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Indication for resuscitative thoracotomy in thoracic injuries—Adherence to the ATLS guidelines. A forensic autopsy based evaluation

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ABSTRACT

Background: The appropriate indications for Resuscitative Thoracotomy (RT) are still debated in the literature and various guidelines have been proposed. This study aimed to evaluate whether Advanced Trauma Life Support (ATLS) guidelines for RT were applied correctly and to evaluate the proportion of deceased patients with potentially reversible thoracic lesions (PRTL).

Methods: The database at the Department of Forensic Medicine at Copenhagen University was queried for autopsy cases with thoracic lesions indicated by the SNOMED autopsy coding system. Patients were included if thoracic lesions were caused by a traumatic event with trauma team activation. Patient cases were blinded for any surgical intervention and evaluated independently by two reviewers for indications or contraindications for RT as determined by the ATLS guidelines. Second, autopsy reports were evaluated for the presence of PRTL.

Results: Sixty-seven patients met the inclusion criteria. Two were excluded due to insufficient data. The overall agreement with guidelines was 86% and 77% for blunt and penetrating trauma, respectively. For patients submitted to RT the overall agreement with guidelines was 63% being 45% and 74% for blunt and penetrating trauma, respectively. For patients who did not undergo RT the agreement with guidelines was 100%. In all cases where RT was performed in agreement between guidelines and the clinical decision the autopsy reports showed PRTL in 16 (84%) patients. In cases of non-agreement PRTL were found in 9 (82%) patients.

Conclusions: Agreement with ATLS guidelines for RT was 63% for intervention and 100% for non-intervention in deceased patients with thoracic trauma. Agreement was higher for penetrating trauma than for blunt trauma. The adherence to guidelines did not improve the ability to predict autopsy findings of PRTL. Although the study has methodical limitations it represents a novel approach to the evaluation of the clinical use of RT guidelines.

Introduction

Over the past decades, Resuscitative Thoracotomy (RT) has developed from being a simple direct haemostatic procedure to include pericardial decompression, open cardiac massage and repair as well as aortic cross-clamping [1–4]. The procedure is potentially lifesaving with long term survival ranging from 10 to 30% for penetrating trauma and 0–2% for blunt trauma [4,5]. Experts agree that the procedure is justified; however, it is debated to which patient categories it should be applied. There is a general agreement that RT is a procedure best reserved for a

Abbreviations: RT, resuscitative thoracotomy; SOL, signs of life; PEA, pulseless electrical activity; TC, trauma center; ATLS, advanced trauma life support; PRTL, potentially reversible thoracic lesions; CPR, cardiopulmonary resuscitation; ISS, injury severity score; DET, Denver emergency thoracotomy.

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patient with documented signs of life (SOL) on arrival to the trauma center (TC) but there is a discrepancy in recommendations for the use of appropriate indications for RT in patients with cardiopulmonary arrest. Some authors argue that RT in patients with cardiopulmonary arrest is a futile and costly procedure exposing healthcare personnel to unnecessary risk while others argue that RT can be indicated even after several minutes of cardiopulmonary arrest [6]. In light of this conflict various indications for the appropriate use of RT are proposed in the literature. The American College of Surgeons-Committee on Trauma has proposed the Advanced Trauma Life Support (ATLS) guidelines with level II recommendations for the application of RT [4,7]. The guidelines state that a patient in cardiopulmonary arrest who has sustained a penetrating wound should be evaluated for any SOL including pulseless electrical activity (PEA) on ECG upon arrival to the TC. If none are present RT is not indicated. For patients with blunt trauma the same conditions apply, however PEA is not considered SOL. Data supporting these guidelines have been largely derived from retrospective survival analyses from various trauma registries, the majority of which not validated for factors predictive of survival after RT. Although the ATLS guidelines are widely used throughout the world it remains unclear to what extent they are applied in the emergency clinical setting.

This study aimed to evaluate whether ATLS guidelines for RT were applied appropriately in a series of patients who died from a traumatic event following thoracic trauma. Furthermore we aimed to evaluate the proportion of deceased patients with potentially reversible injuries.

Methods

The database at the Department of Forensic Medicine, Copenhagen University, Denmark was queried for autopsy cases with thoracic injuries as classified by the SNOMED diagnosis coding system [8] for the period January 2002 to December 2012. Table 1 specifies the diagnoses used for the query. The autopsy reports were reviewed and patients with a substantial thoracic trauma were identified by the following criteria:

Inclusion criteria

- Age > 18.
- Death attributable to physical trauma.
- Autopsy diagnosis indicating a substantial thoracic trauma as defined by Table 1.
- Activation of the trauma team at the level I TC at Rigshospitalet, Copenhagen University Hospital, Denmark.

Exclusion criteria

- Medical chart not available.
- Trauma involving extrathoracic regions with minor thoracic trauma as rib fractures and/or haemothorax less than 300 cm^3 and no other intrathoracic injury as defined by Table 1.

RT was defined as thoracotomy performed in the trauma resuscitation bay. Procedures performed in the operating room were included if the thoracotomy was the next immediate event following the initial resuscitation in the TC. The autopsy report was evaluated for the presence of potentially reversible thoracic lesions (PRTL) defined as any anatomically clearly defined lesion of the lung, heart and vessels potentially available for surgical treatment. Authors SON and PL performed this evaluation in conjunction and in cases of disagreement JR held the deciding vote. Since no validated method exists for characterising traumatic thoracic lesions in terms of reversibility the presence of PRTL does not necessarily indicate that the lesion was surgically salvageable or that the patient would benefit from intervention.

Data were collected from our institutions prospective Trauma Audit Research Network, the Patient Analysis and Tracking System and the patient charts. The following variables were registered: Age, gender, injury mechanism, time of injury or first contact to the emergency medical system if the incident of trauma was unwitnessed. Furthermore, time and vital signs (blood pressure, respiratory rate, Glasgow Coma Score, and heart frequency/pulse) on arrival to the TC were registered. Injury severity score (ISS) was calculated according to the Abbreviated Injury Scale (American Association for Automotive Medicine, Des Plaines, IL 2008). Patient case presentations were prepared for assessment in regard to mechanism of injury, time from scene to TC and physiological parameters on arrival to the TC. Case presentations were blinded with respect to whether or not RT was actually performed in the present case. Two independent reviewers, both board certified cardio-thoracic surgeons and certified ATLS instructors, evaluated the blinded case presentations. Using the guidelines outlined in Table 2, reviewers were asked to evaluate whether RT was indicated or contraindicated. The reviewers noted for each patient the indication or contraindication for RT. If RT was not indicated the reviewers were asked whether, in a clinical setting, they would you have performed an RT despite the lack of indications using the

Table 1
SNOMED diagnoses based on autopsy findings. The list was used for the initial query of the database to identify patients dead following a thoracic trauma.

Description	Topography code
Lesion of the venae cava	T48600
Lesion of the oesophageal vein	T48670
Lesion of the oesophagus	T62000
Fracture of the sternum	T10310
Fractura of a thoracic vertebrae	T10600
Lesion of the diaphragm	TY2400
Lesion of the mediastinum	TY2300
Lesion of the thoracic region	TY2100
Lesion of the aorta	T42000
Lesion of the coronary artery	T43000
Lesion of the pulmonary artery	T44000
Lesion of the pleura	T29000
Pneumothorax	TY2200
Pulmonary contusion	T28000
Pulmonary haemorrhage	T28000
Pulmonary lesion	T28000
Lesion of the respiratory tract	T25000
Haemothorax	TY2200
Lesion of the heart	T32000
Lesion of the pericardium	T31000
Haemopericardium	T3X200

Table 2
ATLS guidelines for resuscitative thoracotomy [7].

Indications
- Evacuation of pericardial blood causing tamponade
- Direct control of exsanguinating intrathoracic hemorrhage
- Open cardiac massage
- Cross-clamping of the descending aorta to slow blood loss below the diaphragm and increase perfusion to the brain and heart

Contraindications
- No SOL on arrival*
- Severe traumatic brain injury
- Most likely extra thoracic cause for circulatory collapse

* Signs of life (SOL) were defined as one of the following: Spontaneous ventilation, presence of carotid pulse, measurable or palpable blood pressure, extremity movement and cardiac electrical activity on ECG. For penetrating trauma pulseless electrical activity was considered SOL, for blunt trauma it was not.