (bpm)	71	76	—	—	103	65	—	78	74
GCS	—	15	—	—	—	12	—	15	14
SpO ₂ (%)	—	—	—	98	95	94	—	—	—
Compartment Syndrome									
Max CP (mmHg)	21.3	70.4	8.5	32.2	38.7	62	74	54.6	67.1
ΔP (mmHg)	38.7	14.6	—	32.8	21.3	-32	—	30.4	7.9
CS Indicated	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Intervention									
Affected Compartments	—	R Lower Leg Anterior	—	R Lower Leg Anterior	L Lower Leg Anterior + Superficial posterior	R Lower Leg Anterior + Lateral	L Lower Leg Anterior + Superficial posterior	R Lower Leg Anterior	R Lower Leg Anterior
Fasciotomy Performed	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CP after Fasc (mmHg)	—	5.2	—	—	~0	5.1	3.9	1.4	9.5
Amputation	No	—	No	—	Yes	—	—	—	—

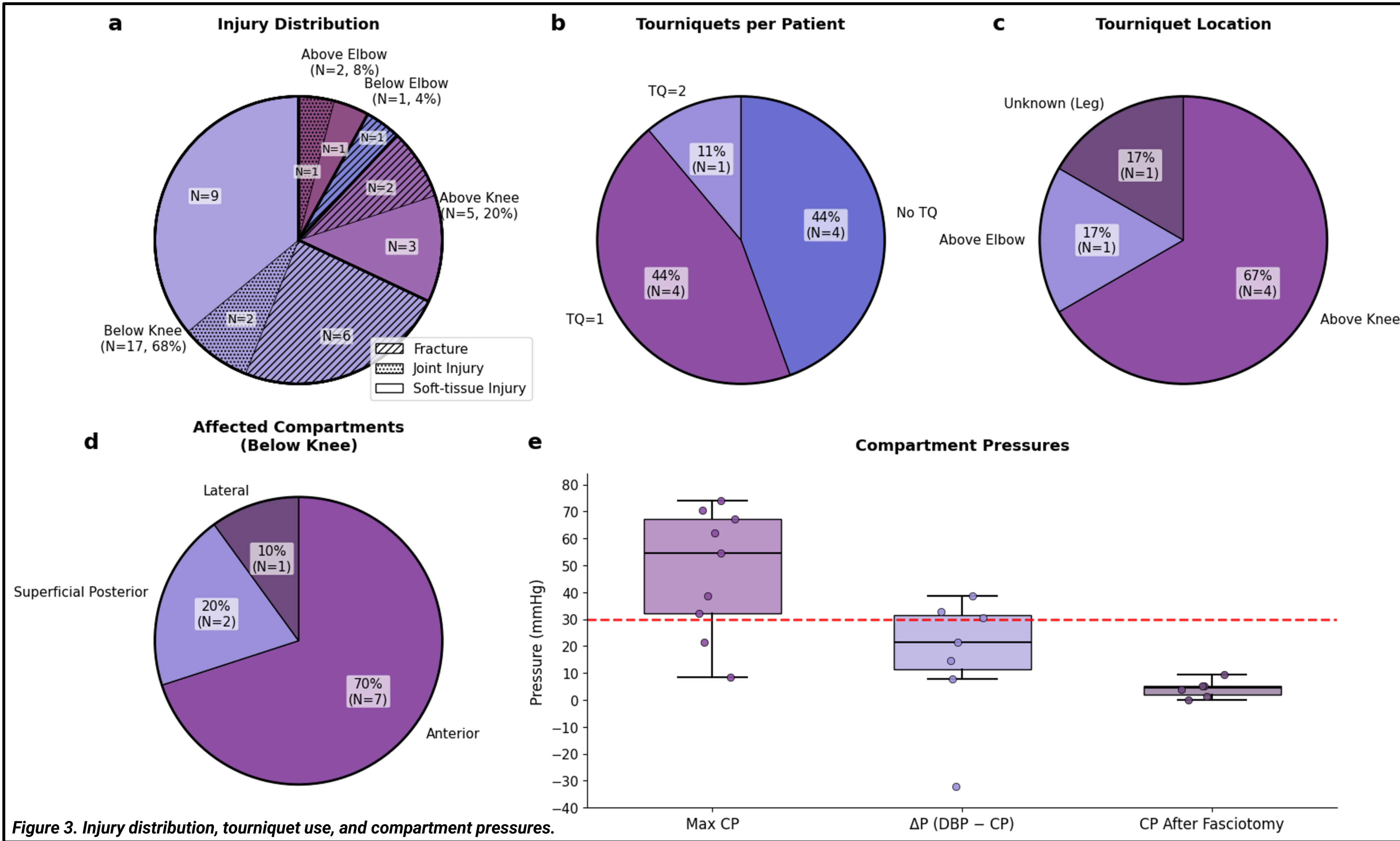


Figure 3. Injury distribution, tourniquet use, and compartment pressures.

Disclaimer

The study was approved by the research and ethics committee of the Heart Institute of the Ministry of Health of Ukraine (HIMHU). Device measurements were collected for observational purposes only and did not guide clinical decisions. Devices were provided by MY01 at no cost.