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Pericardiocentesis, drainage and instilled tranexamic acid: definitive management in a 25-case series of penetrating cardiac tamponade

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ABSTRACT

Objectives: To describe the outcomes of a protocol using ultrasound-guided pericardiocentesis with pericardial drain placement as definitive treatment for penetrating cardiac injury with tamponade in a resource-limited war zone setting, where emergency thoracotomy is often unavailable.
Design: Single-center prospective case series.
Setting: Nasser Medical Complex, a major tertiary trauma center in southern Gaza, over a period of 24 months during active conflict.
Participants: 25 patients (21 male, 4 female), aged 4-65 years, not in cardiac arrest, with traumatic pericardial effusions and hematoma caused by penetrating injury presenting within approximately 3 hours.
Interventions: Ultrasound-guided pericardiocentesis via a large-bore 16 gauge dialysis catheter, aggressive aspiration of fresh blood, instilling 1 gram of intrapericardial tranexamic acid (TXA) and pericardial drain placement for 48 hours with serial echocardiographic monitoring.
Main Outcome Measures: Survival to hospital discharge, need for subsequent thoracotomy and complications.
Results: This study demonstrated a high survival rate of 96%, with 24 out of 25 patients surviving to hospital discharge (the sole non-survivor died from other injuries). The protocol successfully prevented the need for thoracotomy in 100% of cases, establishing it as a definitive treatment. A recurrence rate of 8% was observed, requiring repeat drainage in two patients, while follow-up was maintained for 83% of survivors.
Conclusions: In a warzone setting, a protocol of pericardiocentesis with pericardial drain placement and intrapericardial TXA served as definitive management for selected patients with penetrating cardiac tamponade, resulting in high survival and avoiding the need for thoracotomy. This approach challenges current practice and offers a life-saving alternative in resource-constrained environments.

Introduction

Nasser Medical Complex, a 700-bed tertiary hospital in southern Gaza, has functioned as a primary trauma referral center throughout two years of ongoing conflict. With an average of 200 war-related casualties daily, trauma emergency teams have managed an unprecedented volume of penetrating trauma [1] During 2025, for example, Nasser Hospital received 750 cases of penetrating thoracic trauma with approximately 60 cases of cardiac injury. Penetrating chest trauma can cause life-threatening injuries such as cardiac tamponade, massive hemothorax, tension pneumothorax, and great vessel injury [2].

Established trauma protocols, mandate urgent thoracotomy for penetrating cardiac injuries [3] Pericardiocentesis is utilised as a temporising measure to relieve tamponade when immediate surgical

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intervention is unavailable [4], It is considered useful in hemodynamically unstable patients as a bridge to definitive treatment [4]

Adherence to this protocol during the initial year of the conflict resulted in a mortality rate of approximately 50%, reflecting both injury severity and resource constraints.

A critical shortage of cardiac surgeons (only one was available for the region), inability to provide around the clock surgical cover, along with resource limitations of available emergency cardiac instruments necessitated a paradigm shift. Emergency physicians began performing resuscitative procedures, including ultrasound-guided pericardiocentesis. Initially viewed as a temporary bridge to surgery, this procedure, when performed with a large-bore drain and adjunctive intrapericardial tranexamic acid (TXA), yielded unexpectedly definitive results. This case series reports the outcomes of 25 patients managed with this protocol, demonstrating its potential as a primary treatment strategy in similar low-resource, high-acuity settings.

Patients and Methods

Study design and setting

This prospective case series was conducted at Nasser Medical Complex between May 2024 and June 2025. At the start of this period active conflict had been ongoing for around 7 months and the anecdotal evidence for alternative approaches to cardiac tamponade (driven by necessity) was building.

Participants

Consecutive patients presenting with all three of:

- penetrating chest trauma
- clinical signs of obstructive shock (hypotension, elevated jugular venous pressure, muffled heart sounds) [5]
- echocardiographic confirmation of cardiac tamponade (pericardial effusion >2.5 cm with hematoma)

were included. Bedside ultrasound is considered highly sensitive and specific for pericardial fluid [6]. Patients in whom the attending physician assessed to be pulseless, or demonstrating absent myocardial contractility on ultrasound were triaged directly to emergency thoracotomy and excluded from this series. Those with unsurvivable injuries were also excluded.

Intervention

The intervention was performed by 5 senior doctors in the department, (including the departmental lead) one of whom at least was always present in the resuscitation room through the study period.

A standardised protocol was followed:

1. **Triage:** Bedside echocardiography (eFAST) was performed to confirm tamponade and assess cardiac activity.
2. **Procedure:** Under strict aseptic technique and ultrasound guidance, pericardiocentesis was performed via a subxiphoid approach using a 16-gauge dialysis catheter. Equipment shown in Fig. 1.
3. **Aspiration:** Immediate manual aspiration of fresh blood using a 50ml syringe until haemodynamic improvement was observed.
4. **Adjunctive Therapy:** Instilling of 1 gram (10 ml) of TXA into the pericardial space.
5. **Drain Management:** The catheter was secured as a drain and left in place for 48 hours, with daily echocardiograms to monitor re-accumulation and cardiac performance with help from our cardiac surgeon.

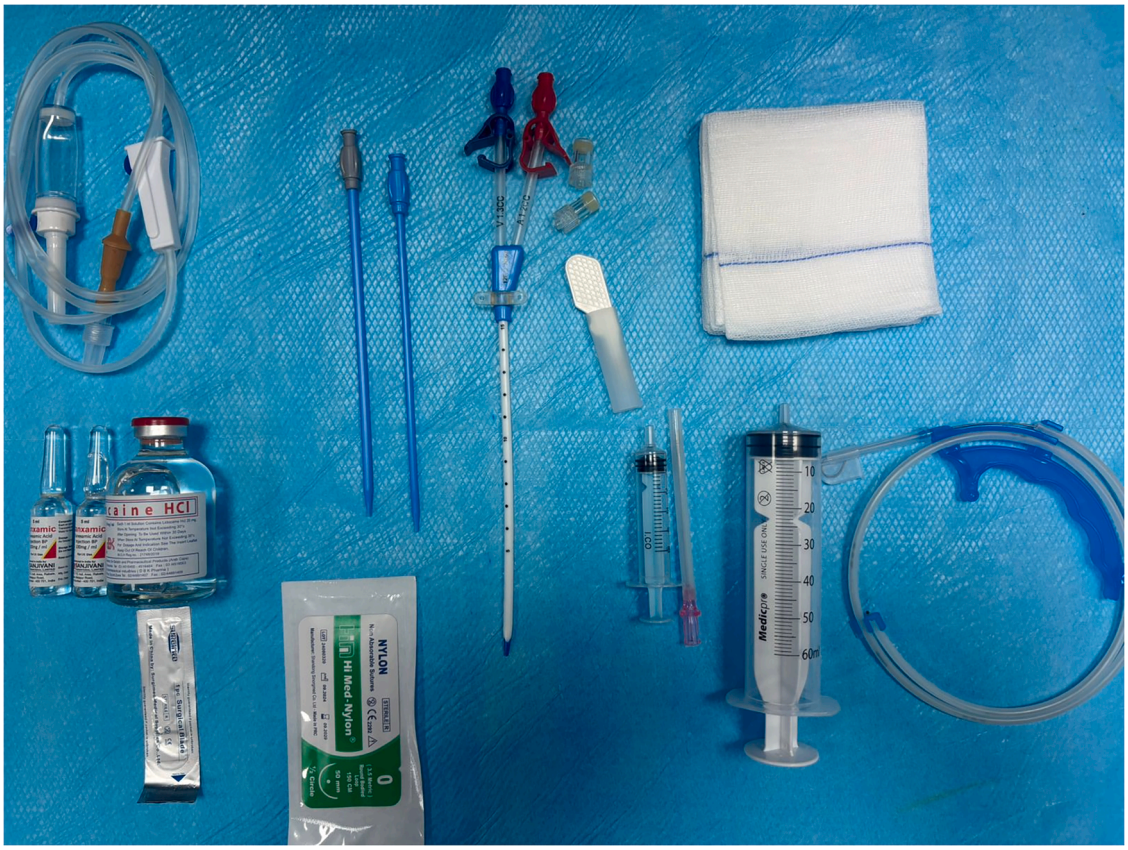

Fig. 1. Equipment used.

Outcomes

Primary outcomes were survival to hospital discharge and the need for subsequent surgical intervention. Secondary outcomes included procedure-related complications and length of hospital stay.

Results

This analysis of 25 patients treated in a Gaza war zone from May 2024 to September 2025 evaluated pericardiocentesis with drain placement for penetrating cardiac injury. The primary outcome, survival to hospital discharge, was 96% (24 of 25 patients), with the sole mortality attributable to a severe concomitant brain injury. Critically, no patient required a subsequent thoracotomy, establishing the procedure as definitive therapy for the cardiac injury. The complication profile was favourable, with no immediate procedural complications. Several patients developed pneumonia or lung atelectasis, related to associated thoracic trauma. Late complications included a recurrence rate of 8% (2 of 25 patients), who required a repeat drainage procedure. Follow-up at three months was achieved for 75% of survivors (18 of 24), with the vast majority showing no effusion and doing well; 6 survivors were lost to follow-up. Details of each case are shown in Table 1.

Discussion

This case series demonstrates that ultrasound-guided pericardiocentesis with pericardial drain placement can serve as definitive treatment for penetrating cardiac tamponade, challenging the long-standing mandate for urgent thoracotomy. In our cohort of 25 selected patients, the protocol resulted in a 96% survival rate without the need for surgery, a stark contrast to the 50% mortality observed with our prior thoracotomy-first approach.

This strategy hinges on two critical factors: stringent patient selection and expert personnel who can perform echocardiography and insert a pericardial drain urgently, ideally within 5 minutes. For patients with preserved cardiac activity, the injury may represent a self-sealing wound in the myocardium mostly in a low-pressure chamber. We consider the success of our protocol is attributable to two reasons. Firstly, effective evacuation of tamponading haemorrhage using a large-bore dialysis catheter, which is superior to conventional medical pericardiocentesis kits, whose small bore prevents adequate evacuation of blood. Secondly, we hypothesise that the haemostatic action of intrapericardial TXA stabilises the clot at the myocardial wound site, effectively forming a natural plug that is contained by the pericardium.

Limitations

The strengths of our study include its prospective consecutive design and standardised protocol in an extremely challenging environment. However, significant limitations must be acknowledged. This is an uncontrolled case series from a single centre, limiting generalisability. The exceptional circumstances of a warzone and the critical role of patient selection mean these results may not be directly applicable to all trauma settings. We were unable to reliably ascertain the time from injury to presentation at our facility where some patients arrive by ambulance, private vehicles or, in some cases, horse and cart. Distances in Gaza are not great, however, and we estimate that the majority of our patients will have arrived at Nasser Hospital within 1 to 3 hours of injury.

We acknowledge that our patterns of penetrating trauma following blast injuries may not mirror those found in other settings. This is especially so, given the delayed nature of most presentations due to transport limitations, this necessitates that any high-pressure chamber injury could not survive to hospital presentation. However, we consider that our initial criteria (obstructive hypotension + pericardial effusion > 2.5 cm) may represent a traumatic physiological state that would respond to our intervention irrespective of initiating injury.

This experience forces a re-evaluation of trauma guidelines, especially for high volume major trauma within resource-constrained environments. It also adds to a growing body of evidence where more conservative approaches to traumatic cardiac injury have been advocated. In South Africa especially, Nicol et al have demonstrated subxiphoid pericardial window (SPW) followed by pericardial drain as an alternative to midline sternotomy in stable patients without active bleeding [7] This approach reduced intensive care bed days which, in resource constrained settings is especially valuable [7] The SPW as described by Nichol and others, takes place in theatre, involves a 5 cm incision with direct visualization of the pericardium, leading to either drain placement or a decision to move to median sternotomy.

With necessity being the mother of invention, our series differs from previous treatment paradigms in the following ways:

- Our subjects were all haemodynamically unstable with fluid demonstrated by ultrasound in the pericardium.
- We utilised a wide-bore pericardial drain in place of the SPW, with pericardial lavage using tranexamic acid.
- The intervention was conducted in the emergency department using tools and skills available to appropriately trained emergency and general surgical personnel

Our findings suggest that for a specific cohort, a percutaneous approach is not a compromise but a superior strategy. The technical specifics—large-bore drainage and intrapericardial TXA—warrant formal investigation in controlled studies. Most penetrating cardiac injuries both in developed or lower resource settings will present to smaller hospitals with longer and potentially fatal travel times to centers of cardiothoracic expertise. We would suggest that our protocol of using e-FAST, large bore drain and TXA may act as stand-alone intervention for patients in whom stabilisation can be achieved. In this sub-set a subset of pericardial injury our minimalised intervention is proved safe, resource-sparing, and led to favourable patient outcomes.

Conclusion

In a conflict setting with limited surgical capacity, a protocol of ultrasound-guided pericardiocentesis with large-bore drain placement and intrapericardial TXA proved to be a definitive and life-saving treatment for penetrating cardiac tamponade in patients with preserved cardiac activity. This approach achieved a high survival rate while avoiding thoracotomy. We recommend that this protocol be considered as a primary intervention in comparable resource-constrained environments and that its key technical components be integrated into future trauma guidelines.

Ethics statement

The study was approved by the Nasser Medical Complex institutional ethics committee June 2024 with a waiver for informed consent for inclusion due to the nature of the emergency care and the conflict situation as well as all cases being anonymised in reporting. This post-dated data collection by a short time however the nature of the ongoing state of emergency due to active war designated this an exceptional circumstance.

CRediT authorship contribution statement

Mohammed Qandil: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Paul Ransom:** Writing – review & editing, Writing – original draft, Validation, Formal analysis, Data curation. **Majdi Abu Shammala:** Writing – review & editing, Project administration, Methodology, Data curation, Conceptualization. **Ahmed Srour:** Writing – review & editing, Project administration, Formal analysis, Data curation. **Moath Khafaja:** Writing –

Table 1
Details of each case of s undergoing supxiphoid 16-gauge pericardial left sided drain placement under echo guidance.

Study number	Age and gender	Mechanism of injury	Echo findings	Mean Arterial Pressure mmHg (MAP) & Ejection Fraction % (EF) pre-procedure	Drain amount	Mean Arterial Pressure (MAP) & Ejection Fraction (EF) post-procedure	Complication(s)	Length of stay prior to discharge (days)	3 month follow-up
1	13yrs Male	Shrapnel	2.5cm effusion with hematoma	MAP 40 EF 30	180ml	MAP 65 EF 60	Pneumonia 5 days post the procedure (related to shrapnel injury to the lung)	8	No effusion/doing well
2	4yrs Male	Shrapnel	2.7cm effusion with hematoma	MAP 30 EF 20	150ml	MAP 65 EF 50	None	4	No effusion/doing well
3	65yrs Male	Shrapnel	3.0cm effusion with hematoma	MAP 42 EF 30	250ml	MAP 55 EF 50	None	3	No effusion/doing well
4	12yrs Male	Shrapnel	3.0cm effusion with hematoma	MAP 35 EF 20	170ml	MAP 65 EF 45	None	7 (underwent laparotomy for abdominal injury)	Lost to follow up
5	14yrs Female	Shrapnel	2.9cm effusion with hematoma	MAP 40 EF 20	180ml	MAP 65 EF 50	None	Not applicable (declared dead because of severe brain injury)	Not applicable
6	8yrs Female	Shrapnel	3.0cm, effusion with hematoma	MAP 30 EF 20	150ml	MAP 65 EF 45	None	3	No effusion/doing well
7	32yrs Male	Shrapnel	3.5cm effusion with hematoma	MAP Unrecordable EF 20	160ml	MAP 65 EF 45	Lung atelectasis	5	No effusion/doing well
8	13yrs Male	Shrapnel	2.5cm effusion with hematoma	MAP 38 EF 30	90ml	MAP 65 EF 50	Fever, tachypnea	6	No effusion/doing well
9	4yrs Male	Shrapnel	2.6Cm effusion with hematoma	MAP 30 EF 25	120ml	MAP 70 EF 60	None	3	No effusion/doing well
10	62yrs Male	Shrapnel	3cm, effusion with hematoma	MAP 40 EF 35	150ml	MAP 75 EF 50	None	4	Lost to follow up
11	12yrs Male	Shrapnel	2.5cm, effusion with hematoma	MAP 45 EF 35	140ml	MAP 60 EF 50	None	7 (underwent laparotomy for abdominal injury)	No effusion/doing well
12	16yrs Female	Shrapnel	2.6cm effusion with hematoma	MAP 40 EF 25	190ml	MAP 65 EF 50	None	4	Lost to follow-up
13	21yrs Male	Shrapnel	3.2cm effusion with hematoma	MAP 35 EF 40	240ml	MAP 70 EF 60	None	7	4 weeks later reaccumulation and pericardiocentesis with drain repeated and patient improvement
14	50yrs Female	Shrapnel	3.8cm effusion with hematoma	MAP 40 EF 35	200ml	MAP 85 EF 60	None	5	No effusion/doing well
15	29yrs Male	Shrapnel	5cm effusion with hematoma	MAP 40 EF 30	400ml	MAP 60 EF 50	None	3	No effusion/doing well
16	35yrs Male	Shrapnel	4.5cm effusion with hematoma	MAP 42 EF 40	450ml	MAP EF 65	None Noted pneumonia	5	No effusion/doing well
17	8yrs Male	Shrapnel	3.5cm effusion with hematoma	MAP 50 EF 35	250ml	MAP 65 EF 60	Drain dislodged after 24 hours Lung atelectasis	4	Reaccumulation of pericardial dark serous fluid, drain repeated at 5 weeks and did well
18	29yrs Male	Shrapnel	6cm effusion with hematoma	MAP 45 EF 35	500ml	MAP 65 EF 60	None	3	Admitted after one week because of pleural effusion, no cardiac complication
19	35yrs Male	Shrapnel	4cm, effusion with hematoma	MAP 50 EF 25	350ml	MAP 60 EF 55	None	3	Lost to follow up
20	12yrs Male	Shrapnel	4cm, effusion with hematoma	MAP 25 EF 35	280ml	MAP 65 EF 50	None	15 (concomitant liver injury,	No effusion/doing well

(*continued on next page*)

Table 1 (*continued*)

Study number	Age and gender	Mechanism of injury	Echo findings	Mean Arterial Pressure mmHg (MAP) & Ejection Fraction % (EF) pre-procedure	Drain amount	Mean Arterial Pressure (MAP) & Ejection Fraction (EF) post-procedure	Complication(s)	Length of stay prior to discharge (days)	3 month follow-up
								treated conservatively)	
21	15yrs Male	Shrapnel	3.4cm effusion with hematoma	MAP 42 EF 45	280ml	MAP 70 EF 60	None	4	Lost to follow up
22	18yrs Female	Shrapnel	3.5cm effusion with hematoma	MAP 55 EF 40	170ml	MAP 60 EF 60	None	3	No effusion/doing well
23	19yrs Male	Shrapnel	3.5cm, effusion with hematoma	MAP 45 EF 30	280ml	MAP 60 EF 50	None	5	No effusion/doing well
24	12yrs Female	Shrapnel	2.5cm effusion with haematoma	MAP 40 EF 45	200ml	MAP 70 EF 60	None	4	Lost to follow up
25	28yrs Male	Gunshot	4.5cm effusion with haematoma	MAP 30 EF 40	350ml	MAP 65 EF 60	None	3	Normal echo 3 months later

review & editing, Project administration, Formal analysis, Data curation. **Noor Alkhateeb:** Writing – review & editing, Project administration, Investigation, Data curation. **Anisa Jabeen Nasir Jafar:** Writing – review & editing, Validation, Formal analysis. **Saher Abughali:** Writing – review & editing, Project administration, Investigation, Data curation.

Declaration of competing interest

none

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