Brief clinical report

Emergency department resuscitative thoracotomy for nontorso injuries

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Background. *Resuscitative thoracotomy performed in the emergency department (EDT) continues to have clear indications in patients sustaining trauma to the torso, particularly penetrating injuries. However, adjunctive use of aortic cross-clamping during EDT for hemorrhagic shock also may be useful in the acute resuscitation of patient with nontorso injuries (NTI). We questioned the utility of EDT in patients with nontorso trauma.*

Methods. *Patients undergoing EDT have been prospectively followed since 1977 at our regional level I trauma center.*

Results. *During the 26-year study period, 959 patients underwent EDT; 27 (3%) of these patients underwent EDT for penetrating NTI. Three (11%) of these patients survived to leave the hospital, with only 1 patient sustaining mild neurologic deficit. The mechanism of injury in the survivors was stab wound to the neck (1), gunshot wound to the neck (1), and extremity vascular injury (1). All survivors of EDT for NTI underwent prehospital cardiopulmonary resuscitation and successful endotracheal intubation in the field. There were no survivors of EDT for penetrating injury to the head.*

Conclusions. *Resuscitative EDT with aortic cross-clamping is a potential adjunct in the acute resuscitation of NTI involving penetrating neck or extremity vascular injuries.*
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The utility of resuscitative thoracotomy performed in the Emergency Department (EDT) is often debated. Although some groups propose EDT is futile care that exposes health care providers to high risks during its performance, others advocate use of this life-saving procedure in selected cases.[1-6] Our most recent review of this topic, spanning over 25 years of experience, argues that EDT should be performed in patients with penetrating torso injuries, regardless of the presence of pulseless electrical activity or the need for prehospital cardiopulmonary resuscitation (CPR), if signs of life were present within 15 minutes of arrival to the emergency department.[7] One adjunct of EDT is aortic cross-clamping, which redistributes limited blood volume in these hypovolemic patients to the upper extremities and head; this procedure enhances aortic diastolic and carotid systolic pressures, which increases perfusion to the brain and myocardium.[8-11] In patients with massive hemorrhage, attributable to either extremity vascular injuries or penetrating neck trauma, hypovolemic shock may provoke pulseless electrical activity before adequate blood volume can be replaced. We questioned if EDT would be of benefit in the acute resuscitation of patients sustaining exsanguinating nontorso injuries. We *hypothesized* that select patients with nontorso injuries are candidates for EDT and would benefit from aortic cross-clamping during initial resuscitation of hemorrhagic shock.

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METHODS

The Rocky Mountain Regional Trauma Center at the Denver Health Medical Center is a state-certified and American College of Surgeons–veri-

Table I. Total number and associated survival rates by mechanism of patients with nontorso-penetrating injuries undergoing emergency department resuscitative thoracotomy

	GSW-N	*SW-N*	*EVI*	*GSW-H*	*Total EDT*
No. of EDT	8	3	7	9	27
Survivors of EDT	1(15%)	1(33%)	1(14%)	0(0%)	3(11%)

EDT, Resuscitative thoracotomy performed in the emergency department; *EVI,* extremity vascular injury; *GSW-H,* gunshot wound to head; *GSW-N,* gunshot wound to the neck; *SW-N,* stab wound to the neck.

fied level I trauma center with pediatric commitment. This medical center also serves as the base hospital for the Denver emergency medical services system, which is a 2-tiered prehospital system of fire department responders certified in basic life support and ground-based, paramedic-staffed ambulances with advanced life support capabilities. Per established protocol, paramedics initiate CPR in any unresponsive patient who do not have a palpable carotid pulse or in patients who lost a pulse en route, but are deemed potentially salvageable. On arrival at the emergency department, initial management of the injured patient is a combined effort of trauma surgeons and emergency medicine physicians; the trauma surgery team performs all postinjury EDTs.

A prospective database of all EDTs performed at Denver Health Medical Center since January 1977 has been maintained by the senior author (E.E.M.).[12,13] Information collected includes mechanism of injury, prehospital and emergency department vital signs, presence of cardiac activity, length of prehospital CPR, and patient outcomes including any neurologic deficits. Base deficit from the initial emergency department arterial blood gas has been recorded prospectively since 1995. Data from this registry were augmented with a specific review of the prehospital paramedic reports for all survivors of EDT. The Colorado Multi-Institutional Review Board approved this study.

RESULTS

During the 26-year study period, 959 patients underwent EDT; 27 (3%) of these patients underwent EDT for nontorso-penetrating injuries (NTI). Mechanisms of injury included gunshot wound to the head (9), gunshot wound to the neck (8), extremity vascular injuries (7), and stab wound to the neck (3). Three (11%) of these patients survived to leave the hospital (Table I); all were men with a mean age of 48.7 ± 11.1 years (range: 31-69 years). Mechanism of injury in the survivors were stab wound to the neck (1), gunshot wound to the neck (1), and extremity vascular injury (1).

The patient with the gunshot wound to the left neck sustained injury to the internal and external carotid arteries, and the internal jugular vein, as well as a fractured mandible. He arrived in the ED with asystole and ongoing CPR; EDT was performed with cross-clamping of the aorta. After volume resuscitation, the patient regained pulses after cardiac compression ×10. He was transported to the operating room where the external carotid artery and jugular vein were ligated, and the internal carotid artery was reconstructed by using a reversed saphenous vein graft. His hospital course was complicated by abdominal compartment syndrome and pneumonia; he was discharged to rehabilitation on postinjury day 41 because of persistent right-sided weakness. At 1 year postinjury, the patient is living independently with his family and ambulating without assistance, with minimal right upper extremity weakness.

The patient sustaining a stab wound to the left neck had multiple bleeding sites in the neck, a spinal cord contusion at the C-2 level, and penetrating injuries of the left cheek and right calf. He suffered cardiac arrest attributable to hemorrhagic shock caused by bleeding from multiple sources. After EDT with aortic occlusion and rapid volume resuscitation, he regained a palpable blood pressure. He had a prolonged course because of paraplegia, respiratory failure, and associated infectious issues; he was discharged on postinjury day 28 without evidence of cerebral ischemia.

The third patient severed his radial artery after putting his arm through a plate glass window. EDT was performed for pulseless arrest, and an aortic cross-clamp was applied. With the use of volume resuscitation and pharmocologic agents, the patient regained a systolic blood pressure above 120. Ligation of the radial artery and closure of the chest was performed in the operating room, with 8 minutes of total aortic clamp time. He was discharged neurologically intact on postinjury day 10. Patient demographic data including length of prehospital CPR and cardiac rate/rhythm at the time of EDT are presented in Table II. Notably, all survivors of EDT for NTI underwent prehospital CPR and successful endotracheal intubation in the field. There were no survivors of EDT for gunshot wounds to the head.

Table II. Patient demographic data for survivors of emergency department thoracotomy for nontorso trauma.

Mechanism-location	*Age (y)*	*CPR (min)*	*Cardiac rate/rhythm*	*Base deficit*	*Neurologic deficit*
SW-N	46	5	80 beats/min	—	None
EVI	69	5	30 beats/min	22	None
GSW-N	31	3	Asystole	23	Mild

CPR, Cardiopulmonary resuscitation; *EVI,* extremity vascular injury; *GSW-N,* gunshot wound to the neck; *SW-N,* stab wound to the neck.

DISCUSSION

On the basis of our experience, EDT for exsanguination attributable to nontruncal injuries can be used to salvage selected patients. In our ongoing experience, we have defined the following indications for EDT in torso trauma: in blunt trauma patients with less than 5 minutes of CPR and in penetrating trauma patients with less than 15 minutes of CPR.[7] Others, however, have excluded nontorso injuries as candidates for such a heroic maneuver, but these 3 cases indicate EDT may be a potentially useful adjunct in the treatment of selected critically injured patients.[3] The specific goal of EDT in patients with cardiac arrest attributable to exsanguination is to restore systemic perfusion; thus, we believe aortic cross-clamping should be done first, followed by cardiac massage. Moreover, in models of inadequate intravascular volume, cardiac compressions fail to augment arterial pressure or provide adequate systemic perfusion.[14]

Overall survival for EDT in nontorso injuries in our series was 11%, with penetrating injuries to the neck having an 18% survival rate and exsanguinating extremity injuries, a 14% survival. All survivors required prehospital CPR, which confirms our prior report that CPR in the field does not indicate futile care.[7] On the basis of these data, we propose that resuscitative emergency thoracotomy with aortic cross-clamping is a potential adjunct in the acute resuscitation of patients sustaining penetrating neck or extremity injuries. We encourage other centers' review of their experience with EDT for such injuries to further clarify the potential role of EDT for penetrating nontorso injuries.

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